

99 Ways to Die



And How to
Avoid Them

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For my mother, Kathleen Marie Alker. This was the hardest part of the book to write because you were everything.

THE BIRTH OF 99 WAYS TO DIE

In the beginning, there was evolution. If I've lost you already, this might not be the book you want, but it is the book you need.

In the 1830s, Charles Darwin boarded a ship named after a hunting dog to find special birds in the Galapagos Islands. The ship was the HMS *Beagle*, and the birds were finches, a very diverse feathered family that changed everything, and absolutely nothing.

Darwin proposed that over generations the finches' beaks had evolved their form based on the birds' diets. For instance, the shape and size of the beak evolved to accommodate the seeds the birds needed to crack open to eat. This generational change took place because the birds with the most successful nut-breaking beaks could support more offspring and pass on their genetic material, beaks included. It was miraculous how environmental pressure and time shaped a species. This evolutionary process was named *natural selection*.

Two hundred years later, it can be argued that human development has evaded traditional evolution. Natural selection requires the unsuccessful to die off, specifically without having offspring. Humanity has decided against this policy, which is how I got my job.

I am a board-certified death escapist. As an emergency medicine doctor, I confront death daily. Every time evolution rears its ugly head in the form of a table saw without a safety stop or a loaded gun stored in a front pocket, emergency medicine fights back. But I am also an educator, passionate about public health and preventative care, so, even though it's bad for business, I wrote a book to prevent emergency department visits.

99 Ways to Die is an exploration of and map to avoiding the ninety-nine most terrifying, interesting, and unfortunate ways to die, ranging from everyday household poisons to regrettable sex. While this book is not medical advice, it will be more enlightening than a Google search that incorrectly diagnoses all symptoms as cancer.

I wrote this book for the same reason I became a doctor: my mother.

Shortly after my birth, my mother was diagnosed with lymphoma, a type of cancer that science fights with valor and often victory today, but that was then a death sentence. My mother was told she had six months to live. Nonetheless, she persisted. She miraculously won the war against her lymphoma, but the battle scars left her with a lifetime of side effects from cancer treatments. She would go on to have two open-heart surgeries, a brain tumor, autoimmune hepatitis, and pulmonary hypertension, all before the age of fifty.

My family is distinctly nonmedical. There isn't a nurse, paramedic, scientist, or doctor on any limb of the family tree. We are a family of business professionals—and one circus performer.

We had difficulties understanding what was happening when my mom was sick. A doctor would speak in incomprehensible medical jargon, and then we would pass the nonsensical message down like a game of telephone.

In high school, I decided to branch out from the family tree. I could do science. How hard could it be? Fast-forward through thirteen years of college, graduate school, medical school, and residency: It was hard.

In college, I majored in molecular, cellular, and developmental biology. It checked all the boxes. By my second year of college, I found out what a “premed” student was and decided to cannonball into this hypercompetitive pool. I fell in love with the dream of a fulfilling career in medicine helping people, but also with the idea of acting as a medical translator and advocating for my family. At this point, my mother was preparing for her first open-heart surgery, which was a success.

Several years later, I attended graduate school in public health at Harvard's International Institute in Cyprus, then returned home just before my mother was diagnosed with a brain tumor. I became her caregiver, counting her pills and attending her doctors' appointments. Fortunately, my biology and public health degrees were already helping me translate the language of medicine.

Around the time my mother recovered from her Gamma Knife brain surgery, I was accepted into medical school at George Washington University in Washington, DC. It was one of the best days of my life. The price tag was wild, but I loved medical school and being surrounded by people passionate about science. I graduated and *matched* to my first-choice

emergency medicine residency program at the University of California, San Diego, and even gave our class graduation speech. But my mother never saw me graduate.

In my last year of medical school, she died. She was my purpose and my best friend. To overcome overwhelming loss, I needed a new purpose. I began medical residency at home in California, and I soon found others needed a medical translator. I started helping friends, patients, and strangers. I gave a TEDx Talk on understanding dying, worked as a healthcare consultant for a member of the US Congress, wrote medical stories for national newspapers, and started working as a medical advisor for television and film.

My love for translating the intricacies of science and medicine into stories eventually brought me to write this book about terrifying ways you can be killed. For most, this book will be an entertaining insight into a new world, but if I do my job well, it might just save your life.

INFECTIONS

BACTERIAL INFECTIONS

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Strep Throat

Flesh-Eating Disease (Necrotizing Fasciitis)

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BACTERIAL INFECTIONS

LEPROSY

You've heard of leprosy, but what is it? This is one of those forgotten questions, like why do seashells sound like the ocean? What does "O.K." stand for? And why do men have nipples? Accounts of leprosy have been recorded in religious texts and modern literature and recently served as the inspiration for the fictitious disease grayscale in *Game of Thrones*, but what is leprosy?

Leprosy is an ancient disease that is still present in 120 countries, with 200,000 new cases a year, including approximately 150 annual cases in the United States. This disease dates back to when humans learned to draw on rocks. Osteo-archaeological remains in India have dated leprosy to 2000 BC, but the disease is traceable to the Upper Paleolithic period.

During the Middle Ages, there was a decline in leprosy due to other diseases killing everyone—enter the Black Death. In the centuries that followed, leprosy's much more promiscuous cousin *Mycobacterium tuberculosis* became widespread, causing tuberculosis but creating cross-immunity to leprosy.

Leprosy, also known as Hansen's disease, is caused by the slow-growing *Mycobacterium leprae* bacteria infecting skin, nerves, eyes, and the mucosal tissue of the nose and airway. The bacteria live inside certain types of blood and nervous system cells and can incubate inside a cell for up to twenty years—basically a sleeper cell. Early symptoms of leprosy include patches of skin that are lighter in color. This can unfortunately be confused with the symptoms of the benign and common tinea versicolor, an easily treatable fungal infection.

Left untreated, chronic leprosy will cause deterioration of nerves, which in turn causes paralysis and injuries to insensate limbs. The body may reabsorb fingers and toes that are no longer in use; skin infection causes discoloration and ulceration; abrasions on the eyes lead to blindness; and mucosal infection leads to the collapse of the nasal bridge, causing the

associated saddle-nose deformity. Death is most often not a direct result of leprosy but might come as a result of complications such as skin infection, respiratory problems, and suicide.

This disfiguring disease was once believed to be highly contagious, and that belief led to the ostracization of those with leprosy, referred to as lepers. As the disease is slow to progress, infected individuals lived long lives, so leper colonies formed.

Leper colonies became fully functional and autonomous societies out of necessity. In Hawaii, the Kalaupapa peninsula was founded as a leper colony in 1866 when nine men and three women were dropped off and told to “figure it out.” Those sent to leper colonies underwent permanent traumatic separation from their loved ones. Forced to start new lives in isolation, colonies chose to build their own societies. In Ilha Grande, Brazil, leper colony coins were created as a form of internal currency. Prior to his violent revolutionary years, Ernesto “Che” Guevara gave an account of one of these microcosms in his memoir, *The Motorcycle Diaries*, after he swam across the Amazon River to deliver medical care to a leper colony in San Pablo de Loreto, Peru.

The crazy thing is, we still don’t understand the transmission of leprosy. It is believed to spread in respiratory droplets with coughing or sneezing, but science isn’t sure. What we do know is that leprosy is not very contagious, is not transmitted through casual contact, and can also be found in a few animals, such as the armadillo and the Eurasian red squirrel. Prolonged, close contact with someone infected seems to transmit the disease, or getting handsy with an armadillo.

It was once thought that leprosy was genetic. It’s not, but there are certain genetic predispositions that allow for the disease to flourish in certain people. According to the Centers for Disease Control and Prevention (CDC), 95 percent of people can fight off the bacteria with natural immunity, leaving only 5 percent susceptible to leprosy infection.

In the 1920s, a resident unit opened for leprosy patients in Carville, Louisiana. The facility became known as Carville, and by 1940, physicians there had discovered that sulfone antibiotics, such as dapsone, treat leprosy. Today leprosy is curable with a multidrug regimen that still includes dapsone.

Even after the cure was found, leprosy remained a socially stigmatized disease. Today there are more than seven hundred informal leper colonies in

India. In Hawaii, separation laws were abolished in 1969, but many formerly exiled to the leper colony of the Kalaupapa peninsula chose to stay for the remainder of their lives in the community they had built.

In 2022, leprosy attempted to make a comeback in the US, concentrated in central Florida. Don't freak out, Florida only reported twenty-seven human cases. The source of the comeback looks to be a mammal, but not the one you're thinking. A *New England Journal of Medicine* study found leprosy bacteria in up to 20 percent of US southern armadillos.

If you have a persistent rash, see a dermatologist to rule out leprosy with a skin biopsy. Just keep in mind leprosy is exceedingly rare—unless you're an armadillo enthusiast in central Florida with a genetic predisposition, then the rash might be leprosy.

STREP THROAT

Strep throat is caused by group A streptococcus infecting the throat and tonsils. Symptoms of strep throat include sore throat, fever, pus on the tonsils, and swollen neck lymph nodes. There is usually no cough associated with strep throat. These symptoms require evaluation at an urgent care or primary care office, and diagnosis can be done through symptoms, or via a throat swab.

Group A strep is a bacterium killed by plain old penicillin, although there are other antibiotics that are commonly used. While antibiotics may help with strep throat symptoms, this is not the primary reason that we give them. Most healthy people will likely recover from strep throat without incident, but the complications of untreated strep throat can kill you in the following ways:

1. Peritonsillar abscess

If left untreated, strep throat can cause an abscess next to the tonsil that requires needle drainage. In severe cases, the abscess can progress to worsening neck infection and throat closure, but this is rare.

2. Rheumatic fever

A prolonged group A strep infection can elicit an autoimmune response causing rheumatic fever, a disease that attacks the body, causing myocarditis (heart inflammation), arthritis, rash, skin nodules, and a body shaking called Sydenham chorea. This disease

can cause long-term effects, such as rheumatic heart disease, the need for a heart transplant, and even death. In the 1920s, rheumatic fever and heart disease were a leading cause of death in children, but since the advent of antibiotic treatment, the disease has become rare in the US, though it is unfortunately still prevalent abroad. A study published in the *New England Journal of Medicine* of rheumatic heart disease in India estimated more than a hundred thousand deaths in 2015 alone.

3. Post-streptococcal glomerulonephritis (PSGN)

While trying to fight strep throat, the body creates clumps of antibodies and bacteria that get stuck in the kidneys, causing the body to attack itself. More common in children, PSGN symptoms begin with blood in urine and swelling all over the body. The kidneys then go into failure, but most people will recover, only rarely requiring dialysis or kidney transplant.

4. Scarlet fever

Historically, scarlet fever has been a problem. For instance, in the little town of Fredericksburg, Virginia, the 1861 scarlet fever epidemic rapidly took the lives of thirty-eight children. Scarlet fever is basically strep throat plus an unappealing, sandpaper-feeling rash, but it can lead to invasive disease.

I bet you had no idea that strep throat was such a problem. I didn't either until I went to medical school and they scared the crap out of me.

If you're diagnosed with strep throat, finish all prescribed antibiotics, even if you are feeling better. If you have a reaction to the antibiotics, contact a provider to get a different antibiotic and complete the full course of the new antibiotic as prescribed.

Strep throat is spread through droplets of saliva. These can be sneezed, coughed, hacked, or hocked in your direction, and can also sit on surfaces. To infect you, it needs to get in your nose or mouth. So wash your hands, don't share drinks with strangers, and if you're in your twenties, use dating websites with caution.

If your child is diagnosed with strep throat, alert the school or daycare. You know that's where they got it in the first place. The CDC recommends that children be on antibiotics for at least twenty-four hours without fever before returning to a group setting like daycare. The same quarantine instructions apply to adults, but most people ask for a week off.

FLESH-EATING DISEASE (NECROTIZING FASCIITIS)

If this title didn't catch your eye, you're too hard to impress. Not much is as terrifying as a rapidly spreading bacteria that liquefies flesh into zombie goop.

The bacteria that cause necrotizing fasciitis rapidly eat away at the tissue in a process called liquefactive necrosis, turning flesh into a gray soup. The symptoms begin as a normal skin infection, but the redness, pain, fever, and sometimes blisters on the skin then progress rapidly.

Hippocrates described the disease in his writings, although he was really at a loss for what to do about it. He basically wrote: *This thing spreads quickly and can kill you. Try not to get it.* Decent advice.

The next discoverer was the French Renaissance surgeon Ambroise Paré. Paré was a barber-surgeon. A barber-surgeon is a terrifying conjunction that is exactly what it sounds like. From the last days of the Dark Ages to the advent of the medical malpractice lawyer, surgery was performed not by physicians but by barbers. They already had razors and steady hands, so after a short deliberation and some sharpening, barbers were nominated as surgeons. They were often called upon to amputate limbs, and Paré, after doing so, described pus below the skin that spread to healthy tissue, likely necrotizing fasciitis.

During the Civil War, a Confederate army surgeon described a flesh-eating disease that killed almost half of those infected. The disease was known as hospital gangrene—again, likely necrotizing fasciitis.

Finally, in 1884, Dr. Jean Alfred Fournier, a French physician with a passion for venereal diseases, described a flesh-eating disease of the scrotum, a type of necrotizing fasciitis he named after himself: Fournier's gangrene. I would have named it Jessica's gangrene after my seventh-grade bully, but there's a lot of ego in medicine and sometimes you just want to be remembered for the little dangly bits of humanity you saved.

Necrotizing fasciitis is caused by a bacterial infection. The most common single bacterial species to cause necrotizing fasciitis is group A strep, *Streptococcus pyogenes*. These are the same bacteria that cause strep throat. Before you freak out, necrotizing fasciitis is mostly a result of the location of the bacteria at a specific tissue level called the fascia. Think of it like the location of a bee sting. If you get stung on the little toe, it is no big deal, but if you get stung on the tongue, there could be trouble.

Vibrio vulnificus is not a Hogwarts spell but a saltwater bacterium that can also cause necrotizing fasciitis. If you get cut in the ocean or brackish water, wash the cut out thoroughly and seek medical care. If needed, you will be placed on antibiotics to prevent infection. Flesh-eating bacterial infections can also be polymicrobial, meaning many different types of bacteria together cause the infection, so rest assured there are a multitude of bacteria that could attack.

Those with increased risk for necrotizing fasciitis include IV drug users as well as those with compromised immune systems due to cancer, steroid use, liver cirrhosis, and diabetes. The necrotizing infection often begins with trauma, allowing the bacteria to enter the skin. This could be a cut, bump, or bruise. The bacteria travel down the planes of the skin to the fascia, a layer of connective tissue that overlays the muscle. The bacteria then use the fascia as an express highway to the rest of the body. The fascia is basically the bacterial autobahn—no speed limit.

Necrotizing fasciitis can begin as a simple skin infection, with redness, pain, and swelling of the skin. A major difference is the rate of infection spread. While a normal skin infection, known as cellulitis, will remain local for days, the redness, pain, and swelling caused by necrotizing fasciitis can consume an entire leg in a matter of hours. The infection often starts in an extremity and sometimes creates blood-filled blisters and a crunchiness under the skin caused by gas-forming bacteria. These patients likely have high fevers, nausea, vomiting, low blood pressure, and abnormal lab values. Death in this disease is due to overwhelming infection and sepsis causing organ failure.^{*} Mortality rates from the disease are widely variable, quoted at 20 to 80 percent, with most patients dying in less than fourteen days.

To survive necrotizing fasciitis, the patient must be diagnosed early and taken to the operating room immediately.

To survive necrotizing fasciitis, the patient must be diagnosed early and taken to the operating room immediately. Big-gun antibiotics are given, but the bacteria spread so rapidly that the definitive treatment requires surgery. If you can cut it out or cut it off before it spreads too far, you'll make it.

The disease is apparently rare in the United States, around 0.4 in 100,000 people, but it seems I see it several times a year in the emergency department (ED). Because it was a disease that I encountered early in my

residency training, it may have created an enhanced awareness of the disease, referred to in psychology as the Baader-Meinhof phenomenon, where an illusion of frequency is created. For example, if you buy a car, you then start seeing your car's model everywhere. The cars were always there, but you now notice them, so it seems like they are present more frequently.

To avoid necrotizing fasciitis, always wash out wounds, especially if exposed to salt water or brackish water. If you have signs of an infection, seek medical care, especially if the redness is spreading quickly. Be particularly mindful if you are immunocompromised or have diabetes. Perhaps the Baader-Meinhof phenomenon will be helpful in this case, as prevention of mortality and morbidity in this disease centers on early identification to facilitate early intervention.

TUBERCULOSIS

When a patient comes into my emergency department coughing up blood, TB is not the most common diagnosis. You're wondering, what is? But I must keep some secrets, or you'll stop needing me to solve your medical mysteries. We become concerned about TB if a chest X-ray shows pneumonia that infects the tops of the lungs, or if a patient says, "I have TB."

These patients will then be placed in a special negative-pressure room. This is because TB is airborne, and we do not want it to tour the ED. To avoid infection, medical professionals will wear an N-95 mask, which you may know of from its starring role in the recent pandemic.

Given humanity's long history with the bacterium, TB has managed to get copiously cast in modern-day culture, and as the great John Green writes, *Everything Is Tuberculosis*. Victor Hugo's *Hunchback of Notre Dame*'s hunch was likely caused by a form of TB called Pott's disease, and when Fantine dies from "consumption" in *Les Misérables*, it is due to TB. TB is featured prominently in Puccini's opera *La Bohème*. Claude Monet painted *Camille sur son lit de mort*, a painting of his wife on her deathbed, perishing from TB. Van Morrison might have been inspired by the abundance of bedcovers in the painting in writing the song "T.B. Sheets." In the cinematic masterpiece *Fight Club*, TB appears in a walk-on role, as Marla and Jack split up support groups to crash so they'll no longer run into each other:

JACK:

We'll split up the week. You can have lymphoma, tuberculosis, and—

MARLA:

No, you take tuberculosis. My smoking doesn't go over well.

JACK:

I think testicular cancer should be no contest.

MARLA:

You have your balls, don't you? Technically, I have more of a right to be there than you.

JACK:

You're kidding.

MARLA:

I don't know ... am I?

Unfortunately, some titans succumbed to TB. Eleanor Roosevelt was the longest serving First Lady of the United States, also known as “the First Lady of the World” for her international human rights work. As a progressive, she was an ardent civil rights advocate and businesswoman. She even kept her last name after marrying, but that may have been because her last name was already Roosevelt, being that she was Teddy Roosevelt's niece. Eleanor Roosevelt suffered from aplastic anemia, a disease where the bone marrow stops making blood cells. Her aplastic anemia was treated with steroids, which suppressed her immune system, allowing tuberculosis hiding in her body to reactivate and kill her.

TB is a bacterium that floats through the air, is breathed in, and infects the lungs. What starts out as a lung infection can turn into an infection in the spine, kidneys, or brain. Initial TB symptoms last three weeks and include fever, body aches, night sweats, and cough with bloody sputum. At this point, the bacteria may enter a stage of latency, living silently in the body for decades. If the immune system becomes depressed, TB can reactivate, causing a new lung infection or infections elsewhere in the body. For instance, Quasimodo's TB spread to his spine. In another manifestation of TB, disseminated TB, the bacteria infect the blood. This is most often seen with severe immune system suppression, such as AIDS.

The biggest problem with TB is that it is easy to catch and hard to cure. People in the initial stage of TB are infectious. During latency, TB patients are asymptomatic and do not spread the infection, but the disease can reactivate in the lungs at any time, again causing the patient to become symptomatic and infectious. According to the CDC, patients with TB in parts of the body other than the lungs are usually not contagious.

Curing TB takes dedication, and we are talking about up to nine months of four different antibiotics. These are not ordinary antibiotics; rifampin makes you cry tears of blood (well, it's not actual blood, but your tears turn blood red), and ethambutol makes your vision turn blue. Another issue is that TB is a quick study, so the bacteria become resistant to antibiotics rapidly, which creates multidrug-resistant TB. This adds to the complexity of treatment. The TB vaccine, known as the BCG vaccine, was made from the *Mycobacterium bovis* bacteria related to both TB and leprosy, and has some effectiveness against both diseases.

The TB vaccine is not common in the US, but internationally you will see individuals with a small circular scar on their arm from this vaccination, similar to the smallpox vaccine scar. Unfortunately, the BCG vaccine only reduces the risk of contracting TB by half, which is unimpressive when compared to other vaccines, such as the 91 percent risk reduction for people fully vaccinated for COVID-19.

TB is the thirteenth leading cause of death in the world. The World Health Organization estimates that a quarter of the world's population will be infected with TB during their lifetime, but only 10 percent of those infected will have symptoms, which works out to about ten million people falling ill a year from TB and two million annual TB deaths globally. Until recently, tuberculosis was the deadliest infectious disease in the world, but it was knocked off the top spot by a virus, COVID-19. COVID-19 "coulda been a contenda," but the rapid success of the vaccine shut the virus down, so TB took back the top spot.

In the United States, there are an estimated thirteen million cases of latent TB, with only around eight thousand active cases reported each year. But floating in the Pacific Ocean somewhere between Hawaii and Australia are a group of islands with a TB incidence rate thirty-five times higher than any US state's. The islands were the unfortunate location of the United States' first hydrogen bomb test, but these days they are known for being the first to instate a cryptocurrency as a legal tender: the previous US territory known as the Marshall Islands. One of the Marshall Islands, Ebeye, is only a mile wide and more densely populated than Manhattan, thus overcrowding and lack of health resources have led to tuberculosis being a leading cause of death on the islands.

When traveling, educate yourself on which countries have higher rates of TB and be mindful of people with symptoms. Tuberculosis prevention

includes good hygiene, like covering the mouth when coughing, and handwashing. The bacteria are unfortunately airborne, so an N-95 is needed for adequate protection during exposure. UV light apparently kills TB, but I don't know what you're going to do with that information. Keep in mind that you are at an increased risk for the disease if you have a suppressed immune system, such as HIV/AIDS. If you are exposed to TB or have symptoms, there are blood and skin tests for the disease. Tuberculosis is treatable for those fortunate enough to have resources.

The best hope we have for defeating TB is a highly effective vaccine. As of March 2024, a new tuberculosis vaccine entered stage III clinical trials, funded by over \$500 million from Wellcome and the Gates Foundation, bringing hope for a future free of TB.

BOTULISM

I have a reputation for attracting certain types of patients. In medicine, this phenomenon is called a *cloud* effect. You can be a “white cloud,” meaning your shifts tend to be less hectic, or you can be a “black cloud,” which is a nice way of saying you are a shit magnet.

I am a black cloud, specifically for pediatric patients. It is almost as if sick children are waiting outside the emergency department for me to come on shift. It got so bad that the medical scribes, students who scribe physicians' notes, would make helicopter sounds when I came on shift. Because I work in a general ED, I must call a helicopter to fly stabilized critically ill children to pediatric hospitals. What started as a trend became a measurable phenomenon, to the point that colleagues are worried about switching shifts with me since sick kids inevitably come in.

If you're a child with a rare genetic condition and are uncontrollably seizing, you somehow find me. If you had a heart transplant this year and are under the age of ten, I'm your gal. If you are a five-year-old uncontrollably bleeding from your throat, losing consciousness, and requiring a massive blood transfusion, you know where I am. All these kids survived, but I now have night terrors.

Every other adult medical specialty is allowed to say, “No, I don't treat pediatric patients,” and defer to a pediatric specialist, who is more highly trained. Not emergency medicine. In emergency medicine, we treat anything that walks through the door—delightful.

Here's the worst part: I am not a kid person. I understand that sounds bad but let me explain. I was unsure of kids to begin with—they are shift, and their hands are sticky—but then sick kids began to target me, and I don't appreciate it. If you have ever tried to put tap dancing shoes on a rabid raccoon, you know what it's like to try to get oxygen on a two-year-old.

In cities, pediatric patients get funneled to pediatric hospitals, where everything is tiny, and all doctors are specifically pediatric trained. Outside of cities, there are no pediatric hospitals, so children swarm the general emergency department like an unorganized Spartan army, trailed by their parental helot squires. Most of the kids have colds and need Tylenol, but some of them are trying to die.

One of the most important things to realize about children is that they are not tiny adults. The physiology, pathologies, and presentation of diseases in children differ from adults. What that means is that when you get strep throat, you have a sore throat, but when a kid gets strep throat, they have stomach pain and are vomiting everywhere. Adults get pneumonia from COVID-19, kids get sniffles and then a weird inflammatory disease. The common causes of diseases, treatments, and proper medication doses are completely different in children. They have little hummingbird hearts and don't even breathe the same. Kids are exotic creatures. I imagine veterinarians feeling similarly vexed when they spend a career treating dogs and cats and then someone brings in a gecko with a fever.

Because kids are physiologically unique, they have unique vulnerabilities. If you don't have kids or aren't in the medical field, it may surprise you that infants should not drink water. That's right, water, the elixir of life.

Another weird thing that babies cannot have is raw honey.

I'm hoping someone is handing out pamphlets to new parents in the delivery ward that explain all this. I try not to deliver babies, but when I am forced to, it's an emergency, and I don't have time to whisper in the mom's ear, "Don't give your baby water or honey."

Honey can contain *C. botulinum* spores, causing infantile botulism. *C. botulinum* spores are the seedlike protective structures that contain botulism bacteria, and those bacteria produce botulism toxin that then circulates in the blood, binds to nerves, and causes paralysis. Adults have very acidic stomachs that do not allow the *C. botulinum* spores to hatch and release

bacteria, but children under the age of one have less stomach acidity, so the spores can release botulism bacteria. Babies' botulism symptoms include weak cry, droopy eyes, and difficulty breathing. These are floppy babies with poor muscle tone. Any baby with these symptoms will need an ambulance to the nearest emergency department for treatment with antitoxin and breathing support.

Another weird thing that babies cannot have is raw honey.

Contracting botulism as an adult is, of course, very different. Children are exotic creatures, and you are a labradoodle.

When adults get foodborne botulism it's often from eating preformed botulism toxin, not the *C. botulinum* spores. Foodborne botulism occurs when the *C. botulinum* bacteria contaminate stored food, commonly home-canned or home-jarred foods stored over long periods. During this storage time, the spores germinate, releasing bacteria that make botulism toxin, which, when ingested, causes paralysis. Low storage temperatures, high acidity, and salt all help prevent the botulism bacteria from growing. Although *C. botulinum* spores are heat-resistant, boiling food to a temperature greater than 185°F (85°C) for more than five minutes kills the toxin.

Approximately 110 cases of botulism are reported in the US annually, with 70 percent being infantile botulism. Most doctors will never see botulism, but anytime I come on shift the black clouds roll in.

There are two patient complaints no emergency doctor likes to see: dizziness and weakness. This is because the patient is either having a severe life-threatening emergency or there is no emergency. For instance, dizziness can be a stroke, or you stood up too fast. These are difficult complaints, as they are also symptoms of being alive, which makes it harder to identify the patients who are trying to die.

One night, an undomiciled woman came into the emergency department for weakness. The surrounding community had one of the largest populations experiencing homelessness in the US, and my ED was the primary source of medical care for this population. Many of my patients came in for medical complaints, but their true emergency was their need for social resources like food, water, and shelter. It is easy to become jaded by

this misrepresentation, making it challenging to stay vigilant for acute medical pathologies.

I don't know if I'm vigilant or lucky, but I sat with my patient talking for some time about her weakness, which is hard to do in a busy ED. Her weakness had odd qualities, like it was mostly her upper body, and I noticed her eyelids drooping—possibly because she was exhausted from being on the streets, but droopy eyes aren't something you ignore in emergency medicine. I was most concerned about two pathologies, one of which was the Miller-Fisher variant of Guillain-Barré syndrome; the other was later confirmed by one of the best toxicologists in the country. The patient had botulism associated with a wound.

Wound botulism is exceedingly rare, but more common in IV drug users. The wound becomes infected with *C. botulinum* bacteria, which then produces the toxin resulting in paralysis. This diagnosis is rare and easy to miss. This was one of my proudest medical moments; the patient did well, and the toxicology department liked me, which is always a win.

The symptoms of adult botulism are strange because the toxin has a unique way of attacking the neurological system. Most neurological diseases attack either the central nervous system (the brain and spinal cord) or the peripheral nervous system (the nerves that connect the rest of the body to the brain and spinal cord). Botulism attacks both.

Initial symptoms of toxin ingestion are nausea, vomiting, and diarrhea, and the throat may become dry and painful. Within seventy-two hours a descending paralysis ensues, starting at the head and moving down the body. Manifestations of the toxin attacking the brain cause seemingly unrelated odd symptoms like droopy eyes and inability to urinate. The body sensation remains normal and there is no pain.

Treatment of adult botulism includes administration of the antitoxin and supportive care, including supporting breathing with a ventilator if needed. Antitoxin binds botulism toxin circulating in the blood before the toxin can bind a nerve. If botulism toxin does bind a nerve, its effects are irreversible, and it takes two to four months for the nerve to grow back and start working again. The antitoxin will prevent further worsening of paralysis but will not reverse paralysis already present. If you do have symptoms of botulism, grab your home-jarred food and go to the closest emergency department. Seriously, grab your jar, because we can test it for botulism and we might poke you less.

Botulism isn't all bad. Today, botulinum toxin changes lives one wrinkle at a time. Botox uses botulinum toxin, not the bacteria, to paralyze the muscles, usually in the face, but it is also used to treat migraines, urinary incontinence, and excessive sweating. Botox does not reverse wrinkles already present but prevents further wrinkles from forming, so if you are going to use it, it's better to start when you're wrinkle-free.

Most bad outcomes with Botox are from improper location or concentration of injections, causing temporary paralysis of muscles you need, like the muscles that move your eyeballs so you can look around. There is no reversal agent if things go wrong; similar to a botulism infection, the paralysis must abate on its own. The muscle-freezing effects last three to six months, so if you are upset about bad Botox you'll have to tell people using your words.

Unfortunately, in rare cases, Botox injections have caused serious side effects, such as paralysis of the breathing muscles. The FDA jury is still out on whether Botox has killed anyone, but they issued a black box warning stating that there is a risk of botulism-like symptoms associated with systemic spread of the toxin. The crazy thing is that in some states you don't have to be a medical professional to inject Botox, which seems a touch risky, especially because botulism is the most poisonous substance known to man, with a lethal dose of 1 nanogram/kilogram.

This chapter was incredibly informative. Look at all you learned:

- Don't give infants honey or water.
- Children are not tiny adults, but exotic geckos with sticky fingers.
- To avoid botulism, steer clear of home-canned foods, home-jarred foods, and IV drugs.
- Pediatricians should be paid more.

SUPERBUG INFECTIONS

Anyone who has demanded antibiotics for a viral cold, this chapter is for you.

The problem with bacteria is that, like humans, they evolve to survive. When you place bacteria under stress, the ones that can't take it die, and the strong survive and replicate. One thing that is stressful for a bacterium is an antibiotic.

Antibiotics are medications used against bacteria. Some antibiotics, which are known as bacteriostatic, stop bacterial growth while the body fights off the infection. Other antibiotics are bactericidal, killing bacteria directly in a multitude of creative ways.

The first antibiotic, penicillin, was discovered in 1928 in a lump of mold, and it was glorious. The first antibiotic could cure syphilis, dental infections, pneumonia, and strep throat until everyone said they were allergic.

Less than 1 percent of the population is truly allergic to penicillin but more than 10 percent claim a penicillin allergy. This is probably because the antibiotic was prescribed during a childhood viral infection and a rash formed. Childhood viral illnesses are infamous for causing rashes, plus giving penicillin to patients with viral mononucleosis (aka mono) can cause a rash, but this is not an allergy. I am not calling your mom a liar, but it's pertinent to get tested by a doctor for your drug allergies, especially if you believe you have multiple. If you are actually allergic to multiple antibiotics, you could end up admitted to the hospital for intravenous (IV) antibiotics or may only be a candidate for inferior antibiotics with worse side effects, so it's good to know for sure.

Today we have over a hundred antibiotics, most of which fall into thirteen categories, but only certain antibiotics work against each bacterium. This becomes complicated, but think of the outside layer of a bacterium as a locked box and the antibiotic as a key—only a key that matches that lock will allow the antibiotic to bust in and destroy the bacteria. This is why the leftover azithromycin, or Z-Pak, in your medicine cabinet did not treat your urinary tract infection.

The length of the antibiotic course is also important; for most infections, one day of antibiotic treatment won't do much. It is key to finish the full course of prescribed antibiotics, even when you are feeling better, because residual bacteria could still be present in your body. If treatment is stopped too early, those residual bacteria can then become resistant to the antibiotic you are taking, and the infection can grow again.

Antibiotics do not treat viruses or fungi. In fact, antibiotics sometimes allow fungi to flourish—for instance, yeast infections are common after taking antibiotics. Most antibiotics do not have effects on parasites, but there are some that do, and one in particular is amazing.

This is where I get to wax poetic about my favorite antibiotic, doxycycline. Doxycycline is the most versatile, amazing drug. Not only does this antibiotic treat bacterial infections including MRSA, but it also prevents malaria and can treat pretty much all tick-borne diseases. For atypical pneumonia: doxycycline; cellulitis: doxycycline; Rocky Mountain Spotted Fever: doxy; acne: the D. Such a sexy pill.

Antibiotic use in humans over time creates general bacteria resistance in the population, and this is especially problematic in hospitals, where the big-gun antibiotics are used. When a patient is dying of an infection, doctors will often reflexively pull out the antibiotic nuclear options. For instance, in the emergency department, we are taught to cover all possible points of weakness, which makes us terrible stewards of antibiotic use. Antibiotic-resistant bacteria tend to hang around in hospitals but can also be found in patients who are on antibiotics for chronic infections. Certain bacteria, such as MRSA, have become famous for their antibiotic resistance.

MRSA isn't very exciting anymore. MRSA stands for methicillin-resistant *Staphylococcus aureus*, and it was originally resistant to penicillin and methicillin, but now is resistant to most penicillin-related drugs and cephalosporins, if you must know. It used to be found only in hospitals, but now it's all over the place; and in hospitals 5 percent of patients have MRSA on them.

MRSA developed in the 1950s when they were giving everyone and their mom antibiotics. When MRSA is contracted in the community, it sometimes starts as a skin infection filled with pus and looks like a pimple. This develops into an abscess and these patients often believe they have a spider bite. MRSA can also cause other diseases such as pneumonia and blood infection.

There are a handful of antibiotics that still treat MRSA. I can think of eight off the top of my head (which isn't great since there are ten), but with a bit more bacterial resistance, I won't need to remember any of them. To be fair, the two antibiotics I didn't think of can only be used with special approval from antibiotic aficionados, the gatekeepers of germicides, the dons of bug drugs: the infectious disease doctors.

My family has no doctors, but my husband's family is a veritable cornucopia of physicians. There is a lot of *concurring* in the family group chat. I messaged my husband's uncle, an infectious disease doctor, on

Halloween and asked him to name the spookiest bacteria, and he sent back a whole list. I think the point is there are a lot of emerging bacteria to be afraid of, mostly due to antibiotic overuse. Resistant infections are becoming more common, with at least two million a year in the US. The CDC has a superbug watchlist of the most urgent threats such as *Acinetobacter*, *Candida auris*, *Clostridioides difficile*, Enterobacterales, and *Neisseria gonorrhoeae*. Yes, that last one is the sexually transmitted infection gonorrhea, and soon there will be no antibiotics left to bail out the next generation of promiscuous college students.

There are a few other important things to know about antibiotics that can be dangerous but are not related to bacterial resistance.

Antibiotics can also cause infection, which is counterintuitive. A certain type of diarrhea called *Clostridioides difficile* colitis (*C. diff*) is caused when antibiotics kill the good guy bacteria living in the intestine and the *C. diff* takes over, causing explosive diarrhea. This is one reason doctors tell you to take probiotics during and after taking antibiotics, as it helps regrow the good guy gut bacteria. The oral antibiotics that most commonly cause *C. diff* are clindamycin, penicillins, cephalosporins, and fluoroquinolones like ciprofloxacin. *C. diff* is commonly contracted in hospitals and is increasingly seen in patients taking stomach acid–reducing medications called proton pump inhibitors. *C. diff* is also treated with antibiotics, so the whole thing is a bit confusing, but a great example of how antibiotics treat specific infections. If antibiotics don't work to kill your *C. diff*, you can also get a poop transplant, which is a real thing.

Another important antibiotic fact is that some antibiotics can expire and poison you.

Another important antibiotic fact is that some antibiotics can expire and poison you. For example, tetracyclines, including my favorite antibiotic doxycycline, can expire in a bad way, so discard those old antibiotics at pharmacies and get disease-specific antibiotic treatment when indicated—not for your viral cold, Karen.

Last antibiotic point: alcohol and antibiotics. If you drink when taking Flagyl (metronidazole), you may have a disulfiram-like reaction. Disulfiram is a drug to help those addicted to alcohol stop drinking. If you drink while on disulfiram, your heart will race, your face will flush, and you will

projectile vomit copiously. I believe this is where the “don’t drink alcohol on antibiotics” talk started. This probably happened violently to a few people, and they spread the word loud and clear.

As far as I know, and I know some stuff, alcohol and most antibiotics have no major interactions. The National Institutes of Health (NIH) listed Z-Paks (azithromycin), Macrobid (nitrofurantoin), Flagyl (metronidazole), griseofulvin, ketoconazole, isoniazid, and cycloserine as having harmful interactions with alcohol. The pharmacy prescription pill bottle will generally note if you cannot drink alcohol, and it also has other important information, so read that. I do not endorse drinking while you have a bacterial infection, but because we have a relationship based on trust, I am giving you this information, which I may later regret.

The takeaway from all this antibacterial chatter is that you shouldn’t take antibiotics if you don’t need them. If you are prescribed antibiotics, finish the entire course. Never take leftover or expired antibiotics, because they are probably the wrong ones and may poison you.

VIRAL INFECTIONS

EBOLA

Ebolavirus is the type of virus with the potential to end everything: mysterious animal hosts, easily spread, and lethal. Ebolavirus kills more than half of the people it infects. This terrifying virus even found a way around needing host survival to spread, as Ebola can be contracted from dead bodies. The virus remains contagious for at least seven days after death, but one study found the viral RNA remained viable for ten weeks. The virus did make one mistake: Ebolavirus is transmitted from symptomatic patients through contact with bodily fluids, such as blood, stool, urine, and saliva. The disease is not airborne.

Ebola is an odd and terrifying disease, so its likely source is fitting: bats. Bats are believed to have transmitted the disease to mammals such as antelopes, chimps, and gorillas, and then the virus was spread to humans through contact with the aforementioned animals, including bats. Don't touch bats.

There are four species of the Ebolavirus that cause disease in humans. The first outbreak in 1976 occurred in a village adjacent to the Ebola River in what is today known as the Democratic Republic of the Congo (DRC). The infected were dying of *Zaire ebolavirus*–associated hemorrhagic fever, which is as bad as it sounds. A second, surprisingly unrelated, outbreak of the *Sudan ebolavirus* species occurred almost simultaneously five hundred miles to the north in Sudan. Since 1976, there have been over twenty Ebola outbreaks, most recently in Uganda in 2025.

The largest Ebola outbreak took place in 2014 in West Africa, concentrated in Guinea, Liberia, and Sierra Leone, where 28,610 people were reported infected. This epidemic resulted in Ebolavirus spreading to several other African countries as well as Italy, Spain, the UK, and the United States. In the US, eleven people were treated for Ebola, and the first documented transmission of the virus in the US occurred when two nurses treating Ebola patients fell ill with the disease.

The virus does not spread during the initial asymptomatic incubation period, which can span up to twenty-one days, but Ebolavirus can remain in bodily fluids long after a patient has recovered from infection, meaning patients are still capable of spreading the virus. A pregnant woman who recovers from Ebola may even have the virus in her breast milk. Patients who have symptomatic Ebolavirus are always infectious.

Ebolavirus remains infectious on dry surfaces for at least several hours and is viable in water for three days and up to five days in drying blood. Treat everything an Ebola patient touches as potentially infectious. Handwashing and alcohol-based hand sanitizers are key to limiting spread. Do not touch bodily fluids or any items that patients come into contact with, including bedding and clothing.

It is key to not touch the bodies of patients who have died of Ebola, as they remain infectious for at least a week after passing. In many Western African countries hit hardest by the 2014 Ebola outbreak, there are important cultural and religious burial practices, like washing and clothing the body of the dead, which were not simple to cast aside. Additionally, West African secret societies have specific burial practices required to transfer powers to successors. Integrating safe burial practice personnel into these practices was one of the greatest challenges in the 2014 epidemic.

It is key to not touch the bodies of patients who have died of Ebola, as they remain infectious for at least a week after passing.

Ebolavirus enters the human body through injection, cuts in the skin, or contact with the eyes, nose, or mouth. Early symptoms of the virus set in around day nine after infection. The virus begins with “dry symptoms,” such as fever, body aches, and sore throat, and then progresses to “wet symptoms” of vomiting, diarrhea, and bleeding. The virus targets immune system cells and blood vessels, causing small clots as well as leaking from the blood vessels, which then causes patients to bleed from the eyes, nose, mouth, and other orifices. Eventually, low blood pressure causes organ failure and death.

Once a person is infected with Ebolavirus, the treatment includes in-hospital supportive care such as hydration, blood transfusions, and blood pressure support. In 2020, two monoclonal antibodies were approved by the WHO for the treatment of the *Zaire* species of Ebolavirus. These treatments

improve outcomes in Ebola patients by preventing Ebolavirus from entering some cells, but they do not cure the virus.

Fortunately, there is now a vaccine to prevent Ebola. The Ça Suffit Ebola trial, headed by World Health Organization medical officer Dr. Ana Maria Henao-Restrepo out of Geneva, Switzerland, showed the vaccine had 100 percent protection against one of the four strains of Ebolavirus. Keep in mind this is one trial, and so the vaccine's true effectiveness may be slightly lower when measured in a larger population. Regardless, I'll take it. The vaccine, known as Ervebo, is FDA-approved in those older than twelve months to prevent one of the four human strains of Ebolavirus and is recommended for those with occupational exposure. Although there is no current plan for commercial distribution in the United States, the US government does have stockpiles of the vaccine.

Always watch for CDC and WHO travel warnings and be sure to know what epidemics might be taking place where you live or plan to travel. Hygiene is key in preventing Ebola, but science has saved the day again with a vaccine to aid in the fight against future Ebola epidemics.

CORONAVIRUS INFECTIONS (SARS, MERS & COVID-19)

The coronavirus is named after the virus's crown-like shape, which can be seen under a microscope. It has earned this crown by evolving from a common cold into several deadly diseases. Every species is intrinsically driven by the evolutionary need to replicate and survive. For viruses, this requires a balance between lethality and the ability to spread. The virus aims to infect new victims before killing its original host.

Coronaviruses are respiratory viruses that circulate among animals and humans. The common human coronavirus causes a cough, runny nose, sore throat, and fever. Although first identified in humans by scientists in the 1960s, these viruses were almost certainly circulating long before, evolving to create the perfect combination of contagion and lethality.

The coronavirus's first attempt at lethality was severe acute respiratory syndrome (SARS), which started in Guangdong Province, China, in 2002. At this point, China had a bad reputation for going viral in part because of the deadly 1997 bird flu (H5N1), which originated from birds in China. China has 1.4 billion citizens, epidemiological challenges, and a tradition of live animal markets, all of which can contribute to the spread of animal

infections to humans. Pigs, birds, and wild animals have served as effective breeding grounds for viruses that then jump to humans with close contact, but these issues are complex.

The SARS virus is a respiratory virus that causes pneumonia. It spreads through droplets when people cough and sneeze, but it is not airborne. The virus infects the cells of the respiratory tract, and the lungs eventually become clogged due to inflammation and fluid, in some cases resulting in an inability to breathe and death. The three coronaviruses in this chapter share this disease course. In the 2003 outbreak of SARS, one in every ten people infected died, but the spread was controlled quickly with 8,098 infections, only 8 in the United States.

Middle East respiratory syndrome (MERS) burst onto the scene in 2012 in Saudi Arabia. The virus circulated efficiently, making it to five out of the seven continents, giving Australia a much-deserved break. Approximately four of every ten people who contracted MERS died. That's a lot.

It is hypothesized that the MERS virus was cultivated in nature's creepiest Petri dish, the bat, then infected camels, and these spitting camels hocked a MERS loogie onto humans. Interestingly, this virus is still primarily transmitted from camels to humans. Human-to-human transmission is possible but is generally limited to close contact in healthcare settings. MERS has similar symptoms to SARS and is unfortunately still circulating, with a majority of cases in Saudi Arabia.

There was no vaccine for SARS or MERS, so public health strategies and evolutionary inadequacies of the virus were responsible for its control. It is harder to get a virus to Paris if it is dominantly spread by camels. When traveling, be aware of CDC travel warnings, limit contact with animals, and wear masks in high-density areas, especially if you are sick.

The most infamous coronavirus is COVID-19, a topic that is, unfortunately, hard to skip over. But I will omit the redundant science of the virus and just share my experience.

I had been working for several months at a rural hospital when the COVID-19 pandemic hit. Around this time, the emergency department became the sole access point for healthcare in the United States, and we were not prepared for the massive influx. Many departments lacked masks, gowns, and ventilators, all of which were used up too quickly. I had nurses wearing garbage bags as gowns and bandanas as face masks. Thus, 40

percent of US healthcare worker fatalities from COVID-19 occurred in just three months during the early pandemic.

The World Health Organization estimates as many as 180,000 healthcare workers died from COVID-19 during the first six months of the pandemic. In the US, healthcare workers' fatality rate from the virus was seven times higher than the general population's. And it wasn't just healthcare workers at risk, but their families. For instance, a nurse colleague contracted the disease and unknowingly infected her family member, who quickly died from the virus.

It was a soul-crushing challenge to have inadequate knowledge, resources, and personal protection, all the while enduring the suffering of patients because available therapies failed. Unthinkable nightmares became reality: choosing which patients received ventilators, performing CPR on young healthy pregnant women, and separating dying patients and families. When patients did survive long enough to be admitted to the intensive care unit, the units were full, so patients would wait for days in the emergency department, sometimes transferring across several state lines.

As if the pandemic wasn't enough, in the first week of January 2022, a terrible snowstorm hit the East Coast of the United States, cutting off power to half a million homes, and centering itself directly over my town. On the I-95 freeway, drivers were stranded in their cars for twenty-four hours. Hospitals were full, helicopters could not fly, and ambulances joined cars in motionless, snow-covered traffic, frozen on apocalyptic highways.

As one of the only emergency department physicians who lived close enough to access the hospital, I became responsible for covering multiple shifts. Arriving at the ED, I was drawn into the past, to the moment I stood at the façade of Chu Ibn Rochd Hospital in Casablanca, Morocco. On my first day working at the public hospital as a medical student, I mistakenly used the patient entrance and stood among a hundred patients shouting for care. The current scene was similar chaos, but this time there was snow.

The fifty-bed ED was overflowing with hundreds of anonymous, unmanaged patients in the waiting room, in halls, and on stray gurneys. As I passed a single occupancy patient room, I was surprised to see a small group of people sitting in a circle, all attached to oxygen, sharing tubing like a peace pipe.

As I sat down to sign into a computer, the hospital lights flickered and went dark. The whirring of machines and alarm bells lacking power backup

were momentarily silenced as the hospital generator kicked in, restoring power.

My colleague sat down beside me and told me about every known patient in the department. The peace pipe oxygen room was full of patients who had lost power in their homes and required supplemental oxygen. In another single occupancy room was a group of patients who needed to be transported home but had been in the emergency department for twenty-four hours due to road conditions. We had run out of patient rooms for the critically ill—even the code rooms, used for CPR patients, were occupied.

During our conversation, a nurse called for help as a five-year-old boy was having repeated seizures in the waiting room. The child was in a life-threatening succession of seizures called status epilepticus. If the seizures continued, he would die. He was taken to my colleague's code room where a breathing tube was placed and the seizures were stopped with sedating medications, but there was no way to transfer him to a pediatric hospital.

I rounded on my inherited patients, meeting Betsy just as her testing from overnight resulted. Betsy's CT scan showed a blockage in her small bowel. To prevent this blockage from perforating her bowel, a tube needed to be placed through her nose to her stomach to pull out fluid from the blockage into an external vacuum. This vacuum was attached to the hospital wall, thus Betsy needed to be in a room, so she was placed in the last room, bed five, our CPR room.

Since every bed was full, it was impossible to see new patients in rooms, so I went to the waiting room to find a man with his foot turned 90 degrees to the right at the ankle. There were no chairs available, so he sat in an emergency department wheelchair, lost among a sea of patients waiting to be seen. I quickly walked over to ensure there was a pulse in his foot. I explained to him that I had no rooms, monitors, or nurses available, so I could not sedate him to fix his ankle, but if he was tough, I could straighten the dislocation with him awake. He said, "Let's do it." I pulled forcefully on his ankle, then splinted him without sedation.

I returned to the chaos of the internal department, passing through triage, where my friend Jane, an emergency medicine physician assistant, performed mass casualty triage on arriving patients. She had paused her work and was speaking sternly to an elderly woman who then petulantly plopped into a hallway chair. I motioned for Jane, who approached me, visibly frustrated.

“What is that about?”

“That’s Agnes. She has dementia, but there is no one available to watch her. She thinks she works here. Every time I turn around, she starts talking to a new ‘patient,’ or is at a computer, pretending to take notes.” I looked over at the small elderly woman, who then stood with purpose and quickly shuffled around the corner.

Jane and I walked to the computer station to review patient triage complaints, turning the corner to find Agnes sitting at the nurses’ station proficiently typing uncaptured words on a locked computer screen. Agnes was again devastated to be told that she was not a healthcare hero as Jane escorted the crestfallen eighty-year-old back to her chair.

Patients continued to arrive at the hospital in droves, which was surprising because the road conditions prevented most ambulances from reaching the hospital. Around this time, an unresponsive patient was announced, and I was called on the hospital overhead paging system to room five, Betsy’s room.

I raced to room five to tell Betsy that at any moment a patient would be brought to her room receiving chest compressions. If she wanted to, she could close her eyes, but there was no other room for her or the CPR patient. She looked terrified but nodded her understanding and screwed her eyes shut. In this instance, opening her eyes would only make the nightmare worse.

The pandemic unearthed substantial inadequacies in our healthcare system, especially under pressure. During the pandemic years, many patients died of treatable conditions such as heart attacks, because a lack of resources precluded certain procedures, surgeries, and access to medical care.

There were no hospital beds for patients with hip fractures or kidney failure. Open-heart surgery could not be done without ventilators. Cancer patients could not get appointments to start treatment. During the COVID-19 pandemic, it took only the added stress of a foot of snow to dismantle our healthcare system completely. Today most of the deficits in resources and healthcare staff encountered during the pandemic remain unresolved, although they are now less glaring in the absence of extreme systemic stress.

Despite healthcare workers’ best efforts, more than a million American lives were lost in just over two years during the pandemic, over twice the

death toll of any US war. However, the virus's lethality and infectivity could have been drastically worse, and in the future, it will be, not only taking more lives directly but also further crippling the infrastructure of US healthcare. The system must evolve, because no one should die due to an inability to access medical care.

PARASITIC INFECTIONS

MALARIA

One night I was working in the emergency department and met an interesting patient. We will call him Joe. Joe was a healthy guy, but for the last week he hadn't been feeling well. He had fevers, chills, and night sweats. In the morning, he would start to feel better, just to feel terrible again a few nights later. At first, Joe thought maybe he had the flu, but after a week of fevers as high as 104°F, he knew something else was wrong. He called his primary care doctor and scheduled the earliest available appointment, which was in six months. Joe then came to the ED.

For the record, it is not the fault of primary care physicians that no appointments are available. Primary care and preventative medicine are poorly prioritized and reimbursed by US insurance companies. Primary care doctors require daily clinic schedules to be packed full of patients, which blocks off provider schedules and adds to the paucity of appointments available in a system already stressed by the provider shortage. This is a major contributor to the 139.8 million annual emergency department visits in the United States, which ironically cost insurance companies much more.

Joe and I met to discuss his illness under the flattering fluorescent lights of the ED. He hadn't been around anyone ill, and he could not figure out why he had been getting sicker for weeks.

In the ED, we are very goal-oriented. The goal: Nobody dies. We tend to be a bit single-minded in this regard and may forget to ask other important questions, such as, "Do you own a parakeet?" "When was the last time you assisted in the delivery of a baby cow?" And "Have you recently been in contact with a flying squirrel?" These medical board-style patient history questions all have critical answers in detecting rare infections.

For Joe, the most important question was "Where were you on the night of June 25th?" The answer: Malawi, where he contracted malaria.

The distribution of the malaria parasite is reliant on its vector, the *Anopheles* mosquito. The *Anopheles* mosquito is infected with the parasite

when it feeds on a human or animal with malaria. The mosquito can then transfer the parasite to subsequent bite victims.

Malaria kills more than half a million people every year, with 95 percent of these deaths being in children under five, and over half occurring in just four countries: Nigeria, Niger, Tanzania, and the Democratic Republic of the Congo.

The *Anopheles* mosquito lives in tropical and subtropical areas, which is why malaria is transmitted in these areas. The global distribution of the *Anopheles* mosquito is changing with the warming of our environment, and in 2023 five cases of malaria were identified as being transmitted within the southern United States.

There are four main types of malaria parasites transmitted by the *Anopheles* mosquito to humans: *Plasmodium falciparum*, *P. vivax*, *P. ovale*, and *P. malariae*, the deadliest being *P. falciparum*. These parasites are injected by the mosquito into the bloodstream where its human-host life cycle begins.

The malaria parasite travels through the bloodstream to the liver, where it invades, replicates, then bursts liver cells, releasing a new stage of the parasite that infects red blood cells and multiplies. The infected red blood cells fill with the malaria parasites until they too burst. In certain types of malaria, this process occurs in a timed sequential fashion. For instance, in Joe's case, every two to three days his red blood cells would burst, releasing malaria parasites into the bloodstream, causing his symptoms to recur, then improve until the next parasite release.

Patients usually develop symptoms around ten days postinfection and have fevers, chills, headaches, muscle aches, and all those pesky indistinct flu-like symptoms that could be due to anything from the common cold to a deadly blood-borne parasite. This is why doctors are still helpful, but it is also how diagnoses get missed. You have to ask the right questions and already know the possible suspects. Retrospectively, the killer may seem obvious, but initially it takes a good detective to figure it out.

Some patients may clear the parasite with their own immune system, but treatment is recommended. Historically, the mainstay of treatment was chloroquine or hydroxychloroquine, but given resistance and the need for improved therapy there are now a multitude of drugs that are administered by doctors based on the geographic location and species of the malaria parasite.

Without treatment, this progressive disease causes continued loss of red blood cells creating severe anemia and jaundice, and high parasite load causing kidney failure, seizure, coma, and death. The deaths are most associated with *P. falciparum*, but other flavors of malaria parasites come with unique problems, such as *P. vivax* and *P. ovale*, which can hide in a person's liver for years and cause secondary infection.

The first medical treatment for malaria, chloroquine, was not discovered by Hans Andersag until 1934, so prior to this humans had to develop a way to survive, especially in sub-Saharan Africa where a majority of *Plasmodium falciparum* deaths occur. During the human struggle for survival, evolution may have created its own solution: sickle cell anemia. Around 80 percent of children born with sickle cell disease are in sub-Saharan Africa, where a single sickle cell gene is the key to malaria resistance.

In sickle cell, faulty hemoglobin causes red blood cells to *sickle*, or collapse in on themselves, becoming targets for the body's immune system and inhospitable to malaria parasites. Patients with only a single sickle cell gene do not have clinically symptomatic sickle cell disease but are resistant to malaria infection. Unfortunately, if an individual has two genes for sickle cell, this confers sickle cell disease, which itself is life-threatening and debilitating.

In 2007, I saved every penny working my retail job for a plane ticket to Tanzania. I bought the cheapest possible ticket, requiring twelve plane changes and an overnight stay in Doha, Qatar, as a twenty-year-old solo traveling woman. It was fine, but possibly not my most solid safety planning.

I made it to Dar es Salaam, Tanzania, and met up with a group of student volunteers and physicians traveling to a medical clinic in the rainforest at the base of Mount Kilimanjaro, the highest peak in Africa. Before the trip, all the travelers completed the needed vaccines and started on malaria prophylaxis.

Malaria prophylaxis medications stop the parasite from creating a clinically significant infection in human hosts, resulting in symptoms of the disease. The medications are pills taken orally and include Malarone, chloroquine, doxycycline, mefloquine, primaquine, and tafenoquine. When malaria exposure is a threat, you should work with a provider to determine

which prophylactic is best based on interactions, side effects, and travel destination, as some malaria parasites have known resistance.

I was taking doxycycline. Side effects of doxycycline include photosensitivity, meaning you get sunburn more easily. I am one of the lighter forms of wazungu, a Swahili word for light-skinned individuals, but I would rather wear a hat than have psychedelic dreams on mefloquine.

We arrived at the medical clinic, situated at the base of the mountain. The clinic was a cement building with several exam rooms and a laboratory. The laboratory contained many of the tests required for the diagnosis of common illnesses in the area, including microscopes for the diagnosis of malaria.

We had been in the country for a little over a week when we learned to diagnose malaria. A sample of blood is taken from the patient and placed under a microscope and examined for the sneaky intracellular parasite that causes malaria. It is like trying to find Waldo in a field of candy canes.

In science, it is always important to establish a baseline. In this case, we needed to understand what normal blood looks like before we could learn to search for the parasite in blood. My counterparts and I were religiously taking our antimalarial medications, and so we each took our blood and created slides to look at uninfected blood. The medical clinic's technician set up the slides and looked through the microscope to find our blood was chock-full of malaria parasites.

Antimalarial drugs do not prevent the malaria parasite from entering your bloodstream; rather, the medications target a particular life stage of the parasite to prevent the infection from taking hold. Furthermore, no malaria prophylaxis is 100 percent effective, thus the importance of also preventing mosquito bites via DEET and mosquito nets. Retrospectively, we were likely protected by our prophylactic medications, but it was still a bit of a surprise.

Protecting yourself from malaria is a multi-step process. When traveling, always look up CDC destination recommendations. Know what seasons mosquitoes are most prevalent, and consider avoiding "malaria season," if possible. When traveling to malaria-endemic locations, prophylaxis via prescription medications is recommended. Even if you're taking medication, sleep under mosquito nets, use DEET bug spray, avoid outdoor exposure at dawn and dusk when mosquitoes are most active, wear

protective clothing, and remove any standing water mosquitoes use for breeding.

Unfortunately, the over-the-counter insect repellent thiamine (vitamin B₁) has been shown to be ineffective. It's dealer's choice, just don't use it as a sole protection method. Lemon eucalyptus oil, lavender, cinnamon oil, thyme oil, catmint oil, soybean oil, citronella, tea tree oil, geraniol, and neem oil have all been shown to have some effect on keeping pesky mosquitoes away, but weighing the risk of a bite is recommended. If you're in Canada, where you have virtually no risk of contracting malaria, essential oils may be sufficient. In a country where mosquitoes carry deadly diseases, it is recommended to take further precautions. If you choose to use essential oils in addition to chemoprophylaxis and other recommended exposure reduction techniques, go for it. Hell, throw some olive oil on there if you want. But essential oils alone are not recommended as a sole prevention method.

Aside from individual efforts, broad public health efforts have been very effective in reducing malaria risk. One of the earliest and most successful efforts in this regard was during the building of the Panama Canal.

In the late 1800s, shipping companies had gotten whiny about having to go around South America to get places, so construction began on the Panama Canal. The French had recently completed the Suez Canal in Egypt, so they took the lead. How hard could it be? There was just one petite problem—Panamanian mosquitoes carrying parasites that caused malaria and yellow fever. The bugs killed more than twenty thousand workers and bankrupted the project. Enter American outdoor enthusiast President Theodore Roosevelt, who oversaw the vector control in Panama followed by the construction of a shipping shortcut.

The real hero was the Chief Sanitary Officer of the project, William Crawford Gorgas, who oversaw the elimination of the vector mosquito prior to construction with fumigation, standing water reduction, and sick patient quarantine to prevent mosquitoes from biting the infected. Sanitary Officers never get the spotlight but are heroes nonetheless. Yellow fever was temporarily eradicated from Panama and malaria was greatly controlled during the canal's construction.

Today, malaria is a major target of multinational medical organizations including such philanthropic organizations as the Against Malaria

Foundation and the Gates Foundation. Malaria is a disease that can be eradicated; we've done it in over forty countries. The greatest hope for global eradication, per usual, is a vaccine. In 2025, two malaria vaccines have been approved by the WHO, but these vaccines still lack efficacy, only reducing severe malaria by about 30 percent. Malaria vaccines are still being studied and bring hope for a malaria-free future.

TICK-BORNE DISEASES

One of the most perplexing and perturbing patient complaints for an emergency medicine doctor is "I have a rash." This emergency department visit is an inevitable disappointment for the patient, as a rash is seldom deadly and therefore cannot be diagnosed in a department where resources and diagnostics are directed at targeting emergent diseases.

Psoriasis, seborrheic dermatitis, eczema, intertrigo, contact dermatitis, rosacea, viral exanthems, or almost any rash present for over a month without associated symptoms will not be definitively diagnosed in the ED. There exists a doctor whose entire job is skin. It is a magical job that works nine to five, sometimes four days a week, with no weekends or holidays. Many rashes need to be seen by a dermatologist, requiring a biopsy for diagnosis. However, we all must enter the gauntlet to compete for the rare appointment.

That being said, some rashes are emergencies, and one of those rashes is attached to a tick.

Sitting in the doctors' box on a weekend night shift in the ED, I saw "rash" pop up on my computer screen as the chief complaint for my next patient. I took a deep breath and readied myself for a dismal patient satisfaction score, due to the patient's utter disappointment in my lack of resources and inability to be a dermatologist.

As an aside, there are several types of patient satisfaction scores, all of which are subjective patient-rated scores denoting the level of personal fulfillment received from the medical visit. Over the last decade, Centers for Medicare & Medicaid Services (CMS) and thereby insurance companies have begun to tie these scores to hospital reimbursement for patient care, and therefore hospital administrators have become obsessed with these scores because it is how they get paid.

The emergency department research studies of patient satisfaction, including a 2012 national study published in the *Journal of the American Medical Association (JAMA)*, have shown that higher patient satisfaction scores are associated with increased mortality, so the happier you are with your ED visit, the more likely you are to die.

Why? The answer is simple: A high percentage of emergency department satisfaction is related to wait times, and which patients must wait?

A patient having a heart attack or stroke, bleeding out from a car accident, or acutely dying in any capacity will have no wait time. Patient satisfied. A higher satisfaction score for care, but a sicker patient—therefore, more likely to die. If a patient comes in with a rash they've had for four months and is hoping to be diagnosed and treated for new-onset psoriasis, the patient will spend ten hours in the waiting room, hate the experience, and return home with the rash, disgruntled, to live another day. Patient unsatisfied.

Metrics in medicine can be dangerous for several reasons, one being Goodhart's Law: When a measure becomes a target, it ceases to be a good measure, because it becomes a target for manipulation. But in medicine, the more pressing matter lies in insurers' emphasis on the wrong metrics in healthcare and reimbursing based on those faulty measures. Eventually, the system will be manipulated by financial incentives, leading medical business leaders to demand changes in medical care for financial gain. This could lead to a patient dying in the waiting room while psoriasis guy gets a room to increase his satisfaction score. This is the feared outcome when corporations make healthcare decisions.

So, I see "rash" pop up on my screen as the patient complaint, and I proceed to room thirty-seven to collect my unsatisfactory patient score. When I arrive and see the rash, I mentally do a Dr. Peter Benton celebratory air punch à la the nineties television drama *ER*, because the patient came to the right place—this rash can be lethal. I can diagnose and treat this rash, and the patient will be so satisfied, because this rash was attached to a tick, a dog tick, to be exact, carrying the bacterium *Rickettsia rickettsii*. This patient had Rocky Mountain Spotted Fever (RMSF).

In 1906, Howard Ricketts demonstrated that Rocky Mountain Spotted Fever was a disease spread by wood ticks in the Rocky Mountains of Idaho, and it was later found to be associated with dog ticks in the eastern United

States. The disease is also seen in Mexico, Central America, and South America. An infected tick feeding for more than six hours can transfer the bacteria, but it can also be transferred during tick removal.

Usually, on day seven after inoculation, symptoms begin with headache and fever. A rash appears within five days of symptoms' onset. However, this disease can be tricky because one-third of patients do not report a tick bite, and 10 percent of patients never develop a rash. For those fortunate enough to develop the distinct rash, the diagnosis is made more easily. In my Irish family, our arms are covered in so many freckles that they blend, almost making the skin look tan from far away. The RMSF rash looks similar, but the freckles are bright red covering the entire body—you can't miss it.

What makes this disease so deadly is that the bacteria get inside the cells that line the blood vessels and cause damage. This makes the blood vessels leak and release chemicals that cause the blood to clot, so patients have bleeding as well as uncontrolled blood clots. The bacteria can also cause direct infections in the brain, heart, and liver, eventually causing multi-organ failure and death.

Death from RMSF can occur in as little as five days, and before treatment was found, in one area of the US, up to 80 percent of those infected would die. But fortunately, a treatment was discovered, and it happens to be the world's greatest antibiotic. Treating everything from acne to zoonotic disease, this antibiotic can cure MRSA, prevent malaria, and thwart cancer (specifically of the stomach). This is the treatment for almost every tick-borne disease. Whether you have COPD or cellulitis, ladies and gentlemen, the greatest drug of all time, my personal pill hero, the butcher of bacteria, the rocker of Rocky Mountain: doxycycline. Today, without antibiotic treatment, one in four people who contract RMSF will die, but with early doxycycline treatment, the fatality is less than 1 percent.*

Another rash that cannot be ignored is the target-shaped rash, known as erythema migrans, after a tick has given you Lyme disease. Picture this: You are in the woods and get bitten by a tick that puts a target on your back. High hopes it's not hunting season, but this tick doesn't need a weapon to take you out; it uses the bacteria *Borrelia burgdorferi*.

The target rash, which appears at the location of the tick bite in 80 percent of those infected, usually appears within fourteen days of the bite. In the first weeks following the infection, patients have flu-like symptoms

such as body aches and headache, although fever is less common. If the patients are not treated with doxycycline, the bacteria can start to cause problems, infecting the brain and the heart, causing myocarditis and meningitis and sometimes even blocking the heartbeat. These manifestations of Lyme disease are rare and death from Lyme is around 0.6 percent in the US.

As with most tick-borne diseases, there is a blood test for Lyme disease. This test commonly checks for antibodies to the Lyme disease bacteria, IgM and IgG, not the bacteria itself. When your body is exposed to a bacterium, such as *Borrelia burgdorferi*, it creates an IgM antibody that attaches to the bacteria and acts as a red flag for the immune system to attack. It can take several weeks for the IgM to be made, and when enough IgM is produced the body will eventually produce a second memory antibody, IgG, to save long-term, in case the bacteria ever tries to return.

Depending on the disease, the IgG antibodies can last a lifetime in the body and are not a sign of active infection but previous infection. In Lyme disease, the IgM antibodies can also last for years after the bacteria is gone. Being positive for these antibodies, especially IgG, does not necessarily indicate an active infection, making this method of disease detection somewhat faulty. Lyme disease is most often treated based on clinical symptoms, which is fine since the treatment is a simple course of antibiotics that should cost no more than twenty dollars, and which cures 90 percent of patients with its initial course.

Because of testing inaccuracies and the prevalence of the disease, especially among affluent populations, the disease has become a target of medical charlatans and medical businesses alike. Some labs have created non-FDA-approved testing that insurance does not cover, so patients who continue to have chronic fatigue, muscle aches, and insomnia despite treatment for Lyme are paying out of pocket for lab tests and unproven treatments. Rightly frustrated patients looking for a diagnosis are sometimes taken advantage of by businesses and practitioners who are aware of the inaccuracies of Lyme testing, but the wrong diagnosis helps no one, and “chronic Lyme” is one of those diagnoses. Always be suspicious of those offering miracle medical diagnoses and solutions in exchange for out-of-pocket costs.

“Chronic Lyme” is a bit of a hot-button issue that’s gotten a lot of press because celebrities love the Hamptons, which is a Lyme-filled tick paradise,

and because patients have had significant hardships due to chronic symptoms that have been associated with possible past Lyme infection. The CDC discourages the use of the term *chronic Lyme* because it implies that there is an ongoing bacterial infection when there is not, and the definitive cause of patients' symptoms is unproven. The current accepted terminology by the Infectious Diseases Society of America (IDSA) is Post Treatment Lyme Disease Syndrome (PTLDS). This is a suspected inflammatory response with six months of subjective symptoms (fatigue, muscle pain, brain fog) within six months of a confirmed Lyme infection that has been treated and cured. This is a difficult disease to diagnose and currently has no proven treatment, as chronic antibiotics aren't proven effective, but most patients' symptoms will resolve within the year. I do not treat this disease and frankly want nothing to do with any disease that cannot kill you, and while acute Lyme disease can be fatal, PTLDS is not.

Ticks also carry babesiosis parasites, as well as ehrlichiosis and anaplasmosis-causing bacteria that take you out at the organs if untreated, but fatality is low with treatment. There are also some lesser-known tick-borne diseases such as Powassan encephalitis (POW), tularemia, southern tick-associated rash illness (STARI), Colorado tick fever, Q fever, and alpha-gal.

Alpha-gal is not usually deadly, but it can be. The disease is not well understood but is associated with lone star tick bites. In twelve years of surveillance in the US more than a hundred thousand cases were identified. Those with the disease develop an allergy to galactose- α -1,3-galactose (alpha-gal), found in the meat of mammals, so when consuming anything that once had fur, anaphylaxis and airway swelling can ensue. More common symptoms are hives, vomiting, diarrhea, and abdominal pain, usually within two to six hours of eating meat or dairy products.

Internationally there exist unique, interesting, and terrifying tick-borne diseases. In Africa, the Balkans, the Middle East, and Asia the Crimean-Congo hemorrhagic fever is contracted through a tick bite transferring the virus to humans that causes bleeding all over the body and into the brain, with a mortality of up to 40 percent. There are no definitive treatments for this disease, so care is mostly supportive, although some have attempted to use the antiviral medication ribavirin, historically used in hepatitis C treatment, with limited success.

In Asia and parts of Europe, tick-borne encephalitis, also known as forest encephalitis in China, is a disease caused by a flavivirus, transmitted via *Ixodes* tick bite, that causes flu-like symptoms followed by meningitis and sometimes paralysis. The good news is there is a vaccine! Efforts are being made to create a vaccine for Lyme disease, but currently, the tick-borne encephalitis vaccine is the only vaccine for tick-borne illness. If you are traveling or living in northern Europe or eastern Asia, especially if planning on outdoor activities, this vaccine is recommended by the CDC.

Never to be outdone, Australia is home to several unique species of ticks with their very own deadly diseases—Australian spotted fever and Queensland tick typhus, the latter being transmitted by the paralysis tick, a tick with a special hidden talent.

Tick paralysis found its way onto an episode of the popular TV drama *House*. It is most commonly caused by the scrub tick (*Ixodes holocyclus*), also known as the paralysis tick, in Australia, while in North America the dog tick and the Rocky Mountain wood tick are often the culprits. Unlike most tick-borne diseases that are caused by bacteria, tick paralysis is due to a neurotoxin in the saliva of more than forty species of ticks. The toxin is usually transferred after at least three days of continuous feeding by a female tick. The toxin is poorly understood and is believed to disrupt sodium channels in nerve cells, which is how nerves communicate, resulting in paralysis. By day seven of the tick being treated to an all-you-can-eat blood buffet, the patient begins having symptoms, starting with lower extremity weakness that causes paralysis and moves up the body, eventually affecting the muscles that control breathing, causing death due to paralysis in as quickly as twelve hours without medical care.

If these symptoms sound familiar, it may be because other diseases with different mechanisms have similar symptoms, such as Guillain-Barré syndrome and botulism. A major difference is in the diagnosis and cure of tick paralysis: Find the tick and remove it and symptoms will completely resolve within twenty-four hours.*

The best way to avoid death by a tick is to avoid the tick. Know the regional tick-borne diseases and seasonal distribution. Ticks are generally more prevalent in the spring and summer when it is most important to avoid tick-filled tall grass and bushes, but they are active year-round. When outdoors use insect repellents, wear covering clothing, and shower immediately after being in nature. If you can stop the tick before it bites or

remove it immediately, the odds will be in your favor. When showering, check hair and crevices for ticks. Lastly, use tick prophylaxis in pets, because they can contract tick-borne diseases as well, and check pets with a tick comb after outdoor activities.

If a tick does attach, the trick is quick tick removal. The faster the tick is found and safely removed, the less likely it is to transmit disease. Although some diseases are transmitted immediately, most diseases require the tick to be attached and fed for a prolonged period for transmission. For instance, to transmit the bacteria that cause Lyme disease, a tick must be attached for longer than twenty-four hours.

The faster the tick is found and safely removed, the less likely it is to transmit disease.

Tick removal is not rocket science, but if you screw it up by leaving the tick's head attached, you still have problems, as it can become infected. Do not use fire or petroleum jelly suffocation, or wait for the tick to detach. The CDC recommends immediately using a clean pair of tweezers to grab the tick as close to the skin's surface as possible, then pull straight up, and do not twist or jerk. After removing, clean the bite with soap and water or alcohol, then flush the sucker.

When in doubt, you can have tick removal done in urgent care or the emergency department, especially if the tick is engorged and has been attached for an unknown period, since you are likely going to need prophylactic antibiotics to prevent disease in some regions of the US. But don't despair, Lyme disease postexposure prophylaxis requires only a single dose of the greatest antibiotic of all time, the eliminator of Lyme: doxycycline.

[SCHISTOSOMIASIS](#)

One of the most dangerous creatures to ever scoot the Earth is the freshwater snail. This little bugger is leaving more behind than a slime trail—it's responsible for the spread of schistosome parasites.

Schistosomes sparked my initial interest in neglected tropical diseases, so I collected literature on the subject. Where most people covet the signatures of athletes and movie stars, I have an author-signed copy of *Forgotten People, Forgotten Diseases* by Dr. Peter Hotez, the LeBron

James of infectious disease. But if Mr. James also wanted to sign my book, I would allow it.

There is evidence of schistosome infections in humans as far back as 1250 BC. Calcified schistosome eggs have been found in the mummies of ancient Egypt and medical papyruses may have described the disease. One of the schistosome parasites, *S. haematobium*, causes blood in the urine, and the disease was so widespread in ancient Egypt that it is unclear whether bloody urine was associated with a disease or was a natural process of male menstruation.

The disease continued to plague modern times, and in the 1920s an estimated 70 percent of the Egyptian male population was infected with *S. haematobium*. Ten years later, the Egyptian government worked to eliminate the parasite, specifically targeting the vector, freshwater snails. In the 1950s the Egyptian government offered free treatment for schistosomiasis in their largest public health campaign to date. Although there have been improvements, schistosomiasis remains prevalent in Egypt, as well as parts of South America, Central Africa, the Middle East, and Asia.

When the opportunity arose to travel to Egypt, the city of ancient pyramids and interesting parasites, I jumped at the chance. I was sick as a dog. Ironically, I got sick at the departure airport, so when I arrived in Egypt, I was already ill. I had a fever, terrible abdominal pain, and an upset stomach. At first, I hoped it was food poisoning and would pass quickly. It was not, it did not, but I refused to miss the trip of a lifetime, so I grabbed a plastic bag and saw everything I could. At one point I was riding a camel against the backdrop of the ancient pyramids, holding my barf bag. Poor camel. Finally, when my travel companions took off for the Sahara Desert, I cried uncle and returned home. But the camel ride photos are epic.

The eggs of the schistosome parasite are found in infected human feces and urine, which contaminate fresh water where snails live. The parasite infects the snails to grow into its next phase, which looks like a cross between a whale and a sperm. This tiny sperm-whale parasite, called a cercaria, is a free-swimming fluke that can penetrate the skin of unsuspecting swimmers and infect humans with the final stage of schistosomiasis.

There are several species of schistosomes, with the most relevant to human health being *Schistosoma haematobium*, *S. japonicum*, and *S.*

mansoni. These parasites set up camp in different body parts. *S. haematobium* hangs in the kidneys' blood vessels, while *S. japonicum* and *S. mansoni* prefer the bowel blood vessels.

In the first months following infection by schistosomes, patients may get those tricky flu-like symptoms. Then the disease becomes more insidious, and symptoms may go largely unnoticed as the body's immune system quietly attacks the schistosome eggs, causing inflammation in major organs. The eggs accumulate where the worms hang out, so *S. haematobium* causes urinary bladder inflammation and blood in the urine, while *S. japonicum* and *S. mansoni* cause gastrointestinal issues. Over the years, this chronic infection causes bladder cancer and liver fibrosis. Schistosomiasis is a known, preventable infection that causes cancer.

Another treatable infection that causes cancer is far more prevalent, infecting half the world's population, *Helicobacter pylori* bacteria. This bacterium infects the stomach, causing ulcers, and if left untreated can cause stomach cancer. Gastric cancer is the fourth leading cause of death worldwide, and *H. pylori* appears responsible for a majority of these cancers. This infection is easily treated with antibiotics and acid-blocking medications, but the symptoms of infection can be subtle. All patients with stomach ulcers should be checked for *H. pylori*.

The problem with schistosomiasis and *H. pylori* is that patients remain asymptomatic and often don't know they have these infections. In the case of schistosomiasis, the best thing is to avoid infection. In areas endemic to the parasites, do not swim or wade in fresh water unless it is properly chlorinated. Bathing water should be boiled or held in storage tanks for several days. If you do accidentally fall into contaminated fresh water, vigorously towel dry. Drinking the parasite isn't specifically harmful as it cannot enter through the GI tract, but other things can, so boil drinking water as well.

If you're infected with schistosomes, the treatment requires only one or two days of a pill called praziquantel, but after initial flu-like symptoms it can be difficult to detect ongoing disease, which can last years. When in doubt, if you have a possible exposure, test. Take a urine and stool sample to your doctor and you too can be tested for schistosomes and *H. pylori*, while you're at it.

[AFRICAN SLEEPING SICKNESS \(AFRICAN TRYPANOSOMIASIS\)](#)

Sleep is one of the most important things we do. A human will spend approximately one-third of their lifetime sleeping. It has been shown that disruptions in the circadian rhythms of night shift workers cause decreased life expectancy and also increased risk for miscarriages in pregnant women. Sleep is an essential part of being human. Given how important sleep is, we know very little about it. And when humans don't understand why something happens, we make it up.

Why does the sun rise in the east and set in the west? That's the direction of the Greek god Helios's chariot.

How did zebras get stripes? A zebra got burned walking through a baboon's fire.

How did the novel coronavirus spread so quickly? 5G towers.

We are a species famous for fabrication because we are uncomfortable with the unknown. Everything from the ocean tides to reasons to eat vegetables can be explained by fables, myths, old wives' tales, or, sometimes, your neighbor Tim. This is all caused by the inability to answer one question: Why?

Even with a narrative unburdened by facts, the underlying moral may be impactful. Storytelling has improved and saved lives. Aesop would agree.

For instance, when your grandmother told you carrots were good for your eyes, that may be true. Carrots contain beta-carotene, which the body converts into vitamin A, and a deficiency in vitamin A can lead to night blindness. However, if vitamin A levels are adequate, carrots are just another vegetable.

Grandma might have gotten her insight into carrots from a British newspaper. During World War II, the British Air Ministry wanted to hide the use of radar technology from the Germans, so they orchestrated a press campaign that their pilots were eating high amounts of carrots, bestowing upon them exceptional night vision. The Brits even sent a telegram to Walt Disney, who immediately created a cartoon carrot family to get in on the ruse. It's still unclear if the Germans were duped, but grandmothers everywhere rushed out to buy carrots.

Once we can explain things scientifically, these old stories are typically forgotten. But when facts remain elusive, fairytales reign supreme. There is no shortage of tales involving the mysteries of sleep: Sleeping Beauty, Rumpelstiltskin, Snow White, the Wizard of Oz. Sleep has always

captivated human interest, but in this disease, it becomes its victim's worst nightmare.

African sleeping sickness is caused by *Trypanosoma brucei*, a parasite. The trypanosome is transmitted by the tsetse fly of sub-Saharan Africa. When it bites, it hurts like a #*\$@%. The tsetse fly is found in rural areas, feeds exclusively on blood, and, unlike most mosquitoes, often bites during the day. When an infected fly bites a human, it can transfer the trypanosome parasite. The parasite can also be transferred from a mother to a fetus. There are rare cases of other types of transmission, such as sexual contact.

The tsetse fly and thus the *Trypanosoma* is found in twenty-four countries, but the World Health Organization reports that in the past five years the disease has primarily been seen in Angola, the Central African Republic, Chad, Gabon, Guinea, Malawi, South Sudan, Cameroon, Côte d'Ivoire, Equatorial Guinea, Uganda, Tanzania, Ethiopia, and Zambia, with more than half of the cases reported in the Democratic Republic of the Congo.

Symptoms begin up to three weeks after the tsetse bite, and transmission can be progressive for a year. A sore may develop at the bite site, and months of intermittent flu-like symptoms may follow, including headache, fatigue, itching, joint pain, and lymph node swelling in the groin, armpits, and specifically the back of the neck—known as Winterbottom's sign. This lymph node swelling on the back of the neck may be an indication of the parasite going to the brain.

During the second stage of African sleeping sickness, the trypanosomes have traveled to the brain, causing neuropsychiatric symptoms. The sleep-wake cycle reverses, with a desire to sleep during the day and be awake at night. Patients are also struck by sudden urges to sleep, similar to narcolepsy. Other neurological symptoms such as motor weakness, hallucinations, and visual changes can all occur. African sleeping sickness causes brain swelling that eventually leads to seizures, coma, and death.

Diagnosis of this disease can be difficult and varies based on the stage of the disease. The parasite can sometimes be found in blood testing or lymph nodes, but definitive diagnosis and staging for the disease often require a lumbar puncture, which is a procedure where a small needle in the spine removes cerebrospinal fluid surrounding the brain.

African sleeping sickness is curable, but fatal if untreated. There are a handful of drugs that treat this disease, depending on the stage of disease

and the subspecies of the parasite. Treatment requires two years of follow-up with lab testing. Unfortunately, some treatments have the possibility of horrific side effects such as kidney toxicity and brain swelling.

At the beginning of the twentieth century, an outbreak of African sleeping sickness killed one-third of the population of Uganda's Busoga region. After it killed a quarter of a million people, there were major efforts to reduce the disease burden via control of the tsetse fly population as well as screening and treatment for the disease. In the last twenty years, new case numbers have reduced by 97 percent, but the fight against this disease continues to require coordinated public health efforts.

There are other ways this parasite impacts human lives. The parasite can also infect livestock, causing nagana, a disease that results in emaciation and death. This disease is estimated to have a direct economic impact, with a loss of as much as \$1.2 billion and three million cattle annually.

There is no vaccine or preventative medication for African sleeping sickness. You can, however, use DEET bug spray, and wear neutral-colored protective clothing, as the tsetse fly is attracted to movement and vibrant colors. The CDC also recommends staying out of bushes.

I'm willing to bet my last poisonous apple that not many readers knew of this disease before reading this chapter. It may be obscure since it is relatively rare, but this is also a neglected tropical disease (NTD). NTDs affect more than one billion people in impoverished communities. The top fifteen countries where African sleeping sickness occurs have a combined GDP less than that of the United States; in fact, their combined income is less than any single-earning country in the top twenty.

There are superior cures and preventative medicines to be discovered, but these efforts must be funded. The system of capitalism in healthcare has left many behind. The world has more billionaires than ever; meanwhile every ten seconds a child dies from malnutrition. These are solvable problems, and humanity can do better.

CYSTICERCOSIS

Whatsoever parteth the hoof, and is cloven-footed, and cheweth the cud, among the beasts, that shall ye eat. For nevertheless these shall ye not eat of them that chew the cud, or of them that divide the hoof: as the camel, because he cheweth the cud, but divideth not the hoof; he is unclean unto you. (Leviticus 11:3–4)

He [Allah] has only forbidden to you dead animals, blood, the flesh of swine, and that which has been dedicated to other than Allah. (Quran, Al-Baqarah 2:173)

Religions often focus on differentiating their practices as unique, but many religions are remarkably similar. For instance, according to the writings of the Christian Old Testament, Torah, and Quran, pork has been off-limits for over a thousand years. “Don’t eat pig” is a major mantra of many religions, but the justifications were a bit creative. The Bible and Torah are concerned with the fact that pigs have toes, as the hooves of pigs are split. The Quran went old school with “Because I said so.”

They were all right. While bats carry rabies, and rats carry fleas that transmit the bubonic plague, pigs carry many types of parasitic worms, some of which can kill you. It was imperative to avoid these historically untreatable porcine-specific parasites, regardless of reasoning. Today we have treatments available, but many people are still inclined to pass on the pork, which may continue to be a good choice. If you can’t live without bacon, maybe skip this chapter. But if a holy book or personal preference keeps you from consuming pig, stay right here to have your decisions reinforced.

Swine can carry up to forty different parasites. Before you get self-righteous, using slurs like “pig pen,” humans can host around three hundred different types of parasitic worms. The problem is pigs are known to eat a little poo from time to time and with it comes worms. A study of one pig farm showed that around half of the pigs were infected with parasites. I bet a lettuce and tomato sandwich is looking pretty good right now.

Pigs can pass you all types of worms, roundworms, whipworms, pinworms, tapeworms, plus nematodes, and other microscopic parasites. Most people are freaked out by the worms because eventually, you have to meet them. None of them are good for you, but only a few are deadly.

One of the worms you want to avoid is *Taenia solium*, the pork tapeworm. I know the urge is to blame the pig, but let’s just say this disease requires two to tango. You can start a cycle anywhere, but we’ll start this one at your butt. A human infected with a pork tapeworm defecates up to fifty thousand microscopic worm eggs into the environment. The pigs eat the human feces containing eggs, usually found in soil, which causes their piggy muscles to fill with parasites. Humans then consume undercooked pork meat containing the worm’s intermediate parasite phase, called

cysticerci. The cysticerci infect the gut of the pork consumer and grow into intestinal worms.

Adult pig tapeworms can live in the human small intestine for years. The adult tapeworms are problematic but not the deadly part of this parasite's life cycle. The real threat comes when a human eats the eggs of a pork tapeworm, instead of the cysticerci found in pork meat. Think of it like eating the caterpillar instead of the butterfly, but grosser. The worm eggs hatch, crawl through the wall of the gut, then circulate in the bloodstream to human muscle and sometimes the brain, where they form the cocooned phase of the parasite, cysts filled with cysticerci.

Treatment for pork tapeworm in the small intestine is as easy as one pill, a single dose of praziquantel, or three days of albendazole. If taken en masse by a population, in conjunction with deworming animals, this drug could stop the transmission of the parasite.

In the brain, pork tapeworm cysticerci cause a disease called neurocysticercosis, which is the number one cause of preventable epilepsy in the world. As many as 8.3 million people worldwide are estimated to have neurocysticercosis, a treatable and preventable disease. One of those 8.3 million people may have been Health and Human Services Secretary Robert F. Kennedy Jr., who stated he had a worm in his brain, which several experts hypothesized was a pork tapeworm. Without treatment, neurocysticercosis can cause headaches, blindness, meningitis, stroke-like symptoms, and death.

Neurocysticercosis is a complicated disease to treat, requiring longer courses of antiparasitic medications, steroids, and anti-epileptic drugs. When the antiparasitic medications start killing the cysticerci, inflammation in the brain can worsen neurological symptoms, which is why steroids are given. Neurosurgery, once the only treatment to remove the cysts, is rarely indicated since the advent of effective medications.

Prevention is preferred, which includes good handwashing, clean food and water sources, and full cooking or freezing pork meat. One study showed that freezing pork for three days at 5°F (-15°C) kills the tapeworm parasite, while another proved that cooking at 176°F (80°C) for ten minutes did the trick. There is also an initiative to stop the parasite at the piggy via a porcine vaccine.

Although rare in the United States, pork tapeworm can be found worldwide, more commonly in rural areas. The disease highlights the need

for clean water and the lack of health equity caused by poverty. Being poor should not increase the likelihood of illness and death, but there is a direct relationship between socioeconomic status and health.

For instance, in the United States, the most important number in determining your health is not your blood pressure or cholesterol; it's your zip code. Melody Goodman, PhD, researched social determinants of health at the Harvard School of Public Health and found that "Your zip code is a better predictor of your health than your genetic code." Social determinants of health in the United States influence where you are born, the food you eat, the medical care you have access to, and even when you die.

There are other types of tapeworms that are perhaps more infamous than the pork tapeworm, but less deadly. Legend has it that in the Victorian diet, women would swallow a tapeworm. Whispers of this weight loss plan resurfaced in the 1970s when diet pills were a raging fad. The weight loss coach was not the pork tapeworm but *Taenia saginata*, the beef tapeworm.

Though beef tapeworms do not cause brain cysts, they still cause nausea, vomiting, gallbladder blockage and infection, pancreatitis, and more. Getting rid of the worm only requires a single pill, but then you must expel the worm. Beef tapeworms can grow up to eighty-two feet long, all curled up in the intestines, producing up to a hundred thousand eggs. I suggest sticking with Weight Watchers.

In the real world, there are a lot of ways these parasites pop up where you least expect them, like in a diaper. One shift in the emergency department the patient brought an uninvited guest. *Ascaris suum*, the pig roundworm, preferentially sets up camp in pigs but can be transferred to humans through pig feces, often found in dirt. My patient was mid-diaper change when the worm made an appearance. It was several inches long and everyone in my ED refused to touch it, which isn't a bad policy. Wearing gloves, I placed the worm in a specimen cup and sent it off to an ecstatic infectious disease specialist to confirm speciation. Turns out the kiddo lived on a farm and had some piggy house pets, which unfortunately had worms. I placed the baby on medication. The pigs were also advised to seek treatment.

There is another *Ascaris* that is far scarier. In Asia, Africa, and Latin America, *Ascaris lumbricoides* has infected up to 1.2 billion people. The most common human parasitic infection in the world is easily treatable and causes severe malnutrition, belly pain, and belly distension. This disease is

more common in children and can be fatal when worms become so plentiful they block and perforate the intestine. A single dose of albendazole cures over 95 percent of patients with this disease, and costs as little as four cents. Many diseases in our world could be eradicated by a shift in priorities. The same religious books that warn about the dangers of pork share other important features, such as encouraging acts of charity.

In Christianity, the New Testament states, “And do not forget to do good and to share with others, for with such sacrifices God is pleased” (Hebrews 13:16). The Hebrew phrase “*tikkun olam*” is an important concept in Judaism where acts of kindness are used to repair the world. And one of the five pillars of Islam is *Zakat*, the religious duty of Muslims to help the needy.

It seems like they all say the same thing: Help others and don’t eat pork. If you are agnostic or atheist, these are just good morals and safer food choices. The truth is it doesn’t matter what you call them; it matters what you do.

HYDATID DISEASE (ECHINOCOCCOSIS)

“Scalpel.” You think I’m dramatizing, but they actually said that, and it is the same word in French.

The walls were blue and white tiled in the well-used but sanitary operating room. The patient lay sedated on a table in the center of the room. He was covered by a sterile blue sheet as the surgeon operated on his liver. I stood off to the side, not even qualified to hold suction as a visiting second-year medical student.

The surgical lights overhead flickered momentarily, then the room went dark. My heart raced. The patient was ventilated on a machine that required electricity, and the surgeon, mid-surgery, had the patient’s abdomen splayed open. Over the pounding of my heartbeat, I noticed the conversation continued as normal, but everyone stood frozen, except for the anesthesiologist, who had taken to squeezing the oxygen bag, mechanically delivering breaths to the patient.

Sensing my unease, the surgeon turned to me, saying in French, “It’s OK, the generator will turn on momentarily.” Fortunately for me, Moroccan physicians speak French in academic settings, such as the hospital. This was

helpful since I only knew ten words of Arabic. Just enough to get me into trouble.

A minute later the lights flickered on, and the world was set swiftly back into motion.

During the summer of 2013, I completed a rotation at the Chu Ibn Rochd Hospital in Casablanca. After a long day of surgery, not being particularly helpful but not getting in the way, I went in search of dinner. Of all the gin joints in all the towns in all the world, I walked into Rick's Café. It really exists, created after the 1942 film, and is a tourist trap. But it had great food, and the piano player was perfect, so I went back twice. What? I'm a tourist, and it's my favorite movie.

Each day I returned to Chu Ibn Rochd Hospital. This is one of the largest and most important teaching hospitals in Morocco. The doctors and medical students were kind and brilliant. There were many similarities between Moroccan medicine and medicine at home, but there were also differences.

These differences were due to environment, population health, and genetics. Therefore, some diseases seen in this population differ from those I would traditionally see during medical school in Washington, DC. One of the most interesting diseases was caused by the parasite *Echinococcus*, also known as the hydatid worm. The parasite is present in the United States but has an estimated five human cases per year, many of which occur in Alaska, so it is unlikely that most United States-trained physicians will see the disease.

Echinococcus doesn't look like a typical worm. It looks like a poorly made sausage link with two suckers and hooks in its mouth. It's a nightmare. Don't Google it.

This worm is generally passed from sheep and dogs to humans. This is known as a zoonotic infection. I think you can probably puzzle that one out, but zoonotic infections are those that can be passed from animals to humans. Zoonotic infections are responsible for some of humanity's most deadly diseases, like human immunodeficiency virus (HIV) and possibly COVID-19. There are two main ways that infections are passed from animals to humans: Humans eat the meat of infected animals or ingest their feces.

Even with good hygiene, when endemic, this worm is difficult to avoid. Parasites survive because they are good at spreading. In some

environments, such as sheep farms, *Echinococcus* becomes pervasive, and the hydatid worm exists all over the world. Unfortunately, a lack of public health education and resource restrictions driven by poverty in farming communities worldwide allows the parasite to thrive and infect between two and three million people today.

After the hydatid worm egg is ingested by humans, it hatches inside the intestines and then enters the bloodstream. As if that isn't scary enough, part of this life cycle creates hydatid cysts in the liver, lungs, and brain.

The hydatid cysts are cysts full of larvae. These cysts are like little land mines within the human body. If disrupted, they can cause an anaphylactic reaction, dropping blood pressure, closing the airway, resulting in possible death. There is a treatment for *Echinococcus*, albendazole, but treatment may take years, and it is often not successful. There is also PAIR (puncture-aspiration-injection-reaspiration) therapy, where a needle draws fluid out of the cyst and injects chemotherapy, but surgery remains the most effective treatment.

The cyst must be carefully removed by a surgeon in order to not release its contents. If you ever played the game of Operation as a child, it's like removing the funny bone, broken heart, and charlie horse, but they can explode.

When the lights went out in the hospital operating room, the surgeon was in a precarious moment before removing *Echinococcus* hydatid cysts from the patient's liver. During my internal panic, the Moroccan physician remained calm, with a steady hand. After the surgery, I was told that the public hospital sometimes loses power and that a generator is always set to turn on.

In Morocco, there is a public healthcare system and a private healthcare system. The public healthcare system provides over 85 percent of the healthcare, but only accounts for 40 percent of healthcare spending, clearly lacking resources.

On that first day arriving at Chu Ibn Rochd Hospital, I entered through the front door, which was an enlightening mistake. A hundred patients stood at the front doors shouting what I assume were their medical complaints. It was in Arabic, so I can't be sure. I stood in the crowd, confused about how the hospital could possibly triage the mob of patients, but also how I might get inside. Luckily, a medical student found me and showed me the physician entrance and how to navigate patient triage. In the crowd were

several patients seeking treatment for hydatid cysts, some of whom had been waiting years to be cured.

During my days off, I got to know the city. Casablanca is a modern industrial city that sits on the Atlantic. I strolled the boardwalk, where locals would walk ponies on leashes. I'm not sure if this is a common occurrence, but I kept passing ponies. At one end of the boardwalk sits the beautiful Hassan II Mosque, on the other a large shopping mall, complete with a three-story fish tank, and in the middle just beyond the shore is the small mystical island of Sidi Abderrahman.

Saint Sidi Abderrahman was a nineteenth-century holy man from Baghdad who was said to walk on water and travel through realms. The island is his possible resting place, thought to have healing powers. The island is now a religious site, home to fortune tellers and mystics, and a destination for those who have lost faith in modern medicine.

It is easy to lose faith in modern medicine because healthcare systems often leave patients behind. The problem is not science, but the system. Most healthcare infrastructures are guilty of this, but maybe none are more guilty than the United States, where despite the world's highest healthcare spending of \$4.3 trillion annually, we are fortieth in life expectancy, with some of the world's highest rates of obesity, heart disease, and cancer. Meanwhile, 62 percent of US bankruptcies are due to healthcare costs. While I worked at Chu Ibn Rochd Hospital, many patients were cured by surgical removal of their hydatid cysts. As far as I know, none of them got a bill.

Humanity must determine if we want a world where healthcare is a right or a privilege. And in the United States, where we have declared certain truths to be self-evident, what does it mean to have the right to life?

While we continue to feud over ideologies for the sake of dollars, there exists a little island full of magic off the coast of Casablanca that costs nothing and gives people hope: Sidi Abderrahman.

RIVER BLINDNESS (ONCHOCERCIASIS)

I bet you thought I would bring up Dr. William Herbert Foege in the next chapter, on smallpox, but plot twist, he is in the river blindness chapter.

For those who don't follow the public health superhero scene, Foege is a medical hero who created a strategy to boldly do what no man had done

before: eradicate a disease from the planet. He is the Spock of smallpox. The smallpox eradication was brought to you by Dr. Foege, and many still don't know his name.

Let me tell you, this doctor thing is not for the faint of heart. It's not all bad: You get to help people in a way that matters, but this is not a career, it's a calling, and it will take over your life. Just be sure you know what you're getting into. If you're looking for hero worship, you want to be a celebrity, not a doctor. If you want to be rich—tech or a trust fund. If you want to eat stolen saltines and peanut butter as a meal at 3 a.m. on Christmas—doctor.

Anyway, after smallpox, superhero Foege and other multinational public health avengers assembled, supported by President Jimmy Carter and the First Lady, to take on their next villain. The disease was river blindness, and the drug was ivermectin, a canine heartworm medication.

In the late 1980s, the head of Merck Pharmaceuticals, Roy Vagelos, approved the testing and production program for ivermectin (brand name Mectizan) after it was discovered to be a possible treatment for river blindness by Dr. William Campbell. Around the same time, the Child Survival and Development task force appointed Foege as its executive director. Foege had killed smallpox and increased worldwide childhood vaccination from 20 percent to 80 percent in six years. This guy was the king of public health program implementation. Merck approached the task force, offering the production of free ivermectin treatment for river blindness if they could design a successful distribution program. Thus, the Mectizan Donation Program was born, which has since approved over 370 million free treatments of ivermectin worldwide and eliminated river blindness in Colombia, Ecuador, Mexico, and Guatemala.

River blindness is spread by the bite of the black fly. The worms enter through the bite, creating nodules in the human skin and connective tissue where they mature and live for up to fifteen years, producing thousands of larvae called microfilariae daily that move through the bloodstream. These baby worms travel through the body for more than a year before they die, and when they do, the body's immune system attacks, creating inflammation. The symptoms of inflammation depend on the location of the microfilariae, but associated inflammation in the eyes eventually causes blindness.

Treatment for river blindness is ivermectin given every six months for fifteen years, which is the lifespan of the worm, or for as long as there is

evidence of infection. The medication will kill microfilariae and stop associated inflammation and blindness, but the worms living in nodules must die on their own before a patient is cured. It is important to not give ivermectin if a person is concurrently infected with the African Loa loa, another type of parasitic worm.

While most people with Loa loa do not have symptoms, the worm can sometimes be seen moving just under the surface of the eye. Ivermectin given to those infected with Loa loa can cause deadly brain swelling, so patients must be checked and treated for this worm before being treated for river blindness.

As far as direct death from river blindness, it has been shown that the higher a person's microfilariae load, the more likely they are to die, but the cause of death is not well understood, with the current hypothesis being immune system suppression.

Today the battle against river blindness rages on, with global estimates still around 18 million infected and 270,000 people blinded by the disease. We have the weapon needed to defeat this villain, in part because, in this case, big pharma put patients first. As George Merck once said, "We try to never forget that medicine is for the people. It's not for the profits."

In the lobby of the headquarters of the \$264.87 billion pharmaceutical giant Merck is a statue of a young African boy leading an older man with a stick, depicting river blindness. This statue is an ode to a drug that is not lucrative nor the epitome of innovation but saves lives.

VACCINE-PREVENTABLE DISEASES

Smallpox

Polio

Measles, Mumps & Rubella

Tetanus, Diphtheria & Pertussis

Vaccine-Preventable Meningitis

Influenza

Hepatitis A, B, Not C

Rabies

SMALLPOX

Smallpox is a disease caused by the variola virus.

The virus has been traced to as early as the third century BC, found in a smallpox pustule on the mummy of Pharaoh Ramses V. Over centuries smallpox spread throughout the world via trade routes, killing three out of ten people who contracted the virus. Those who did not die were often left horribly disfigured by scars the pox left behind. Smallpox even infected the eyes, at one time causing up to one-third of blindness in Europe.

Symptoms of smallpox begin with fevers, body aches, and vomiting. Sores form in the mouth and on the tongue and burst, then pustules or pox appear uniformly in a centrifugal distribution, moving away from the center of the body, eventually including the palms and soles. Once all pustules crust over and fall off, the virus is no longer contagious but unfortunately leaves disfigurement behind. The virus can also infect the brain, and causes stillbirths, and infertility in men.

It is difficult to determine how many people died from this ancient virus. It is estimated that more than three hundred million people died of smallpox from 1900 to 1978. That is equivalent to the total current US population. The most common way to die of smallpox was systemic shock and organ failure.

Flat-type smallpox, more commonly seen in children, was named for the way the pox do not form but coalesce on the skin, making the skin appear “velvet-like.” Flat-type smallpox occurs when a patient has a deficient immune response to the virus and almost always results in death. Another lethal manifestation, hemorrhagic smallpox, causes bleeding into organs.

In 1978, a medical photographer working on a smallpox research floor at a medical school contracted the virus. Her name was Janet Parker, and she was the last person to die from smallpox.

How was the smallpox virus eradicated? It is a tale of bovine heroism and the greatest medical advancement ever made, over and over again, by a few different civilizations.

In 1700s England, a thirteen-year-old orphan boy, Edward Jenner, was eavesdropping on some milkmaids. One milkmaid starts bragging about her perfect complexion and how she will never have to worry about being

disfigured by smallpox. Since she had been infected with cowpox, she claimed to be resistant to smallpox infection.

One story of determination and triumph later, the orphan boy became an English doctor. Jenner remembered the milkmaids' cowpox discussion, inspiring his discovery of the smallpox vaccine. Sometimes folk wisdom is right. Carrots can be good for your eyes, and cowpox, a relatively benign disease, does prevent smallpox.

Unfortunately, to prove his theory, Jenner gave his eleven-month-old son cowpox. It did make his son immune to smallpox but probably should have triggered a child protective services call and Jenner jail time. Contemporary scientists do not do initial vaccine research on children or at-risk populations. Today's vaccine research is conducted on healthy adult volunteers.

There is a second, more likely account of the discovery of the cowpox/smallpox dynamic. Jenner may have overheard the clinical observations of Dr. John Fewster, who discovered that farmers with cowpox were resistant to smallpox. Unfortunately for Fewster, the milkmaid tale is catchy and it's often the catchiest storyteller with a pen who writes history.

It also seems the Western world prefers scientific discoveries to be written down in English. There is evidence of the practice of inoculation in China, Africa, and India long before any Western discovery of vaccines. In China, the smallpox scab was ground into a powder and placed in the noses of healthy individuals to create an attenuated form of smallpox, lessening disease severity. It was a tad earlier than Jenner, around the year 1000.

The modern smallpox vaccine was developed by Louis Pasteur. Dr. Pasteur invented the idea of cooties, also known as *don't touch that or you'll contaminate it with bacteria*. He called this idea germ theory. Pasteur's vaccine was created using an attenuated or weakened smallpox virus, similar to the year-1000 Chinese method.

In the end, the instrumental vaccine heroes were recognized. The English word *vaccine* is derived from the Latin word for cow as a salute to the brave bovines who suffered cowpox for our needs. Vaccines are arguably the single greatest scientific discovery of mankind, which we discovered a few times.

In 1980, the World Health Assembly announced smallpox had been eliminated due to the success of the vaccine. Since eradication, the smallpox vaccine is no longer administered, but stores of the vaccine are

archived in case of bioterrorism or disease re-emergence. The smallpox virus itself is stored in only two locations for research purposes. The WHO chose the US and Russia as the storage locations for the virus since there was only a brief history of volatile relations between the countries.

POLIO

When parents bring children into my emergency department, they are all asked the same question: “Is your child vaccinated?” This is arguably the most important health consideration in a sick child. When a parent answers “no,” I often have a moment of silence for their cognitive dissonance. It just doesn’t make sense. This is similar to walking into a church with a shirt that says “Jesus is NOT my homeboy,” and then asking for a miracle. You can believe whatever you would like, but for the sake of all that is holy, please be consistent.

“Is your child vaccinated?” This is arguably the most important health consideration in a sick child.

The rate of refusal of recommended childhood vaccinations is a commentary on the failing educational and public health systems in the US. There are families in many countries that beg for access to vaccines, while in the United States, vaccine privilege has created opportunities for malignant misinformation and sometimes willful ignorance.

One childhood vaccination recommended by the WHO, CDC, and American Academy of Pediatrics is the polio vaccine.

Polio is a disease that was largely eradicated by vaccines, but given the difficulties getting vaccines to certain countries, especially war-torn areas, Pakistan and Afghanistan had wild polio transmission in 2022. The “wild” poliovirus is the regular old virus, as seen in the wild, and it knows how to party.

Vaccines come in several varieties. One of the most common vaccines is an inactivated vaccine, such as the injectable flu vaccine. This vaccine is the equivalent of taking a picture of a virus and presenting it to the immune system, saying, “Look out for this guy; he is bad news. If you see him, attack.” This vaccine is made from a dead virus, and you cannot get the virus from the vaccine, just like you can’t get attacked by a mug shot. Polio

has an inactivated vaccine given as an injection. Other inactivated vaccines include rabies and hepatitis A.

Another popular vaccine type is the subunit, recombinant, polysaccharide, or conjugate vaccine. These vaccines take an important identifying feature of the virus and show it to the body so that the immune system can identify and attack the virus. This is the equivalent of matching fingerprints to the culprit and then locking the perpetrator in jail. These vaccines cannot cause viral or bacterial illness, just like five fingerprints can't smack your face, and include the vaccines for hepatitis B, HPV (human papillomavirus), whooping cough (pertussis), streptococcus pneumonia, meningitis, and Hib (*Haemophilus influenzae* type b).

Live attenuated vaccines may be where vaccines got a bad rap. A live attenuated vaccine is like a self-proclaimed killer who spent his whole life in prison. He is now 107 years old, and though the killer instinct may still linger, there are not many people who couldn't take the old guy. I don't know if you have ever been attacked by a 107-year-old, but it is not very threatening. You're mostly concerned about them falling.

The issue is that, in rare instances, live attenuated vaccines can recombine, coming together to form a more active virus. The centenarian jailbird could find an able-bodied youngster to work with and they could wreak havoc together. For this reason, live attenuated vaccines are not given to people who are severely immunocompromised, and most are not given to children until a bit later in life, when their immune systems are ready. Live attenuated vaccines include the nasally administered flu vaccine, oral typhoid, measles, mumps, rubella, rotavirus, smallpox, chickenpox, yellow fever, and the oral polio vaccine. The benefit of a live attenuated vaccine is that the vaccine's virus, though weak, can still replicate, so the immune response is stronger, making immunity longer lasting. There are a few other types of vaccines, such as toxoid, viral vector, and hot-topic mRNA, proven safe and effective in large population studies.

For polio, the two vaccine options are the inactivated injectable vaccine and the live attenuated oral vaccine. These vaccines fight the three strains of polio, wild type 1, 2, and 3. Wild type 2 polio was eradicated from Earth in 1999, and type 3 got the boot in 2020. Unfortunately, type 1 is hanging on by a Middle Eastern tapestry thread, still present in Pakistan and Afghanistan.

The live attenuated oral polio vaccine has some risks and benefits, though keep in mind those benefits eradicated those first two strains of polio from Earth. The live vaccine replicates and the virus is passed in the stool, so in communities with poor sanitation, vaccine-associated polio can be passed to others. This was considered a possible benefit to the vaccine when given in remote areas with poor vaccine access because it helped the attenuated vaccine virus propagate. The circulating vaccine-derived poliovirus, as opposed to wild-type poliovirus, is generally benign, but as the virus becomes stronger it can be dangerous for the unvaccinated and those with weakened immune systems. For this reason, the live attenuated oral polio vaccine is not currently licensed in the United States, where only the inactivated polio injection is given. Ironically, the best way to stop the circulating vaccine-derived poliovirus is vaccination.

In the US, the polio vaccine remains part of the CDC-recommended vaccine schedule for children, and for good reason. In 2022, a twenty-year-old Hungarian man was partially paralyzed after contracting circulating vaccine-derived poliovirus, likely while outside of the United States, but the CDC had increased US wastewater surveillance for the virus as a precaution and unfortunately found vaccine-derived poliovirus. Though those vaccinated are safe, the unvaccinated, immunocompromised, and children are at risk. At risk for what? I'm so glad you asked.

Polio is a nasty little picornavirus that may only be made of a single strand of RNA, but that's all it needs to mess you up. This type of virus is transmitted through the fecal-oral route, brought to you by daycares everywhere. The virus can also be found in oral and nasal secretions. The viral infection, which at first causes symptoms of fever, sore throat, nausea, and vomiting, enters the body through the GI tract and then moves into the bloodstream to travel to the brainstem and spinal cord, where it attacks motor nerves, causing a paralysis known as poliomyelitis, infantile paralysis, or paralytic polio. Poliomyelitis most commonly affects children under five years old, with around 70 percent of infected children showing symptoms. Among those paralyzed up to 10 percent will die once the paralysis affects their breathing muscles, as paralysis from polio is often permanent. The polio virus can also cause other diseases, such as brain infections, namely meningitis and encephalitis. The disease is highly contagious, with patients being infectious for several weeks after infection,

which is how the virus killed or paralyzed over half a million people a year prior to the vaccine.

Unfortunately, those who escape major injury from the initial infection can still develop postpolio syndrome fifteen to forty years later, which causes muscle atrophy, weakness, chronic pain, and joint degeneration for which there is no treatment. Grab your crystal, Karen, it's your time to shine. The only treatment for polio is supportive care; there is no cure.

Before the vaccine, in 1927, Philip Drinker and Louis Agassiz Shaw at the Harvard School of Public Health created the iron lung, a machine that would help a polio patient breathe by changing the atmospheric pressure surrounding the body. There are images of warehouses with rows of iron lung chambers containing patients during epidemics, where some patients would remain for months, while others would spend a lifetime. Paul Alexander used an iron lung for more than seventy years after contracting polio at the age of six. He unfortunately passed away during the writing of this book.

Polio has taken down some big names. Frida Kahlo, the awesome Mexican painter with an aggressive *eyebrow*, is often pictured sitting or as a bust in paintings, possibly because at the age of six she contracted polio, and after she was bedridden for nine months, her right leg was permanently shorter than the left. The godfather of film directors, Francis Ford Coppola, recounted the isolation of spending over a year of his life confined to a room with polio. Franklin D. Roosevelt had restricted mobility reportedly due to polio, although there is a spirited debate among scientists over his paralysis possibly being related to another neurological disease. Regardless, the president was a major advocate for the creation of the polio vaccine, which was released in 1955 shortly after his presidency, and administered to Elvis Presley on *The Ed Sullivan Show* to advocate for vaccination. By 1979 the vaccine had brought polio numbers in the US to zero, compared to historical numbers of sixteen to twenty thousand cases of paralytic polio annually.

Internationally, polio was still a widely spread debilitating disease throughout the 1980s, when 350,000 annual cases occurred in 125 countries, paralyzing more than a thousand children a day. This is where crystal-wielding Karen needs to check her privilege, because she lives in a community where she does not fear having to watch her child's last breath due to polio, and that is because of the vaccine and those who chose to

vaccinate. US parents get to make the choice not to vaccinate. Some parents do not have that choice, as they have no access to vaccines.

As if polio wasn't scary enough, some may want to reconsider their stance on vaccines given new viruses coming our way, as well as some old ones. *Jurassic Park*, the epic tale written by physician-author Michael Crichton, had a great teaching point—there are some things better left in the past. Jean-Michel Claverie is a French virologist who has pioneered the field of paleovirology. He is the French Ross Geller of viruses. After a team of Russians revived a thirty-thousand-year-old flower from permafrost, Jean-Michel Claverie decided to one-up them and took to reviving the *giant viruses* found frozen in the prehistoric ice. I kind of wish scientists would stick with flowers, but since the permafrost is thawing, we should probably know what is coming back to life to get ahead of the curve by creating vaccines early.

In conclusion, vaccinate your children for polio, and if you are an adult, check with your primary care doctor to determine if you need a one-time booster, especially if traveling. And be nice to scientists; they have access to prehistoric zombie viruses.

MEASLES, MUMPS & RUBELLA

I grew up in Southern California and was privileged to frequent the happiest place on Earth, which is Disneyland. That preternatural Floridian monstrosity they built in Orlando is not Disneyland.

The only Disney theme park built under the supervision of Walt Disney, Disneyland was imagined in the 1940s and built in Anaheim, California. The theme park allows patrons to be transported to different worlds with only a few steps, from Frontierland to Adventureland to Tomorrowland, but unlike international travel that requires passports and vaccine records, this requires only a purchased ticket. Because traveling to a fantasy world does not require a passport or vaccinations, there are those who travel to Disneyland unvaccinated.

In December 2014, a child with measles was taken to Disneyland, exposing hundreds of park-goers to the virus. It wasn't until January 2015, when an unvaccinated eleven-year-old was hospitalized for measles, that public health authorities sourced the outbreak, which spread to several states, Canada, and Mexico, to Disneyland. The CDC reports that 75 percent of the measles cases in California occurred in people who were

unvaccinated, most due to *personal beliefs*, while Canadian cases occurred almost exclusively in nonimmunized individuals. During the outbreak, one in five US cases of measles required patient hospitalization.

Measles was eradicated from the US in 2000, but due in no small part to *personal beliefs*, vaccination rates sharply declined, and the disease reemerged. I assumed California would be a leading offender, but was surprised to find that according to a CDC 2021–2022 report of MMR vaccination among kindergartners, the least vaccinated states were Alaska, Kentucky, and the home of taxation without representation, the District of Columbia. But there are unvaccinated children in every state, and in 2025, in the South Plains region of Texas, a measles outbreak, largely among the unvaccinated, caused the unnecessary death of at least two unvaccinated children.

A key driver of the decline of measles, mumps, and rubella (MMR) vaccination rates is a debunked article linking the vaccine to a rise in autism published in 1998 that spread like wildfire.

Multiple investigations found that the doctor in question falsified data, performing unethical and invasive testing on children, which was funded by lawyers pursuing litigation against vaccine-producing companies.

The US started vaccinating for measles in 1963, and in the late 1990s autism rates began to rise. Sure, it wasn't a perfect fit, but this was not actual science, so it was close enough. The perceived rise in autism may have been due to new US educational tracking in the 1990s when autism was added to the list of disorders protected by the Individuals with Disabilities Education Act, or the 1994 diagnostic inclusion of the condition previously known as Asperger syndrome, a milder form of autism, or maybe autism rates were truly on the rise. But it had nothing to do with the MMR vaccine. There was no causation here, only a weak correlation, like the parallel increase of New York City murders and ice cream consumption during warmer summer months.

The article was unfortunately published by *The Lancet*. Although it was later retracted, the damage was done. The lead physician was banned from practicing medicine by the British General Medical Council, and an onslaught of verified scientific articles were published showing no link between the MMR vaccine and autism, but the article's legacy lives on in the form of more than a hundred thousand measles deaths every year, most in children under the age of five.

The measles vaccine, part of the measles, mumps, and rubella (MMR) vaccine, prevented an estimated 94 million measles deaths worldwide in the past fifty years, mostly in children under five.

The measles vaccine, part of the measles, mumps, and rubella (MMR) vaccine, prevented an estimated 94 million measles deaths worldwide in the past fifty years, mostly in children under five. Prior to the vaccine up to four million people in the US were infected with the virus annually, with forty-eight thousand hospitalized, resulting in thousands dead or left with disabilities. Despite the full vaccine's near 99 percent effectiveness in preventing measles, worldwide measles deaths increased by 43 percent during 2021–2022, likely due to setbacks in vaccination during the COVID-19 pandemic.

Measles, also known as rubeola, is caused by a highly contagious virus spread by droplets when sneezing and coughing, and can remain in the air for up to two hours. Measles is so contagious that a single exposure will infect up to 90 percent of unvaccinated people.

One to two weeks after measles exposure, a patient will have fevers as high as 105°F, cough, eye redness known as conjunctivitis, and coryza, which is a fancy word for runny nose. These ridiculous medical words are used because they all start with C, and medical teaching loves any excuse for a mnemonic. The patient may then develop Koplik spots, which are white spots in the mouth. Finally, around four days after initial symptoms, a red rash starts on the head and moves down the body. Patients are usually contagious from four days before to four days after the rash appears. This may sound innocuous, but there can be complications.

One in five unvaccinated people in the US who contract measles will require hospitalization. Most severe cases of measles are in children under five, those over the age of twenty, the pregnant, and unvaccinated individuals. According to the CDC, one in twenty children who contract measles will get pneumonia, a lung infection that is the leading cause of death in children with measles. The measles virus is also very good at attacking the brain, causing encephalitis, an infection that leaves children deaf and with intellectual disabilities. In the US, one in every thousand measles patients developed brain infections, often resulting in permanent intellectual disabilities. With up to four million cases of US measles prior to the vaccine, this is a potential four thousand people with permanent

intellectual disability annually, largely children. Three out of every thousand US children infected will die from the virus and there is no treatment for measles. Survivors of the measles virus still have a possibility of developing subacute sclerosing panencephalitis seven to ten years later, which causes a progressive neurological decline in children and young adults that is fatal.

The diseases that scientists target with vaccines are targeted for a reason. They are historically the most prevalent, contagious, or deadly diseases, and therefore the vaccines have the biggest impact on improving public health. Measles was prevalent, contagious, and deadly, and it can be again if vaccination rates decline.

The MMR vaccine is a live attenuated virus, so it is the old killer who has been in prison for life and is now 107, not very threatening but still worth keeping an eye on. This is why the vaccine is given to children a bit later in life and is not given to pregnant women or those with severely weak immune systems. There are other reasons to delay getting the MMR vaccine, such as illness, recent blood transfusion, and current use of antiviral medications. Adverse effects of the MMR vaccine have included fever, rash, lymph node swelling, joint pain, and transient low blood platelet count. The MMR vaccine is not associated with autism or encephalopathy, which is brain swelling and dysfunction that can be caused by a disease, like the measles virus.

The two ugly stepchildren of the MMR vaccine are mumps and rubella.

Mumps is a viral illness that causes fevers, body aches, and swelling of the parotid salivary glands, creating puffy cheeks. The virus can also cause inflammation in dangerous places like the brain, ovaries, pancreas, and testicles, which is where scientists drew the line and created a vaccine. The disease can cause male sterility or decrease fertility, and around half of men noticed shrinkage in testicle size. The mumps infection can also cause deafness, but I think testicular mumps infection is what got the balls rolling on adding mumps to the MMR vaccine.

Rubella, also known as German measles or three-day measles, starts as a simple viral illness with fevers, rash, lymph node swelling, cough, and red eyes. In fact, one in four people don't even have symptoms from the virus; doesn't seem that bad, right? Up to 70 percent of women who get the virus may get arthritis, and there are other complications from the virus such as brain infections and bleeding problems, but the worst problems from this

virus begin before birth. The rubella virus can cross the placental barrier to a fetus and cause deafness, blindness, intellectual disability, liver and spleen damage, heart defects, and stillbirth in 20 percent of those infected. Helen Keller's deafness and blindness were reported not to be due to rubella, but possibly due to *Neisseria meningitidis* or *Haemophilus influenzae* meningitis, which are now also vaccine-preventable.

During the 1964 US rubella epidemic the virus caused over 8,000 babies to be born deaf, 3,580 deaf and blind, and 1,800 with intellectual disability. Of those women infected with rubella in early pregnancy, 85 percent will have children with fetal defects, and a child infected in utero can shed the rubella virus for over a year and develop complications up to four years after birth, including type 1 diabetes, thyroid dysfunction, and visual or neurological abnormalities. Thus, into the MMR vaccine rubella goes.

The MMR vaccine has undoubtedly saved countless lives. Actually, they counted, and the MMR vaccine has saved 93.7 million lives so far and prevented detrimental morbidity, but humans cannot feel the absence of pain; we can only feel its presence. When measles, mumps, and rubella were banished from the United States and generations marched forward, we forgot the suffering caused by these diseases. That is why you picked up this book, to understand the pain of unnecessary deaths and how to avoid them. This particular death can be avoided with one simple vaccine, and testicles will be safer too.

TETANUS, DIPHTHERIA & PERTUSSIS

Tdap and DTaP are the most common, generic forms of the tetanus, diphtheria, and pertussis vaccine. There are a ton of other pharmaceutical brand names for these two vaccines, but you know what Dr. Shakespeare said: "A rose by any other name would smell as sweet."

The uppercase letters in the vaccine mean that a full dose is being given, whereas the lowercase letters are a partial dose, usually used in vaccine boosters. DTaP is given to children under seven, and everyone else gets Tdap. For children, there is a vaccine schedule, while previously vaccinated adults should get a Tdap booster every ten years, or at five years with a dirty wound. This vaccine is the one that makes your arm sore, but man, does it protect you from a lot of bad stuff.

One issue with vaccine-preventable disease is that modern physicians do not see many of these pathologies, so I don't have firsthand stories for you about some of these diseases, but I consider that a good thing, and so should you.

Tetanus is something you never want to see. In 1809, being shot was the least painful part of the Napoleonic Wars, as surgeon and artist Sir Charles Bell depicted in a portrait of a young man who was suffering from *Tetanus Following Gunshot Wounds*. That was also the name of the painting. Surgeons are a literal bunch. The painting is of a nude man uncontrollably clenching every muscle in his body, lockjaw causing teeth to crack, back arched in pain off the floor, suffering severe, life-threatening spasms triggered by a soft touch, noise, or even light. Tetanus gets a 0/10, do not recommend.

Tetanus is caused by the bacterium *Clostridium tetani*, which is ubiquitous in soil, dust, and manure. The dirt your kid eats has a lot of stuff in it, like tetanus and anthrax. Luckily, tetanus is generally not contracted through eating the bacterial spores, and it is not contagious. Tetanus is contracted when *Clostridium tetani* spores infect an open wound, burn, or crush injury. You remember when you scraped your knee and your dad told you to "rub some dirt on it." Don't do that, especially if you can smell farm animals. You know what? Just don't do it. While tetanus is affiliated with animal feces, including those of horses and less commonly dogs and cats, it is not affiliated with rust. I am not sure whose grandma started warning neighborhood kids about rusty nails causing tetanus; it may have been mine. Rust does not cause tetanus, but puncture wounds require an updated tetanus shot, so there is no need to correct Grandma. It's a W, just take it.

The tetanus bacterium creates a toxin that travels up nerves to the spinal cord and brainstem to inactivate inhibitory nerve messaging, so the excitatory nerves that cause muscle contraction fire endlessly. This causes the symptoms of lockjaw, vocal cord spasms, and abdominal muscle spasms, leading to the primary cause of death in tetanus, respiratory failure. If this sounds familiar, it may be because botulism toxin has a similar but different mechanism, with the opposite effect, causing flaccid paralysis.

Today, most reported cases of tetanus are newborn and maternal tetanus occurring in the 75 million unvaccinated worldwide, mostly due to lack of vaccine access.

Today, most reported cases of tetanus are newborn and maternal tetanus occurring in the 75 million unvaccinated worldwide, mostly due to lack of vaccine access. Maternal tetanus is contracted within six weeks of delivery, while neonatal tetanus is generally seen in the first twenty-eight days of life. Both are due to nonsterile delivery environments and tools, such as the knife used to cut the umbilical cord. In 1998, an estimated 787,000 newborns died of tetanus globally, thus the World Health Assembly launched the goal of eliminating global neonatal tetanus. Revitalized by UNICEF, the World Health Organization (WHO), and the United Nations Population Fund, there has been a 97 percent reduction of newborn tetanus, but unnecessary loss remains.

If you are pregnant in the United States your provider should offer you a Tdap shot between weeks twenty-eight and thirty-six of pregnancy, which protects against neonatal whooping cough and also maternal and neonatal tetanus. Despite the availability of the vaccine in the US, the CDC estimates that 44 percent of pregnant women do not obtain the recommended Tdap vaccination.

Tetanus generally occurs within fourteen days of wound infection, progressing for two weeks after initial symptoms. Once symptoms start, treatment often requires intensive care, so in countries without ICU access, tetanus mortality is nearly 100 percent. Treatment for tetanus includes sterile removal of *Clostridium tetani* spores from the wound, antibiotics (which have limited effect), tetanus vaccine, and neutralization of unbound toxin via antitoxin, hopefully blocking the toxin before it can bind nerves and cause further damage. Similar to the botulism toxin, tetanus toxin that has bound nerves is irreversible. Thus tetanus effects last the weeks to months needed to regrow nerves; meanwhile patients are intubated, sedated, and paralyzed, while other pathologies of the disease are managed.

In summary, don't rub dirt on it, wash out wounds with clean water, and tetanus shots should be given as part of the childhood vaccine schedule, with a booster every ten years. If you sustain a flesh wound or start growing a human inside you, you may need a tetanus shot sooner.

The tetanus vaccine, or Tdap vaccine in adults, also contains the vaccination for diphtheria and pertussis.

Diphtheria is an ancient disease, described by Hippocrates in the fifth century BC, caused by *Corynebacterium diphtheriae*, a toxin-producing bacteria like tetanus and botulism. For *C. diphtheriae* to produce toxin, the

bacteria must first be infected with a virus, a corynebacteriophage that carries the tox gene. Yes, bacteria can be infected with viruses, and so can insects, plants, and even other viruses. Corynebacteriophages are weird viruses that promiscuously exchange bacterial DNA with *Corynebacterium* bacteria. They get around. When *C. diphtheriae* bacteria acquires the tox gene from the virus, it then produces a toxin that destroys local tissue, kidneys, nerves, and heart—and causes life-threatening disease. Prior to the acquisition of the tox gene, diphtheria causes flu-like symptoms, a severe sore throat, and sometimes invasive disease that infects the blood, heart, skin, and joints.

Diphtheria infection takes hold two to five days after exposure to respiratory droplets. Vaccinate your friends; they cough on you. The toxin produced by the bacteria causes tissue death and a pseudomembrane, a thick leathery layer of dead tissue, to form, which is why the bacteria acquired its name from the Greek word *diphthera*, meaning “leather hide.” This thick gray membrane of dead tissue can cover the nose, throat, tonsils, and voice box, and can move down to the lungs, making it difficult to breathe. And scab pickers beware, removal of the membrane can cause life-threatening bleeding of the airway. Diphtheria can also become malignant, causing massive swelling and infection on the neck, creating a thick, short-appearing “bull neck” in patients. The bacteria can enter the blood, infecting the heart and causing myocarditis, with up to 25 percent of diphtheria patients having cardiac dysfunction. Heart complications are the major cause of death in diphtheria, with myocarditis being the strongest predictor of death.

There is treatment for diphtheria with antitoxin infusions, antibiotics, and airway protection, often with a breathing tube. Unfortunately, antitoxin has a 10 percent rate of a reaction called serum sickness, but instead of explaining serum sickness, I will just encourage you to get the vaccine and skip diphtheria infection. Today, with aggressive treatment, diphtheria is fatal in 5–10 percent of infections, and up to 20 percent in children younger than five. Before contemporary treatment, half of the people infected with diphtheria died.

During medical school, I was rotating on the pediatric service of a university hospital in Washington, DC, when a nine-year-old boy with no medical problems was brought in by his parents. Earlier that week he had been seen by his pediatrician for five days of fever and sore throat and was

thought to have strep throat, thus had been sent home with antibiotics. The child presented to the emergency department three days later due to neck swelling and difficulty breathing, and this is where I met Andy.

Andy was struggling to breathe, with noisy breaths and an oxygen level of 75 percent, which is well below normal. He had to be intubated with a breathing tube, which quickly filled with copious white bloody fluid, and he was found to have gray patches on his tonsils. A throat swab showed *Corynebacterium diphtheriae*. Andy had diphtheria.

The antitoxin and antibiotics were started immediately, but Andy's troponin heart marker was already highly elevated due to myocarditis and heart inflammation from the toxin. His heart rhythm started to change, and he developed a heart block, which is where the heart can no longer communicate to beat correctly. A pacemaker was placed, but Andy developed other arrhythmias, requiring shocks with a defibrillator. Despite treatment and exhaustive efforts, Andy's heart stopped beating on his sixteenth day of hospitalization.

While this story is true, this was not my patient, as it did not take place in the United States. This is a 2014 *British Medical Journal* case report of a child in Thailand by Charles Henry Washington et al. "Andy" was born at a rural hospital in Thailand, where he received his TB and hepatitis B vaccines at birth, but no subsequent vaccines. Due to readily available vaccines in the US, I have never seen a case of diphtheria, but low diphtheria vaccination rates still plague 16 percent of the world's children. How Andy contracted diphtheria is unknown; he lived with nine people but had no history of contact with anyone with diphtheria symptoms.

A major problem with diphtheria is there are asymptomatic carriers who walk around feeling great, giving it to everyone else. This is one of the reasons the vaccine is so important in preventing diphtheria; like most problematic people, they are unaware of their detriment to society. This is a reason adults need to get Tdap boosters every ten years when immunity wanes.

The last component of the Tdap vaccine prevents pertussis, also known as whooping cough.

Pertussis is the reason for my last Tdap vaccine. I was around the nine-year mark of my last Tdap vaccination when my sister had a baby, so it was time to level up. Pro tip: I have found if I exercise, lift weights, or move my

arm by repeatedly lifting food to my mouth the day of the vaccine, I do not have a sore arm the day following a Tdap vaccine.

I can't imagine watching your baby get pertussis. I couldn't even handle watching my dog get kennel cough. We spent ten hours in emergency vet rooms—rooms, plural. Kennel cough is caused by a pertussis bacterium, *Bordetella bronchiseptica*, which usually does not cause disease in humans.

A related bacterium prevented by the Tdap vaccine, *Bordetella pertussis*, causes whooping cough in humans, named for the “whoop” sound patients make when first able to breathe at the end of coughing fits. The cough is uncontrollable, and can be accompanied by convulsions, cough-induced vomiting, and even breaking ribs. Children under the age of one with whooping cough will sometimes stop breathing and turn blue, with one in every hundred dying from the infection. Although pertussis can be treated with antibiotics, this is another bacterium that is toxin-mediated, so the antibiotics do not ameliorate symptoms; they just stop things from getting worse. *Bordetella pertussis* toxin paralyzes the lungs' cilia, microscopic hairlike structures responsible for clearing bacteria, particulate, and mucus out of the lungs, so the lungs become twin dumpster fires and patients feel like trash.

The *Bordetella pertussis* vaccine got some bad press initially. The initial vaccine was a “whole cell” vaccine, DTwP, which uses the entire bacterial cell to make the vaccine, thus eliciting a strong immune response including high fevers. The vaccine was alleged to have caused neurological damage to children and thus caught the attention of the media. Although causation wasn't proven, the emotional damage was done, so high-income countries created an acellular vaccine, DTaP, which only uses identifying pieces of the bacteria, like fingerprints to identify a killer. The acellular is now exclusively used in the United States. There has been no mass hysteria about the DTaP vaccine in the past thirty-three years, but there's always time.

Vaccines save as many as five million lives a year, mostly in children. It is important to ask healthcare providers questions and understand your health decisions. There will always be an abundance of incorrect information in the world; for every right answer there are an infinite number of wrong answers. Finding the right answer starts with finding a provider you trust, like your primary care provider. If you have vaccine hesitancy, talk to your doctor, but if you want my advice, I will give it to you in the

slightly edited words of the illustrious rapper Saweetie: *Tap in, Tdap, Tdap, Tdap, in.*

VACCINE-PREVENTABLE MENINGITIS

Bacterial meningitis is to be avoided at all costs. Fortunately, the cost is a vaccine that is 100 percent covered by insurance. In the neurology section of this book, we review types of brain infections, namely meningitis and encephalitis. Meningitis is an inflammation of the meninges, a layer covering the brain, most often caused by infection, while encephalitis is inflammation of the brain tissue itself.

Most cases of meningitis are caused by viruses and are not severe, but bacterial meningitis is deadly. The most common causes of bacterial meningitis in adults are *Neisseria meningitidis* and *Streptococcus pneumoniae*, both vaccine-preventable diseases. A third common cause of bacterial meningitis, more often seen in children, is *Haemophilus influenzae* type b, which is also vaccine-preventable.

After the creation of these three vaccines, the incidence of bacterial meningitis dwindled. A study in the Netherlands showed that by 2014 the incidence of bacterial meningitis was reduced to 1.58 episodes per 100,000 population per year. Twenty-five years earlier, prior to the vaccines, the incidence of bacterial meningitis was 300 percent higher.

The *Neisseria meningitidis* vaccines are conjugate and recombinant vaccines. These vaccines use pieces of the bacteria to teach the immune system to identify *Neisseria*'s topical features, readying the body to attack immediately if the intruder is encountered.

There are two *Streptococcus pneumoniae* vaccines, one for the babies and one for the older ladies and gentlemen. These are conjugate vaccines and polysaccharide vaccines that again take fingerprints of the bacteria, ready to attack at first identification. The pneumococcal vaccine helps prevent diseases caused by *Streptococcus pneumoniae*, including meningitis, bloodstream infections, pneumonia, and even ear and sinus infections. This is unfortunately not the streptococcus that causes strep throat, that's *Streptococcus pyogenes*. Fun fact to pull out at your next cocktail party when someone tries to talk politics.

Lastly, the Hib vaccine is a polysaccharide conjugate vaccine, meaning the vaccine shows the immune system the fingerprints of *Haemophilus influenzae* type b to identify and fight off the bacteria in the future.

Haemophilus influenzae type b is a bacterium that can be deadly in infants, causing pneumonia, bloodstream infections, infective arthritis, skin infections, meningitis, and epiglottitis, which is a deadly swelling of the airway. Before the vaccine, more than half of cases of meningitis in infants worldwide were due to *H. influenzae*, and in the US one in two hundred children would develop an invasive infection from the bacteria before age five. After the implementation of the Hib vaccine, rates of invasive *Haemophilus influenzae* infection in the US fell 99 percent, to less than 0.3 in 100,000 in all ages.

None of the vaccines that prevent bacterial meningitis are live vaccines, so it is not possible to get the diseases from the vaccines. The most common side effects include short-lived fevers and injection site pain, but any possible side effect is collected in the VAERS database.

The US Vaccine Adverse Event Reporting System (VAERS) collects reports of any adverse events that occur in the context of being given a recent vaccine. For instance, in 2007 there were reports of five individuals who died of a bacterial illness associated with *B. Cereus* who had recently been given the Hib vaccine, causing concern for contamination of the vaccine. Merck & Company voluntarily recalled 1.2 million Hib vaccine doses while the FDA and CDC rapidly investigated the deaths, which were found to be unrelated to the Hib vaccines.

VAERS reports are an important tool for vaccine safety and surveillance, but reports can be submitted by anyone and are unverified, so this leads to the collection of some interesting “data.” There have been complaints of postvaccine baldness, anal leakage, nosebleeds, and penis growth. The system has been used by anti-vaxxers to publicize the dangers of vaccines, but VAERS is a tool intended for surveillance of trends to be investigated by the FDA and CDC. It is inherently flawed information, much to the dismay of many porn stars and Pfizer, whose last hit single, Viagra, topped the charts at around \$1.8 billion in annual revenue.

Due to the effectiveness of vaccines, cases of bacterial meningitis caused by *Neisseria meningitidis*, *Streptococcus pneumoniae*, and *Haemophilus influenzae* type b are rare, but even with vaccines bacterial meningitis still exists. There are other types of bacteria that can cause meningitis, there are those who choose not to vaccinate, and vaccines do not offer 100 percent protection. Having a vaccine is like wearing a

bulletproof vest: You're much better protected but you can still get shot in the leg.

Due to parts unprotected, I still encounter bacterial meningitis.

I was working a 7 a.m. weekend shift in the emergency department, which I generally prefer because the department is not overwhelmed with patients. Anecdotally, most life-threatening emergencies happen between 1 p.m. and 3 a.m. Monday through Thursday, excluding major holidays and the Super Bowl. For instance, my own mother refused to go to the hospital while in labor with my sister until a football game ended. This may be the type of attitude that makes the night after the Super Bowl and the day after Christmas absolute disasters in the ED.

You may think, as an emergency medicine doctor, I would be drawn toward life-threatening emergencies, but I am not. Like a moth avoiding a flame after being educated on the dangers of bug zappers, I am averse to suffering, and staving off death is stressful. I'd much rather reduce a shoulder dislocation and then have a coffee. Anyway, I was working an early-morning shift, so I believed I could get coffee before my first life-threatening disaster arrived.

I was wrong, obviously, or there would be no story here.

A pediatric patient arrived seizing, with no history of seizures. Seizures can be caused by a variety of medical issues such as brain masses, brain bleeds, hyperthyroidism, low blood sodium or glucose, medication overdose, infection, epilepsy, and at least twenty other causes. As scary as seizures are, there are some seizures that are not dangerous, such as "simple" febrile seizures.

Simple febrile seizures can occur in children aged six months to five years with a fever greater than 100.4°F, but typically greater than 101°F. These are generalized seizures, meaning the patient loses consciousness and often the whole body shakes, lasting less than fifteen minutes with a quick recovery to baseline. The child must have only one seizure in a twenty-four-hour period to qualify as a simple febrile seizure. The cause of simple febrile seizures appears to be, in part, genetic and likely related to the vulnerable state of the developing nervous system in children, but, by definition, recovery is quick and full.

So, how do you know if your child has an easy-peasy, simple febrile seizure or a deadly seizure-causing illness? You don't; that is why you have a doctor, who will now skip her morning coffee. The diagnosis of simple

febrile seizure is complex, especially because it requires the presence of a fever-producing illness.

On this early morning, I was presented with a child between the age of six months and five years old, having a one-minute generalized seizure in that setting of a fever, but I knew something was wrong. The patient met the criteria for simple febrile seizure, which does not require further workup, but I felt a tingle in my Spidey Sense, aka expert pattern recognition due to greater than ten thousand hours of medical training. The child was admitted and treated for the diagnosis of bacterial meningitis. Untreated bacterial meningitis carries a mortality of nearly 100 percent, but even with prompt diagnosis and treatment, in high-income countries, pediatric mortality from the most common form of bacterial meningitis remains around 25 percent.

Some of my stories do not have happy endings. A colleague once told me that every emergency doctor has a number, the number of children you can see pass away before you can no longer do the job. Mercifully, the deaths of children are rare and made even more so by vaccines.

INFLUENZA

“I have the flu” is a common refrain that means many different things colloquially, but only one thing in medicine. “The flu” refers to the influenza virus. A virus so infamous that every cold and unrelated stomach bug is blamed on influenza. But stomach flu, man flu, head colds, and flu-like illnesses are caused by thousands of other viruses, and the notorious F.L.U. has nothing to do with it. I’m here to set the record straight for a virus that should not be confused with a head cold, a virus that kills hundreds of thousands of people a year and is responsible for the deadliest pandemic in history. Grab your hand sanitizer and a mask, because this is the OG virus.

Influenza is ancient. Hippocrates tried to give people a heads-up and described the illness in 412 BC, but people weren’t big on sanitation, so the virus continued to spread. There is some dispute due to the inaccuracy and paucity of historical medical records, but an influenza outbreak in the 1500s is largely regarded as the first pandemic. In the mid-1700s the term *influenza* had been coined in Great Britain to describe the disease. Like a stray dog, we named it but knew next to nothing about it. In 1918, we learned.

Most adults have had the influenza virus before. Mild and common flu symptoms include fevers (a fever is a temperature greater than 100.4°F), cough, chills, and body aches lasting three to seven days. Although some children will exhibit gastrointestinal symptoms and barf all over you, influenza is a respiratory virus, so this is less common, especially in adults. The “stomach flu” is a nonmedical term usually describing one of many viruses unrelated to influenza, such as norovirus, that cause violent nausea, vomiting, and diarrhea, enough to make you hate your Caribbean cruise.

The flu spreads via surfaces and close-range respiratory droplets from sneezing, coughing, or speaking. If the spittle from patient zero comes into contact with the inside of your nose, mouth, or respiratory tract, then it's off to the races. One to four days later symptoms begin. Influenza infects and damages the cells of the respiratory tract, which causes initial symptoms of congestion and cough, but also opens the lungs up to deadly secondary bacterial infections, which was likely the cause of most deaths during the 1918 influenza pandemic.

The 1918 Spanish flu was so named because powerful northern countries quickly looked to assign blame for the illness to foreigners. Spain was neutral during World War I with a free press that openly and honestly covered the devastation of the influenza pandemic, while other countries suppressed media coverage of the death toll of the virus, likely concerned that it would injure morale related to the war effort. Possibly due to their honest reporting, poor Spain got stuck with the slur, even though the country was not the origin of the influenza pandemic, nor the reason for its rapid spread. Apologize to the Spaniards, and let's find more appropriate names for viruses in the future.

According to the Pan American Health Organization, the first reported case of the “Spanish flu” was at Fort Riley in Kansas on March 11, 1918, where overcrowding and poor sanitation spread the flu to more than five hundred men within a week. These troops then marched across the globe, a perfect setup for a devastating war against an unseen enemy.

Influenza A, H1N1, was responsible for the 1918 flu pandemic, infecting one-third of the world and killing more than fifty million people. The pandemic took the lives of Austrian painter Gustav Klimt, US First Lady Rose Cleveland, and automobile manufacturers Horace and John Dodge. Lacking the needed public health infrastructure, we are unable to define the true number of people lost in this pandemic, but the highest

estimates conjecture that for every hundred people infected with the virus five and two-fifths died. Why was the virus so deadly?

It was a *mélange* of conditions, but also, the virus had perfect timing. While the world was distracted by World War I, the virus hitchhiked all over the globe with troops that lived in overcrowded, unsanitary conditions. There was no treatment or flu vaccines, and healthcare capacity was reduced by war efforts. The virus also mutated to become more aggressive, with an estimated mortality rate between 2.5 and 5.4 percent compared to the flu's usual less than 0.1 percent, acquiring the ability to cause respiratory failure in a patient over several hours.

As more people were infected with the virus and lived to develop immunity, along with public health efforts such as closures of public spaces and quarantines, humanity was able to recover. Society returned to normal life by the 1920s, just in time to fight a new enemy: US prohibition laws.

In 1933, at London's National Institute for Medical Research, the influenza virus was finally isolated and identified as an orthomyxovirus; soon after, the first flu vaccine was developed by Thomas Francis and Jonas Salk at the University of Michigan. The vaccine was tested on the US military, and then released to the public in 1945. This was the first time science identified and prevented the spread of the influenza virus, which meant we could get rid of all the old wives' tales. But we did no such thing, so here are some clarifications:

Gargling with salt water does not prevent or treat influenza. It is not possible to "catch a chill": cold air, wet hair, and air conditioners do not cause influenza or any other viral illness. Over-the-counter medications are for symptomatic relief and do not cure influenza, and that includes zinc, vitamin C, and echinacea. The two vitamins and the flower have some promising studies and may help boost the immune system to lessen symptoms, especially zinc, but it has some pesky side effects. *Feed a cold; starve a fever* or *feed a fever; starve a cold*—I've seen it written both ways, so clearly it doesn't matter; when sick, stay hydrated and eat healthy. When choosing to feed a fever or cold, chicken soup as a cure for illness was a stellar marketing campaign by Campbell but has no proven effect.

In 1999, Tamiflu was created and several other antivirals to treat influenza followed. When started within forty-eight hours of the onset of influenza symptoms, Tamiflu has been shown to have some efficacy in decreasing symptoms and duration of the virus by about a day, with the

most common side effects being nausea and vomiting, which is fun to add to your flu symptoms. However, a short course of Tamiflu is good at preventing influenza in those exposed, and this might be where it is most useful. As the FDA states, Tamiflu is not a substitute for the yearly influenza vaccine.

The two major types of influenza virus are influenza A and B. Influenza B is divided into different strains while influenza A is identified by two marker proteins on the surface of the virus, the H and N antigens. For instance, influenza A H1N1 is the subtype responsible for the 1918 flu pandemic and the 2009 swine flu, which started in North America, mostly affecting children and young adults without multiple previous flu vaccines or exposures. Since influenza A can infect animals as well as humans, outbreaks can start in birds and pigs.

The H and N surface proteins, as well as parts of the influenza B virus, are the targets of the flu vaccine. Each year the influenza virus mutates at an alarming rate, much faster than most viruses, changing these targeted proteins. This makes predicting each year's flu vaccine a challenge, so the World Health Organization Global Influenza Surveillance and Response System (GISRS) looks at influenza samples from labs all over the world and consults leading public health experts at a hot-ticket annual meeting to determine what the year's most likely influenza variants will be. This is why some years the vaccine is less effective—it's an educated guess—but revaccination over the years may help build overall immunity to this tricky virus.

The injectable influenza vaccine, recommended annually by the CDC for everyone older than six months, is an inactivated vaccine with small identifying pieces of the virus. You cannot get the flu from the injectable flu vaccine; it is impossible. It is, however, possible to contract the flu from spittle-producing, fast-talking friends during or right after vaccination, which will make patients believe they got the virus from the vaccine. The nasal vaccine is a live attenuated virus, so theoretically, it could cause influenza, which is why it is not recommended in pregnant or immunocompromised patients. One of the only contraindications to receiving the injectable flu vaccine was an egg allergy, but according to the CDC's website, since 2021, influenza vaccine production has gone completely egg-free.

Each year's flu vaccine is recommended in September, but it's never too late to get the vaccine. And since there are multiple strains of influenza, you could always get the other one. The flu vaccine only prevents infection from Flu A and Flu B, and there are more than two hundred other respiratory viruses that can cause similar initial cold and flu symptoms, but common cold viruses generally do not progress to severe or deadly diseases.

If you want to take zinc, vitamin C, and echinacea, turn off the AC, and eat chicken soup, go for it, but to best avoid death by flu, get the yearly influenza vaccine. The injection cannot give you the flu, but your close-talking bar buddies can, so maybe give the vaccine a few days to start kicking in before returning to Cheers.

HEPATITIS A, B, NOT C

Hepatitis A, B, C, it's easy as 1, 2, 3 to contract, which is why these viruses are so prevalent. Hepatitis D and E also exist, but they are not in the song, so we'll skip those.

During residency, I was so delirious with exhaustion that I had several needlesticks in one week. I am vaccinated for hep B, so the major dangers from needlesticks are HIV and hepatitis C. The likelihood of a healthcare worker getting HIV or hepatitis C from a needlestick is low, but it's still a nerve-racking experience. After any HIV exposure, patients can be offered post-exposure prophylaxis using antiviral medications. There is no post-exposure prophylaxis for hepatitis C. Fortunately, after occupational health testing I was all clear, but I don't recommend handling sharp objects on zero hours of sleep.

Hepatitis A spreads via the fecal-oral route. That's right, humans have such terrible sanitation that viruses have evolved to spread from the butt to the mouth. This is evident by the signs in restaurant bathrooms pleading with employees to wash their hands. A study of grocery shopping carts around the United States showed that over 70 percent were contaminated with fecal matter, so clearly signs imploring bathroom hand hygiene should be expanded to include nonemployees.

Hepatitis A often spreads from person to person or via poo-contaminated food. The virus can remain on surfaces for hours and on food for several days. Hepatitis A infection initially presents as food poisoning, with nausea, vomiting, diarrhea, and abdominal pain. After about a week of liver inflammation, known as hepatitis, the liver is unable to make and

excrete bile properly. Because of this reduction in bile synthesis and excretion, the stool becomes white and the skin turns yellow, causing jaundice. Hepatitis A can be dangerous for pregnant women, causing preterm labor, and for those who are immunocompromised, but most patients will make a full recovery within six months, with only 1 percent going into complete liver failure.

Even if survival seems easy, this virus can cause complications, like lifelong autoimmune hepatitis, so it is best to avoid it. Because people have proven they will not wash their hands, a hepatitis A vaccine was created and released in the early 1990s. The CDC recommends this as part of the routine childhood vaccination schedule. Due to the vaccine, this virus has become less of a health threat in the United States but continues to take thousands of lives worldwide due to lack of clean water, sanitation, and vaccine access.

Hepatitis B can be more of a permanent and deadly problem. The World Health Organization estimates 254 million chronic carriers of the virus, with 1.2 million new infections annually. Hepatitis B (HBV) is contracted through blood, semen, and other bodily fluids, primarily through sharing needles or sexual contact. It can also be transmitted from mother to baby during birth. The CDC states that although HBV can be found in saliva, it is not transmitted through kissing, coughing, or sharing of utensils or food.

Acute hepatitis B infection can appear months after contracting the virus, with symptoms of jaundice, loss of appetite, fever, and liver pain in the right upper abdomen, but many patients have no outward symptoms. Sudden hepatic failure occurs in less than 0.5 percent of patients in this acute phase. While the virus is often cleared by healthy adults, it can become chronic, which is most common in children. Chronic hepatitis B causes liver cirrhosis, chronic liver failure, and liver cancer.

Hepatitis B results in an estimated 1.1 million annual deaths worldwide, many of which are due to hepatocellular carcinoma. Cancer is a leading cause of human death worldwide, and almost all primary liver cancer is hepatocellular carcinoma caused by hepatitis B and C. Hepatocellular carcinoma has a survival rate similar to that of pancreatic cancer, making it the third leading cause of cancer-related death in the world.

Hepatitis C is similarly contracted through blood products and sexual contact. Initial infection can cause fever, jaundice, and GI symptoms, or patients may be asymptomatic. Hepatitis C rarely causes acute liver failure

with initial infection, but most people cannot clear the virus from their body, so it results in chronic lifelong infection. Up to 25 percent of chronic hepatitis C will result in chronic liver failure from cirrhosis in the twenty years following initial infection.

The human liver is a magical organ that can regenerate, like a lizard's lost tail. For instance, in a liver transplant, a healthy donor can have up to two-thirds of their liver removed to donate and the remaining liver tissue will regenerate to full capacity in a process known as compensatory hypertrophy. A problem arises if the liver tissue is not healthy. Once liver disease reaches a stage known as cirrhosis, it results in permanent scarring and liver cell death, and these cells cannot regenerate. To diagnose liver cirrhosis, an MRI can be performed, but the definitive diagnosis is made through a liver biopsy that shows scarring.

Liver cirrhosis is caused primarily by hepatitis B and C in most of the world, but in the United States alcohol abuse rivals viral hepatitis for the number one spot. A liver transplant is a possible cure for cirrhosis and liver failure, but many transplant centers require patients with alcohol-related cirrhosis to abstain from drinking for a defined period to be eligible for the procedure.

Historically, hepatitis C has been the leading indication for liver transplant in the US, Europe, and Japan, but unfortunately, liver reinfection is universal in patients still infected with the virus, and accelerated liver disease is seen in most hepatitis C transplant patients.

While there is no vaccine to prevent hepatitis C, in 1998 the FDA approved the first treatment for chronic hepatitis C, interferon alpha, but unfortunately, even in combination with another drug, ribavirin, this treatment required yearlong therapy, was not usually successful, and had terrible side effects. In 2011, a new cure was found: direct-acting antivirals (DAAs), which cure more than 95 percent of cases with oral medication in just eight to twelve weeks. These medications inhibit the hepatitis C virus directly, but the original cost was an estimated \$160,000 per patient. Luckily this cost has decreased with the diversification of treatments.

During my first year as a new doctor, I was an intern in the intensive care unit service. Don't worry, they don't let first-year residents touch anything in the ICU; interns write notes, answer pages, and do paperwork, all with constant supervision.

My first patient had severe liver failure, causing his entire body to swell like a balloon, his skin to fluoresce a bright yellow, and his belly to distend with fluid. His name was Paul, and he was sixteen years old. Paul had come to the ICU after having brain swelling related to his liver failure, known as encephalopathy, and requiring intubation. He slowly improved and was able to come off the ventilator. We checked him for viral hepatitis, autoimmune hepatitis, and drug overdose, but everything was negative. Although some symptoms were improving with supportive treatment, his liver was not recovering. A liver biopsy then showed his immune cells were cannibalizing his liver, confirming the elusive diagnosis of a rare disease: hemophagocytic lymphohistiocytosis (HLH). While HLH is generally fatal for the elderly, it can be cured by a bone marrow transplant in children. Paul was transferred to a pediatric hospital for further treatment but was improving before the transfer. I am hopeful that his treatment resulted in total recovery, but liver failure is a deadly disease regardless of the instigating illness.

The vaccines for hepatitis A and B have saved millions of lives, and new treatments for hepatitis C are extremely effective. The hope is that with time and dedication to vaccination, these viruses and their associated liver failure, liver cancer, and death can be fully eradicated. But you should still wash your hands.

RABIES

One of my core memories from childhood concerns rabies. For readers who are not psychiatrists, psychologists, or watchers of the beloved Pixar film *Inside Out*, core memories are the life events that define your sense of self.

I grew up in a tract home community in suburban Southern California. We had a cute blue house with a white fence and a cherished yellow Lab named Rocky. When I was five, my parents thought it was time I learned a valuable life lesson, the danger of rabies, so they showed me the movie *Old Yeller*. The hero of *Old Yeller* is a yellow Lab who is bitten by a wolf while protecting his human family. Old Yeller survives the initial bite but develops rabies, foaming at the mouth and attacking his family, forcing the child to shoot and kill the beloved family dog.

I am not sure what the moral of the story was, other than “Don’t get rabies.” You better believe I became a tiny rabies vaccine czar. Although the

Old Yeller experience was traumatic, it is likely part of what made me who I am today: a doctor writing a book about death.

As for my parents, several months later I figured out how to order nineties infomercial toys for zero down by phone, so payback was adequate. I'm not sure if I got caught with Better Blocks, Blo Pens, or Floam, but eventually I was found out when bills started rolling in. Surprisingly, the rabies core memory did not incite a lifelong propensity for retail therapy, but rather a love of vaccines and a taste for vengeance. A poetic justice, considering the word *rabies* derives from the Sanskrit *rabhas*, meaning "to do violence."

Left untreated, rabies is 100 percent fatal. Well, 99.999999 percent. There is one individual who survived rabies without vaccine or immunoglobulin treatment: a fifteen-year-old girl from the exotic land of Milwaukee. You thought I was going to say Agrabah? Nope, she is homegrown.

Rabies is caused by a virus that is transferred through the saliva of mammal bites. Certain mammals in the US are prone to rabies, such as bats, raccoons, skunks, foxes, and the little Indian mongoose of Puerto Rico. Be aware, though, that any mammal can contract rabies. Smaller mammals can contract rabies, but they die quickly, before transmission is possible, which is why we don't worry about rabid squirrel attacks. Ninety percent of rabies within the United States occurs in wildlife, because we are privileged to have access to vaccines for our pets and livestock. In many countries, wild dogs are a major reservoir for rabies; thus dog bites account for 90 percent of human rabies deaths worldwide. In Africa and Asia, the disease causes tens of thousands of vaccine-preventable deaths every year, 40 percent of which are in children less than fifteen years old.

In the US, the majority of human rabies deaths are due to bat bites; the disease has been found in bats in every state except Hawaii. Only five out of the forty-five US bat species have transmitted rabies to humans, so if you can speciate bats on the fly you'll have a great advantage. Rabies infection rates in bat populations vary wildly, but one sampling showed that fewer than one out of two hundred bats test positive for it. The people who know say that most bats do not have rabies, but I like to assume 100 percent of bats could give me rabies.

As if they aren't creepy enough, bat bites are painless, so if you ever wake up in a room with a bat or find one in your home, you need treatment for rabies immediately.

If you're not afraid of bats yet, then you're not paying attention. As if they aren't creepy enough, bat bites are painless, so if you ever wake up in a room with a bat or find one in your home, you need treatment for rabies immediately. Bats who are found in odd places such as inside homes or flying around in daylight are probably losing it, thus are more likely to have rabies on the brain.

The CDC website recommends trying to capture the bat found in your home for rabies testing. They even have a step-by-step guide on how to capture your house bat on their website. However, this seems to me like a great way to get bitten by a bat. If I was in the business of handing out medical advice, I would say shut the door to your new bat room, call animal control to capture the bat, and go to the closest emergency department for rabies post-exposure prophylaxis. The CDC has stepped up its advice game, stating bats should never be kept as pets. So even if your house bat tests negative for rabies, you shan't keep him.

OK, time for science. Rabies is caused by a rhabdovirus that enters the skin at the bite site, attaching to and then entering the nerves within the muscle. Over the next ten to fifty days the virus travels up the peripheral nerve to the spinal cord, then to the brain—this is when rabies symptoms manifest. Once the virus has attached to that first nerve, it's game over.

Symptoms of rabies are bizarre and terrifying, which has served as inspiration in literature for centuries, from *The Iliad* to *Cujo*. (I hypothesize that Stephen King and I share *Old Yeller* as a core memory.) Initial symptoms mimic the common flu with fever, weakness, and headache, sometimes with tingling at the bite site. There are then two major forms of rabies: furious rabies, which manifests as hallucinations, hydrophobia (fear of water), agitation, and delirium; and the less common paralytic rabies, which slowly paralyzes the body, beginning at the bite site.

Hydrophobia in rabies is a fear of drinking water due to intense throat spasm caused by the virus. This inability to swallow, coupled with the increased saliva production caused by the virus, results in foaming at the mouth.

The “treatment” for rabies is prevention in the form of vaccination and post-exposure prophylaxis. We vaccinate livestock and pets against the virus and prophylactically vaccinate humans who have exposure risks. If you are bitten by an animal that may be an unvaccinated carrier of rabies, or you’re rooming with a bat, you need immediate post-exposure prophylaxis with the rabies vaccine and immunoglobulin injection. The immunoglobulin is made of antibodies to the rabies virus that bind the virus at the bite site before it attaches to a nerve. You also need the vaccine, given in four doses, to incite the body to make its own immunoglobulin to continue to fight off rabies. Those vaccinated prior to rabies exposure only need a vaccine booster. All of these therapies prevent the rabies virus from ever attaching to a nerve and inciting an infection.

Post-exposure prophylaxis for rabies is needed immediately, and the sooner the better. The more time that passes, the more likely the rabies virus will attach to a nerve, ending the life of the infected. But rabies is a bizarre disease, so while most cases manifest in two or three months, it can sometimes take up to a year, which is why treatment is recommended regardless of the length of time from exposure.

If a rabies infection has taken hold, it is close to 100 percent fatal. As mentioned, there was a Wisconsinite child who survived a rabies infection in 2004 after being bitten by a bat, and thus the Milwaukee Protocol was created. We don’t know why the treatment worked. I’ve read the protocol; it’s complicated, but the key is placing the patient under “aggressive” deep sedation, aka coma. Since 2004, the Milwaukee and the derivative Recife Protocol of Brazil have been used in a handful of cases, but reports of success are limited. The literature basically says, *Maybe it works, sometimes*.

In the case of the Wisconsinite child, I’m sure you’re wondering why her parents did not take her to the hospital for treatment immediately after the bat bite. “We never thought of rabies” was their answer. Thanks to this book, you will now think of rabies, probably more than desired. This is your *Old Yeller* moment. Now go forth, vaccinate, and do violence on rabies.

HEART DISEASES

Heart Attack (Myocardial Infarction)

Aortic Dissection

Broken-Heart Syndrome (Takotsubo Cardiomyopathy)

Inflamed Hearts: Pericarditis, Myocarditis & Endocarditis

Arrhythmias

High Blood Pressure (Hypertension)

HEART ATTACK (MYOCARDIAL INFARCTION)

James and his lady were on their last day of vacation, visiting California from their hometown in Texas, when they came into my emergency department. I must call her “his lady,” because I have no idea what her name was. James was my patient, and he referred to his wife as “Maverick.” She was a quiet, gentle eighty-two-year-old woman, but the name suited her in an endearing way. Each time he called her *Maverick* a blush crept from her neck to her face, and she would roll her eyes at her husband. When I asked where the name came from, he said, “That’s what I’ve called her since we were eleven years old,” and then I got one hell of a story that was not about James’s medical complaint.

“James, tell her about your jaw pain,” Maverick insisted in a worried tone. And that’s when I became concerned, as jaw pain can be a symptom of a heart attack.

Every forty seconds someone in the United States has a heart attack, known medically as a myocardial infarction. A heart attack is caused by a blockage of blood carrying oxygen to the heart tissue, which results in the death of the tissue. One in five heart attacks are “silent,” usually damaging a small amount of heart tissue without the person knowing, but others are “the big one” and cause the heart to stop beating almost immediately. Most heart attack–associated deaths will occur within four hours of symptom onset.

As any cardiologist will tell you, the heart is indisputably the most important organ in the body, as it’s in charge of pumping about two thousand gallons of blood a day to deliver oxygenated blood to the entire body. Theoretically, everyone is born with a certain preordained, unknowable number of heartbeats. If you make it to seventy years old, you’ve had about 2.5 billion beats. Given your heart is approximately the size of your fist, it’s a big job for a little guy. To do all this work, the heart tissue itself needs oxygen via the coronary arteries.

The coronary arteries are the pipes that bring oxygenated blood directly to the heart tissue. If these pipes are blocked, the oxygen cannot get to the heart tissue and this causes a heart attack. Irreversible damage starts at 30 minutes, but there is still a benefit of unblocking the clog for up to 120 minutes.

You should never ignore chest pain—because if you get to a hospital fast enough, a cardiologist can unclog your pipe and stop the damage.* Common symptoms of a heart attack include chest pain that may radiate to the jaw, back, or shoulder, often described as a crushing pressure (worse with exertion), shortness of breath, sweating, lightheadedness, nausea, and vomiting.

You should never ignore chest pain—because if you get to a hospital fast enough, a cardiologist can unclog your pipe and stop the damage.

Blockages in the coronary arteries are caused by all the things you think would clog your home plumbing: hamburgers, doughnuts, potato chips, etc. Risk factors for heart disease include smoking, drinking alcohol, high blood pressure, high cholesterol (specifically elevated low-density lipoprotein [LDL] cholesterol), family history of heart disease, diabetes, obesity, and lack of exercise.

The heart is a magnificent organ, even a neurosurgeon will admit it, but our most important organs can also be our most sensitive. The heart is so sensitive that it may be able to detect the beats of those you love. Since each heart has only a certain number of beats, some prefer to beat together—a study by the University of California, Davis showed that the heartbeats of lovers can synchronize. If I’ve ever met two people with synchronized heartbeats, I would bet it would be James and Maverick.

James’s jaw pain was immediately concerning, as it could have been a heart attack symptom, but it wasn’t. His eardrum had burst on the airplane, which would heal on its own in time. James took the opportunity to make endless jokes about not being able to hear his wife until his ear healed. I joined Maverick in her eye roll.

You see a lot of love in emergency departments, but most is through a lens of tragedy, which makes you realize that a busted eardrum can be a happy ending. James and Maverick walked out of the hospital, hand in hand, hearts beating together.

AORTIC DISSECTION

The respected emergency medicine physician and professor William “Billy” Mallon once said, “If you became an emergency medicine doc because you

loved ‘thank yous,’ boy, did you fuck up ... your best work doesn’t even know who you are.”

Dr. Mallon’s teaching is astute. Many patients saved in the ED never meet their emergency doctor or nurses. The ED is the limbo of medicine; no one is ever meant to stay. As the departmental saying goes, “Either up or out,” meaning a patient is either sick enough to be diagnosed, stabilized, and admitted to the hospital, or they are healthy enough to go home. For critically ill patients, ED interactions are usually a blur.

In the days following near-death experiences, patients will meet the doctors, nurses, and other providers caring for them elsewhere in the hospital; these are the names and faces they will often remember. The emergency department is a bad dream that patients try not to recall, but healthcare workers will always remember their patients.

Michael was one of my patients. He was a healthy family man, and he was nice, which is never a good sign. In medicine, it always seems like the nicest people get diagnosed with cancer and critical illnesses. I couldn’t find any supporting data, but I try to be rude once in a while, just in case.

“So, what brings you in today?”

“I have had this pain in my back. It first started a week ago. I went to an emergency department and had some tests and blood work, and everything was fine. The pain had gone away and then this morning it came back, and I had very minor chest pain. I feel fine now. I have no medical issues, but I just thought I should get it checked. I have young children, and I just want to make sure I am OK.”

Michael was a young man with upper back pain, taking no medications, and a nonsmoker. But I ordered an EKG.

The EKG was normal.

With one week of mild chest pain, no past medical history, no current symptoms, and a negative cardiac workup the same week, Michael could easily have been discharged. But there is a voice that develops with time working in medicine, a gestalt that can’t be reproduced by artificial intelligence or statistics; it is a tiny voice that whispers the truth.

I placed an ultrasound on Michael’s chest, and although his heart looked fine, there was a tear in his aorta, the main blood vessel that carries blood from the heart to the rest of the body. A CT of his chest confirmed the diagnosis of aortic dissection.

The aorta is the largest blood vessel in the human body, and it carries blood from the heart to every vital organ. An aortic dissection happens when a small tear inside the lining of the aorta creates a false track, causing blood to collect in the wall of the blood vessel. Imagine trying to pipe filling into a cannoli, but there is a chip in the pastry so the filling ends up in the wall.

Aortic dissections create a risk of the aorta exploding and can cause blood to surround the heart, creating a pericardial effusion and stopping the heartbeat. The type of dissection that creates a pericardial effusion is called *type A*, and it is 100 percent fatal if not treated immediately. Michael had a type A aortic dissection.

Michael called his wife and children to the emergency department, waiting for them to arrive before telling them the news of his emergent open-heart surgery. I started medications to control Michael's blood pressure and heart rate until the cardiothoracic surgeon arrived to whisk Michael away to surgery.

Michael was intubated with a breathing tube, but it was removed the day after surgery, and he walked the next day. He was released from the ICU within two weeks.

As it turns out, Michael's grandmother had died of an aortic dissection. Michael never knew this; he only knew his grandmother had "some heart problem." Michael was tested for a genetic disorder associated with aortic dissection, called Ehlers-Danlos syndrome; he was positive, so his children were tested and now have regular medical screenings. Find out your family medical history—it might save your life or the life of someone you love.

Michael's story was not a typical story for aortic dissection. Usually a patient with an aortic dissection will have sudden, extreme tearing chest pain radiating to their back. Michael only had a little tickle in his chest, so that threw me off a bit. He was a tough guy, but chest pain is never something to ignore.

Those at risk for aortic dissection include people with genetic connective tissue diseases, such as Marfan's and Ehlers-Danlos syndrome, aortic valve disease, high blood pressure, heart disease, a history of cocaine use, and syphilis. High-intensity weight lifting has also been associated with aortic dissection, so maybe take a few pounds off that deadlift. Dissection can also be seen in trauma, such as car accidents, but spontaneous tears are most common in men over the age of sixty.

Don't do drugs, treat syphilis, know your family medical history, and do the DASH diet to lower your blood pressure. All these things reduce the risk of aortic dissection. This pathology is rare, affecting 11.43 people in 1 million, or about 3,783 people in the US a year, but can pop up unexpectedly. And again, never ignore chest pain.

Several months later, a delivery woman arrived at the emergency department with a cart of coffee and pastries.

"I have a 'thank you' delivery from a patient, Michael."

The ED clerk smiled and prepared to accept the generous gift and show the delivery woman to the department's break room.

"Where is the intensive care unit?"

The desk clerk let out a sigh. "The ICU is on the tenth floor. You'll have to go back down the hall; elevators are on the left." The receptionist looked slightly deflated as the coffee cart's wheels squeaked off into the distance.

We did not choose emergency medicine for the thank-yous. I mean, we love free coffee, but it is not necessary or expected. Medical professionals choose emergency medicine to be there for patients on their worst days. And if patients forget us because it's all a blur, that's OK—we know where the ICU keeps their coffee.

BROKEN-HEART SYNDROME (TAKOTSUBO CARDIOMYOPATHY)

This is one of my favorite medical diseases for two reasons. First, I clearly have macabre interests. Second, human biology, emotion, and language have never intersected more poetically than in broken-heart syndrome.

Have you ever loved someone so much that they become your heartbeat? The beautiful truth is that humans can love so deeply that their heartbeats synchronize. This type of unostentatious love can be overlooked, as it is a *quiet love*, like the heartbeat you never hear: a mother giving up her health and body for her child, a lifelong couple holding hands through cancer treatments, or an enduring friend showing up when needed, despite time and space. This love is not built from epic moments, standing on a lover's front lawn holding a blasting boom box overhead. Quiet love is slow, enduring, and often taken for granted. The days can easily pass without acknowledging this love, which is felt most deeply in its absence. Having lost a quiet love at a young age, I am now careful not to take it for granted. I'm a very loud lover at this point—hand me my boom box.

Quiet love makes sure you've eaten and have a coat, attends countless sports games, secretly changes the car's oil, and sleeps in hospital chairs. It's a love that leaves a light on. It's not an epic story, and it's not particularly rare. Quiet love is not passion, but sacrifice that asks for nothing in return. It is a deep-rooted love with only a small tree to show for it—picture an asparagus plant. They might not write stories about a love so common, but it silently creates the good in our world. I think broken-heart syndrome may be a disease of quiet love.

I can't find any scientific evidence of the causation between quiet love and broken-heart syndrome. I can't even find unscientific evidence. I will say that takotsubo cardiomyopathy is more common in women aged between sixty-five and seventy, with one study finding 90 percent of cases in women with a mean age of sixty-seven years, and I don't think anyone loves others more quietly. Broken-heart syndrome, also referred to as takotsubo cardiomyopathy or stress-induced cardiomyopathy, is often triggered by extreme emotional stress, such as the loss of a loved one, causing the heart to literally break. Studies have shown emotional triggers are involved in one out of every three cases, while physical stress is involved in up to half of cases.

In takotsubo, part of the heart's left ventricle suddenly dilates, due to a temporary weakening in the heart's wall, causing an aneurysm. When the condition was first described in Japan, the aneurysm's odd shape earned the disease the name takotsubo, for its resemblance to the takotsubo pot used by Japanese fishermen to catch octopi, cephalopods that, coincidentally, have three hearts.

The most common symptom of takotsubo heart disease is chest pain. Yet again, don't wait to go to the emergency department if you have chest pain. Chest pain is always worth checking out.

Though the cause of takotsubo is not clear, stress, certain chemotherapy drugs, and anti-arrhythmic medications have been associated with the disease, and there was an increase in incidence during the COVID-19 pandemic.

As with most tragedies, we recover. And as we recover, the heart mends. In broken-heart syndrome, the treatment is supportive care. In medicine, that means treating associated medical issues, like low blood pressure caused by the disease. The broken heart usually repairs itself within two months, although there can be long-term complications in some cases, such

as heart failure, which means the heart does not pump blood as well as it should. Those with chronic diseases, such as diabetes, do have worse outcomes. But miraculously, most hearts that endure broken-heart syndrome recover.

I often wonder if patients feel that loving someone so deeply as to be vulnerable to takotsubo is worth the chance of suffering a literal heartbreak. If the end was known, would takotsubo patients protect themselves from the dangers of quiet love by loving less? For those who have endured such a loss, the answer has always been a resounding “no.”

INFLAMED HEARTS: PERICARDITIS, MYOCARDITIS & ENDOCARDITIS

It is true that you can die of a broken heart, as seen in takotsubo cardiomyopathy, but there are also diseases that enrage and inflame the heart. These diseases can be elusive to diagnostic testing and often take several doctors to diagnose. A heart on fire is full of secrets and subtleties that may end in insidious self-destruction.

Everyone’s favorite morally gray TV physician, Dr. House, was infamous for claiming that “everybody lies.” The fictional physician is an opiate addict, and Hugh Laurie is an actor, making neither a good source for medical advice, but both were right about this. Hell, even I have lied to my doctor—don’t tell her.

Most patients don’t lie with ill intent, but it’s hard to tell sensitive truths to a stranger. Have you ever done drugs? How much do you drink? Number of sexual partners? Men, women, or both? Ever smoked cigarettes? This is information society has taught us to protect for fear of consequence or judgment. When you arrive at your dermatologist appointment for a rash, you don’t really want to talk about your personal drug and sexual history. While some information seems trivial, patients do not know what doctors are looking for. You might think that smoking cigarettes with your friend who gave you gonorrhea is unimportant to the current medical conversation, but it tells the dermatologist where your rash is from and how to treat it.

The other reason many patients lie is simply through omission.

“Do you have any medical problems?”

“No.”

“I see here you’re on fourteen different medications.”

“Yes, I take my medications, so it’s no longer a problem.”

Fair point; however, it would be helpful at the start of an encounter to know that a patient has lupus, diabetes, and recently had a kidney transplant. In fact, it changes everything.

Medical decision-making is based on probabilities determined by scientific research, but these probabilities are disrupted by an infinite number of variables. The same diagnostic test results in two patients with different medical histories will have completely different meanings. A positive pregnancy test in a male* means cancer.

Certain diagnostic tests cannot be used for patients with particular medical histories; for instance, a D-dimer blood test can only rule out blood clots in patients with low-risk histories. Finally, the diagnostic strength of a test, known as the positive predictive value, is influenced by the patient’s history. If a patient has a positive COVID test and gives a history of spending a week in a room full of COVID patients, the likelihood of the positive test being correct is high. But if the patient gives a history of being quarantined on an island with no cases of COVID and tests positive, the test result likely indicates a false positive.

The problem with stretching the truth and omitting information is that it can make seemingly objective medical tests lie, and there are diseases that thrive under these circumstances, such as endocarditis. Endocarditis is intrinsically elusive and certainly does not need any help evading diagnosis, but it is a diagnosis that is often abetted by lies and omissions.

Julia was twenty-five years old and had the whole world in front of her. Unfortunately, things hadn’t gone her way. She moved across the country for a dream but ended up sleeping on the streets. She came into the county emergency department one night with a fever, but no other complaints. When I asked her about herself, she said she had moved for her boyfriend and the chance of a different life, but when things didn’t work out, she’d ended up jobless and homeless. She had no medical history but had been feeling unwell for the past week. She had no cough, no belly pain, no headaches, no neck stiffness. She had no symptoms, aside from a fever of 104°F.

“Have you ever done IV drugs?”

“No.”

Julia had a track record on her left arm that led me to believe otherwise. Luckily for her, the fever and undisclosed drug use were enough to set me

off in the right direction.

Luis had grown up in Central America, and also had “no history of any medical problems,” the day he came into my emergency department after feeling unwell for more than a week with high fevers. During his physical exam, I noticed several small, tender, raised red bumps on his palms. It wasn’t until his brother showed up and stated that Luis had heart valve disease resulting from childhood rheumatic fever that my diagnosis was corroborated.

Both of these patients had endocarditis: an inflammation, usually due to infection, of the inner lining of the heart, most prominently seen in the heart valves.

The heart is a pump with four valves that prevent backflow of blood. If these valves become injured, they are more likely to be a nidus for infection, as it is much easier for bacteria traveling in the blood to latch onto the valve when it is damaged or misshapen. This is why heart valve diseases such as rheumatic fever predispose individuals to endocarditis. Heart valve replacements also put patients at risk for endocarditis, which is why the dentist will give these patients antibiotics before procedures that could cause small amounts of bacteria to enter the blood. In fact, 60 percent of people who suffer from endocarditis have predisposing heart conditions.

Bacteria enter the blood in several ways, sometimes through infection in other parts of the body, such as the bladder or bowel, but one of the greatest risk factors for bacteria infecting the blood, and therefore endocarditis, is intravenous drug use. IV drug use is infamous for causing bacteria on the skin to enter the bloodstream accidentally when injected with one’s drug of choice.

The elusive nature of endocarditis is due to its symptoms—or sometimes lack thereof. Some patients will present with only a fever, but a closer look reveals the things patients don’t know they aren’t telling you. Splinter hemorrhages (small painless bleeds under the nails), Osler nodes (painful red nodules on the hands and feet), and small bleeds in the eyes all lead back to the nidus of infection in the heart. The diagnosis is confirmed by ultrasound showing bacterial growth on the valves of the heart.

There are approximately twenty thousand cases of endocarditis in the US annually. When endocarditis is caused by a highly aggressive bacterium such as methicillin-resistant *Staphylococcus aureus* (MRSA), symptoms may be obvious as patients become ill very quickly. But other species of

bacteria, such as *Streptococcus bovis*, may cause a more indolent course. Oddly, *Streptococcus bovis* endocarditis is associated with colon cancer, a medical issue that is likely to be left out of a patient's history when talking about chest pain. The treatment for endocarditis targets the cause of the disease, so in the case of bacterial endocarditis, antibiotics are given.

There are two other types of heart inflammation that involve different layers of the heart: pericarditis and myocarditis. Luckily these two types of heart inflammation aren't as tricky to diagnose.

Pericarditis is inflammation of the sac surrounding the heart, called the pericardium. This is most commonly due to a virus, such as the Cocksackievirus, which also causes hand, foot, and mouth disease. Pericarditis causes chest pain and classic echocardiogram (EKG) changes known as diffuse ST elevation. The disease is often treated with NSAIDs, like ibuprofen or indomethacin, and colchicine. There are other causes of pericarditis, such as autoimmune disease, Lyme disease, cancer, and tuberculosis, but most occurrences of this disease are viral and generally benign with treatment.

One of the dangers of untreated pericarditis is that it can cause myocarditis.

Myocarditis is a much more dangerous inflammation of the heart muscle, called the myocardium, and is caused by viruses, bacteria (including syphilis), autoimmune diseases, chemotherapy, medications, parasites, and fungi. Myocarditis attacks the muscle of the heart, causing symptoms of shortness of breath, fatigue, and chest pain, and results in heart failure, arrhythmia, shock, and sudden cardiac death. Myocarditis tends to be easier to diagnose because the heart biomarker known as troponin, which is also elevated in the blood during a heart attack, is sky-high. Troponin is released from the cells of the heart into the blood when they are damaged. Myocarditis is treated by targeting the underlying cause of the inflammation in the heart muscle.

So, what can be done to prevent death by an inflamed heart?

1. Never ignore chest pain.
2. Fevers above 103°F warrant further investigation by a medical professional. Start by seeing your primary care or urgent care.
3. Everybody *lies*, but remember your medical information is protected and you never know which truth might save your life.

ARRHYTHMIAS

The heartbeat is the magnum opus of the human body, a biologically harmonious work. Though the heart may be considered simple in function compared to other fancier organs, sometimes it is not the complexity of the artwork that moves us. For instance, the *Mona Lisa* is famous for her simple smile, or possibly because she was stolen from the Louvre in 1911. When important art goes missing, whether a Leonardo da Vinci or a heartbeat, it gets noticed.

There is nothing more central to human life than the heart. This exquisite piece of art runs on a battery two thousand times smaller than a AAA. Electrolytes shift in and out of each heart cell in a delicate dance, creating the electrical current needed to power the heart muscle's contraction in a synchronized samba that sustains life for billions of beats.

There are four chambers of the heart: The top is made up of two atria and the bottom is made up of two ventricles. When blood arrives at the heart, the two atria beat together and pump blood to the lower ventricles. The blood arrives in the ventricles along with an electrical message that dictates the ventricles' beat, so the ventricles contract and send blood coursing throughout the body. Then it starts again, over and over, to the same beat, no matter what tempo. But what happens if the rhythm changes?

An arrhythmia is a change in the rhythm of the heart. Some arrhythmias aren't so dangerous, just a few missed beats, like a piccolo that missed the page turn, but others are disastrous, like letting a four-year-old play the xylophone with the philharmonic.

Here we discuss the worst arrhythmias—ones that are not compatible with life, because the uncoordinated beating of the heart will not allow blood to be pumped to the brain and body. For example, commotio cordis is a condition caused by a blunt chest wall impact directly over the heart, resulting in a deadly arrhythmia and sudden cardiac death. This arrhythmia is most often seen in athletes after impact in contact sports. This is what happened to Buffalo Bills safety Damar Hamlin in January of 2023. During a preseason game at Orchard Park, the twenty-five-year-old sustained a routine tackle, but he was hit at just the wrong moment and collapsed, lifeless, on the screens of millions of *Monday Night Football* viewers.

Luckily, someone at the game knew what they were doing. Before the Chargers leadership abandoned San Diego to become a secondary NFL team in Los Angeles (at which time my mother turned over in her grave), I

attended several games on the sideline with the team. Emergency medicine physicians and emergency services personnel are routinely present at professional sporting events for this exact moment.

That day, the hero was Buffalo Bills assistant trainer Denny Kellington and the medical team, who started immediate CPR and defibrillated Hamlin. This immediate action was the key to saving Hamlin's life.

Commotio cordis happens when a particular part of the chest, and thereby the heart, sustains an exact velocity of blunt impact at the perfectly wrong millisecond, in desynchrony with the heartbeat. This impact interrupts the heart's rhythm, sending it into ventricular fibrillation, an arrhythmia incompatible with life. It's like waiting for the moment of crescendo in the prelude of Bach's Cello Suite No. 1 and then cutting the strings, or unplugging the speaker at the first chorus of Cardi B and Megan Thee Stallion's "WAP," depending on your music preference. This very precise disaster is blessedly rare, with only two hundred confirmed cases in the United States according to the National Commotio Cordis Registry, 95 percent of which were in men, most younger than twenty-five.

Commotio cordis is a survivable event with immediate high-quality CPR and defibrillator shock. The issue is that commotio cordis must be instantly recognized, never delaying CPR or defibrillation. As the seconds tick by, the brain and other organs go without oxygen and the possibility of survival quickly fades. If you ever see a person collapse, have a bystander call 911 and check for a pulse. If no pulse is present, start CPR and have your bystander search the premises for an automated external defibrillator (AED). Everyone should take a CPR class, especially if you are a parent.

Survivors of commotio cordis undergo rigorous testing for underlying genetic heart conditions, including Brugada syndrome, prolonged QT, Wolff-Parkinson-White syndrome (WPW), and hypertrophic cardiomyopathy.

Brugada syndrome is a dominant genetic abnormality in the sodium channels of the heart muscle cells. Because it is a dominant genetic trait, it will often be seen in multiple family members, and all blood-related family members should be tested for the disease. The faulty sodium channels in Brugada syndrome disrupt the electrolytes the heart needs to beat. The broken battery causes the heart cells to beat off rhythm, sometimes causing the dreaded arrhythmia ventricular fibrillation and death. Treatment can include an implantable cardioverter-defibrillator (ICD), an object the size of

a silver dollar that sits in the chest. If the heart misbehaves, the ICD shocks it back into a normal rhythm, like one of those awful bark collars for dogs—one zap, and the heart behaves. While the shock is unpleasant, it often fixes the problem so quickly that the patient never even loses consciousness, so they get to enjoy the unpleasant electrical shock.

Prolonged QT syndrome has a more complicated genetic inheritance pattern, with seventeen associated genes that affect potassium channels, another electrolyte important to the battery that runs the heart. Prolonged QT syndrome causes part of the measured electrical pattern of the heartbeat, seen on an EKG, to be late, specifically a tardy T wave. This tardy T predisposes carriers to *torsades de pointes*, an arrhythmia that sounds like a ballet move because it is. This turning, tumbling life-threatening arrhythmia is named for the pirouette and fouetté turns of ballet dancers, spinning on points of their toes. Treatment for prolonged QT syndrome includes medications called beta blockers that slow the heartbeat and stop T waves from running away to join the ballet.

Both Brugada and prolonged QT syndrome are very rare and run in families. A little less rare is this next life-threatening arrhythmia, which I have seen multiple times in the emergency department.

Pro tip: If you know you have a medical condition such as a life-threatening arrhythmia, please lead with this information when introducing yourself to an emergency doctor, as we are invested in fixing emergencies. I don't know how many times I have listened to a description of someone's lunch—"and then I added sliced oranges to the salad"—only to find out later that the patient had a stroke last week. In the emergency department, don't bury the lede; lead with the lede, because it could save your life.

Sascha was a twenty-year-old otherwise healthy male who came to my freestanding emergency department. I am not a huge fan of freestanding emergency departments; while I see their utility in bringing care to a broader patient population, they are not fully equipped hospitals and thus have limited resources, such as fewer medications, limited blood supply for transfusions, and less support staff. They are often located in strip malls, by highway exits, and sometimes next to Hooters. There is usually only one doctor, the emergency doctor, who on this day was me. "Hi, I'm the doctor, it's me" is how I introduced myself to Sascha, but he didn't get my Taylor Swift reference, because his heart rate was 214 beats a minute, which is too

fast. I asked Sascha if he had any medical problems, to which he said, “No,” but he did say this rapid heartbeat had happened a few times before.

I looked at his EKG and was immediately concerned. There is a common arrhythmia called supraventricular tachycardia (SVT) that is relatively benign and only requires a simple treatment to be corrected. It looks very similar to what Sascha was experiencing, but this was not what Sascha was experiencing. Sascha had a slightly wide QRS complex on his EKG, meaning something else in his heartbeat didn’t look right, other than the fact it was fast.

I went back to Sascha and asked, “Are you sure you don’t have a history of arrhythmia? Because your EKG looks like you have WPW.” To which he said, “Oh yeah, I have that.” What Sascha didn’t know is that the medication given for SVT might kill you if you have WPW, so it was good that I saw his EKG was off by a few milliseconds. For future reference, WPW is the type of diagnosis to get tattooed on your forehead, or at least on your chest.

Once I figured out what Sascha had, I had the misfortune to find myself at a freestanding ED. My limited resources did not include the preferred medication for treating this patient. So I did what any decent emergency medicine doctor would do in my situation: I MacGyvered my way out of it, creating a solution with two rubber bands, chewing gum, a defibrillator, and a nearby hospital. The rubber bands were for my hair, and I was chewing the gum. Sascha did well and we now stock the necessary medication at my freestanding ED.

WPW is an arrhythmia caused by an accessory electrical pathway in the heart. Electricity uses this extra pathway to create a fast and dangerous heart rhythm. WPW is sometimes genetic and presents in the electrical pathways of up to three in every thousand people, but is usually asymptomatic. The definitive treatment for WPW is a cardiac ablation, a procedure where a cardiologist enters a blood vessel in the groin to travel up to the heart with a tool that destroys the heart’s defective electrical pathway. This kills the misbehaving heart cells, creating scar tissue in the faulty electrical pathway to prevent further arrhythmia.

The last abnormality of the heart is the most common, affecting one in every five hundred individuals, and is the most common cause of sudden cardiac death in young athletes, such as Reggie Lewis (Boston Celtics, age twenty-seven), Marc Vivien Foe (Cameroonian professional soccer player,

age twenty-eight), and Miklos Feher (Hungarian professional soccer player, age twenty-four). Hypertrophic cardiomyopathy is the pathological thickening of the left heart muscle, which causes a blockage in blood flowing out of the heart, as well as deficiencies in the electrical pathways in the heart, resulting in arrhythmias. This disease is the primary reason behind cardiac testing and the need for physical clearance before playing sports, so don't skip it—go get your kid an EKG.

A beating heart is the result of an electrical symphony between the cells of the muscle. The rhythm keeps time, measuring our lives in heartbeats. It is a beautiful thing that we take for granted every second, 60 times a minute, 86,400 times a day, and if it does happen to miss a beat, it's nothing a little zap of electricity can't fix.

HIGH BLOOD PRESSURE (HYPERTENSION)

Is high blood pressure killing you? Yes, but probably not today. Blood pressure naturally increases with stress, exercise, or even just standing. These are appropriate physiological responses that are necessary.

Chronic high blood pressure, along with high cholesterol, triglycerides, smoking, genetics, and several other factors, causes the walls of arteries to harden over time and promotes plaque buildup inside these blood vessels. These plaques cause heart attacks and strokes.

Think of it this way: There is a beachfront California home full of ninety-pound vegans who eat vegetables and exercise daily. A street back is a frat house of twenty guys who smoke, drink, and eat fast food twice a day. You're the plumber. Whose pipes do you want to clean?

How does blood pressure become elevated? Kidney disease, diet, genetics, and other factors can cause your average resting blood pressure to increase long-term. This is hypertension or high blood pressure, defined by the American Heart Association as a blood pressure of higher than 130/80 (systolic blood pressure/diastolic blood pressure). High blood pressure earns its title as the "silent killer," since you can't feel its insidious increase but over years it causes blood vessel and organ damage.

In the US, high blood pressure is a leading cause of kidney disease, heart disease, and impotence. Hard to believe, I know. This is why high blood pressure medications, diet, and exercise are recommended when high blood pressure is first detected.

Although high blood pressure spends most days playing the long game as the “silent killer,” every once in a while, it goes full sniper mode and takes someone out. Some days high blood pressure can kill you. On such a day, the top number, known as your systolic blood pressure, causes a hypertensive emergency.

In a hypertensive emergency, systolic blood pressure is greater than 180 but is often over 200 with signs of “end-organ injury.” This means the function of the brain, kidneys, heart, or other organs is interrupted due to high blood pressure. For instance, the brain can bleed or swell, causing a severe headache, confusion, or even coma. Blood pressure this high can also cause heart attacks and kidney failure.

Symptoms of hypertensive emergency include, but are not limited to, headache, stroke symptoms (one-sided weakness, numbness, vision change, or dizziness), decreased urine output, chest pain, and shortness of breath.

For symptoms of hypertensive emergency, a person must go to the emergency department to be treated with intravenous blood pressure medications to rapidly reduce the blood pressure by 20 percent, often with a goal blood pressure around 160/80, which is still high. Blood pressure is not rapidly decreased to normal (below 120/80), because rapidly lowering blood pressure can also cause stroke, heart attack, and renal failure. This is a super fun balancing act for doctors and nurses.

Interestingly, medications are not the best way to decrease long-term hypertension; diet is. The “Dietary Approaches to Stop Hypertension,” or DASH, diet is the greatest reducer of long-term high blood pressure when compared to a single blood pressure medication. I bet you can guess what’s in the DASH diet. You’ll be moving out of the proverbial frat house. Decreasing alcohol intake and increasing exercise are also effective blood pressure reducers. Losing weight can decrease your blood pressure by one point per kilogram, which is 2.2 pounds, but it sounds easier to lose a single kilogram.

Diagnosing hypertension takes three readings of high blood pressure in a relaxed setting or one blood pressure reading that your primary care doctor doesn’t like. If your systolic blood pressure is over 160, there better be a wild animal chasing you, or your primary care provider is probably going to start you on a blood pressure–reducing medication.

A yearly physical, which everyone is attending, is the best way to detect high blood pressure. Some patients have “white coat hypertension,”

meaning doctors stress them out, which makes their blood pressure spike.

The “Dietary Approaches to Stop Hypertension,” or DASH, diet is the greatest reducer of long-term high blood pressure when compared to a single blood pressure medication.

Doctors stress me out, so I check my blood pressure in the pharmacy blood pressure machines. More astute individuals take their blood pressure at home in a relaxed setting and keep a log. Now that I’ve stressed you out, go check your blood pressure.

BRAIN DISEASES

Mad Cow Disease (Prion Disease)

Stroke

Brain Bleeds

Guillain-Barré Syndrome

Brain-Eating Amoeba

Brain Infections: Meningitis & Encephalitis

Dementia (Alzheimer's Disease)

Traumatic Brain Injury

MAD COW DISEASE (PRION DISEASE)

In 1986, on the grassy hills of Merry Old England, herds of happy cows roamed beneath gray skies, chuffed and just faffing around, until something pissed them off. A previously placid cow would throw a wobbly at the slightest perturbation. The bonkers bovine became aggressive, anxious, and ataxic, followed by wasting and death.

What was happening to their tiny cow brains to make them go mad? The answer is complicated, but at this point, I believe we've created a strong foundation for sciencey stuff—we can do this.

Cows, like humans, are born with all their DNA encoded in the genes they get from their parents. Bovine DNA contains the written instruction on how to build a cow; however, the DNA instructions are written in Swedish, as all the best instructions are, so they must be translated into English for our British cow, and thus RNA is created. The RNA instructions, now written in English, are read aloud inside each cell of the cow, as the intracellular machines construct the cow like Ikea furniture—great quality for a reasonable price. For a little energy expenditure, the RNA creates a hundred thousand different proteins. The proteins help build the cow from brain to hooves, and everything in between.

What happens if the instructions aren't read correctly, and a protein is assembled improperly? It's not good.

We've all done it: You get to the end of building a cabinet, and the doors have been attached backward. Improperly assembled proteins, called prions, can accumulate inside cells. This might not matter in some cells, but in places like the brain, where the cells are very specific and sensitive, things turn bad quickly. Misassembled proteins form plaques called amyloids. This is what happens in bovine spongiform encephalopathy or “mad cow disease.” A broken protein gets into the brain and starts to cause other proteins to be built with the same faulty structure; this is like when you try to build your EKENABBEN Ikea shelves by looking at the picture online instead of reading the instructions, but you've unfortunately clicked on the picture of the DOMBAS Ikea wardrobe. The example structure is wrong, so you build the wrong cabinet over and over. In the brain, instead of a room full of faulty cabinets, broken proteins build up, killing the brain cells.

How does the broken protein get into the cow in the first place? You ask a lot of great questions.

In mad cow disease, the bad proteins are from other animals with prion disease. Cattle were being fed meat and bone meal (MBM), made from the leftover remains of other livestock, including cows. I think even Hannibal Lecter could have told you this was a bad idea. Infectious misfolded proteins were ingested by cows, traveled to the brain, and destroyed everything. This is known as a prion disease—the only infectious disease caused by proteins.

Mad cow disease was an upsetting development in the docile creatures, infecting 120,000 British cows by 1993. The rapid spread of this mysterious disease throughout the UK led to drastic control measures, including the unfortunate slaughter of 4.5 million cows, disease testing of every British cow over thirty months old intended for human consumption, and a worldwide UK beef ban. These measures were not enough to stop the spread of this terrifying disease.

In 1996, the disease spread to humans. The first case of mad cow disease in humans, known as Variant Creutzfeldt-Jakob Disease, was diagnosed in a nineteen-year-old British man who quickly passed away, followed by two more similar UK deaths. More than two hundred people died from mad cow-related Variant Creutzfeldt-Jakob Disease during the initial UK outbreak. Since then, cases of cows carrying the disease have been found in the US, Canada, Japan, and Brazil.

Unfortunately, mad cow disease is not the only prion disease. Variant Creutzfeldt-Jakob Disease (CJD) comes from eating infected cows, but CJD has other forms, including “familial,” inherited by genetics; “sporadic,” caused by a spontaneous misfolding of protein; and “iatrogenic,” contracted during a medical treatment such as brain surgery or injection of pituitary human growth hormone—that is, if technicians unwittingly extracted the growth hormone from the brains of human corpses who had CJD.

In all forms of CJD, like mad cow disease, proteins in the human brain fold improperly, killing brain cells. Sporadic and genetic CJD tend to manifest symptoms in people aged fifty to seventy. MRI imaging can detect up to 90 percent of cases, but a brain biopsy is the only way to provide a definitive diagnosis. Symptoms of CJD include jerky movements, personality changes, and loss of vision, intellect, and memory. Most patients pass away within a year of diagnosis.

Other prion diseases in humans include Gerstmann-Sträussler-Scheinker syndrome, fatal familial insomnia, and kuru.

Gerstmann-Sträussler-Scheinker syndrome is a rare genetic disease found in only a few families worldwide. The disease causes progressive neurological decline, loss of balance, and deafness, and results in death in two to ten years from onset of symptoms.

Fatal familial insomnia is a universally fatal genetically inherited progressive insomnia where prions destroy the thalamus, the part of the brain controlling the sleep-wake cycle. Eventually, those with this disease can no longer sleep, spending a year in a waking nightmare, surviving an average of eighteen months after onset.

Kuru, another prion disease, arose in the Fore people of New Guinea due to ritualistic cannibalism of deceased family members, specifically the eating of brain tissue. Kuru is an incurable disease where the misfolded proteins destroy the cerebellum, which causes loss of balance, tremors, and death within six to twelve months of the onset of symptoms.

Prion diseases currently have no effective treatment, making them 100 percent fatal. However, some prion diseases are avoidable, such as Variant CJD and kuru.

If you want to go big in your efforts to avoid prion diseases: Do not eat animals or humans, avoid nonsynthetic human hormone injections, and, if planning to reproduce, get genetic testing for familial prion diseases. This might be a bit much for most people, given the low likelihood of prion disease and the high density of omnipresent dangers to avoid, as evidenced by this very long book.

There are, however, a few less aggressive measures that could save your life, including responsible sourcing of animal products. An abused animal, full of hormones, surviving in dismal living conditions is not going to provide premium healthy products. Treating animals well is good for everyone. Sprouts is an example of a grocery store that offers 100 percent grass-fed beef from farms where the cattle are pasture-raised and not given hormones. This is not only better for you and the cow, but it is recommended by the *foodies*. Some countries also test cattle for mad cow disease. As of January 2025, the US Food and Drug Administration tests twenty-five thousand cattle a year, finding a rate of disease of less than one in a million in the US.

Farm animal cannibalism is not a good idea, especially feeding herbivores their friends and family. In Canada, the United States, and most European Union countries, bovine-derived meat and bone meal is banned

for feed use in cows but is still fed to pigs and horses. The policies on meat and bone meals are country-dependent, so be aware of policies when traveling. Know which countries have had previous outbreaks of mad cow disease and weigh the risks and benefits of eating beef.

STROKE

Edith was a seventy-seven-year-old with chronic left shoulder pain and no other known medical problems. It was close to 8 a.m. when she arrived in my emergency department by ambulance. She was screaming, inconsolable, and the paramedics reported the patient called them for “stroke-like symptoms.”

Edith was a mess. She was shouting and flailing her arms. From my first look at her, she might have had a brain bleed, as these people are generally altered and combative.

I had to give Edith an injection of medication to calm her down. Once she was calm enough to give me her story, it went like this:

“I can’t feel my face. My lips are moving but I can’t control them,” she said while smashing her face between her hands. Not very stroke-like behavior.

It looked a lot like this little old lady was as high as a kite. But Edith had never done a drug in her life. She drank tea instead of coffee because coffee gave her the “jitterbugs.” I know what you’re thinking; anyone can do drugs. I agree, but I am telling you that Edith did not do drugs, except when she accidentally did.

Edith had used CBD oil that night, at the urging of a friend, for her chronic left shoulder pain. Federal law requires CBD oil to have less than 0.3 percent THC, a psychoactive substance found in marijuana, but most CBD oils are not FDA-approved. She used the oil topically and was told it was perfectly safe with no side effects. Everything has side effects. Edith rubbed the entire bottle of concentrated oil all over her left shoulder and she woke up unable to feel her entire face.

Eight hours later, Edith was the most normal person you’ve ever met. You could have put her in a Lipton tea commercial. She was overly apologetic and embarrassed. I discharged her to the nearest Taco Bell.

One of the reasons Edith was scared she was having a stroke was because she was stoned, and the other reason was that she did not know the

symptoms of a stroke.

In a stroke, blood carrying oxygen cannot get to the brain, and without oxygen, the brain tissue dies. The brain's blood vessels are like roads with semi-trucks full of oxygen trying to make their required delivery to different destinations within the organ, and the brain is an Amazon-addicted twenty-year-old with her mom's credit card. The oxygen semi-trucks are never-ending. There are two ways to stop those trucks, thus two types of strokes: You can set up a blockade or blow up the road.

About 90 percent of strokes are caused by a blockage of blood carrying oxygen to the brain, known as an ischemic stroke. When people say "stroke," this is almost always what they are talking about. However, if a blood vessel blows up, bleeding ensues, and this can cause a second kind of stroke, known as a hemorrhagic stroke. Not all brain bleeding causes strokes, only bleeding that prevents oxygen from getting to the brain.

The brain is a veritable highway of blood vessels, so stroke symptoms will depend on which blood vessel gets blocked. The brain has two sides with independent blood flow, so most stroke symptoms will only be on one side of the body.

For example, facial droop, numbness, and arm and leg weakness are all stroke symptoms when occurring on one half of the body. Loss of sensation to the entirety of the face, however, is not a typical stroke symptom. Other symptoms of stroke include vision loss, slurred speech, and inability to speak or understand speech. These individual symptoms are caused by tissue death due to oxygen deprivation in the specific locations of the brain responsible for each function.

The word *stroke* can refer to a blockage of blood flow to any organ, but in medicine it generally denotes a blockage of blood flow to the brain, so chest pain is not a stroke symptom. I often have patients confuse the symptoms of heart attack and stroke. These are both diseases caused by a lack of blood flow carrying oxygen to a vital tissue that subsequently dies, but the organs affected, and therefore symptoms, are unrelated.

Diabetes, hypertension, hyperlipidemia, alcohol consumption, and smoking are risk factors for a lot of diseases including ischemic and hemorrhagic strokes. The good news is, according to the National Institutes of Health, over 82 percent of stroke risk factors are lifestyle choices you control. Other risk factors for ischemic strokes include anything that increases your risk of clots such as hormonal birth control (as seen in

Hailey Bieber's reported ministroke), clotting disorders, and heart arrhythmias such as atrial fibrillation.

In the setting of an ischemic stroke, where a blood vessel is blocked, clot-busting medications can be given to most patients if they arrive within several hours of the onset of symptoms. The more time passes, the more brain tissue dies, and clot-busting medications eventually become ineffective; so never sit on stroke symptoms—go to the emergency department immediately. Clot-busters cannot be given in some circumstances, and they can cause bleeding in the brain, so individuals must discuss the risk and benefit with their doctors. Even after several hours, stroke symptoms always warrant a trip to the emergency department, and large blood vessel blockages can be unclogged through surgery for up to twenty-four hours.

If ischemic stroke symptoms go away and no evidence of stroke is seen on brain imaging by MRI, this is called a transient ischemic attack (TIA), also colloquially known as a warning stroke or ministroke. TIA symptoms are similar to stroke symptoms, but last only minutes to hours, and do not last more than twenty-four hours. There is no way to definitively determine if symptoms were truly due to a TIA; rather, a “warning stroke” is a diagnosis of exclusion. That being said, the risk of a true ischemic stroke within ninety days of a TIA is as high as 17 percent, so treating risk factors such as hypertension and diabetes and starting antiplatelet medicine like aspirin is key in prevention.

Ischemic stroke symptoms are often permanent but are most likely to improve during the first three months of rehabilitation. Symptoms may improve throughout the year following the stroke, but this becomes less likely as time moves on. In the five years following an ischemic stroke, one in four patients will have another stroke, so controlling risk factors is again key.

**The key to stroke survival is early recognition and action, known as Be F.A.S.T.
—identifying stroke symptoms of Facial droop, Arm weakness, and Speech
difficulty, and knowing it's Time to call 911.**

The key to stroke survival is early recognition and action, known as Be F.A.S.T.—identifying stroke symptoms of Facial droop, Arm weakness, and Speech difficulty, and knowing it's Time to call 911.

Luckily for Edith, her stroke symptoms were simply a bad trip that ended happily with a search for a Crunchwrap Supreme.

BRAIN BLEEDS

I was seeing an eighty-five-year-old male for an acute worsening of his heart failure when he introduced himself and told me he had been in the emergency department *just last week* after a bad fall. He hit his head and had a brain bleed, but he was just fine. In fact, he was sure he had at least two more years left in his life, assured by the expiration date on his butt cheek, which he welcomed me to check.

Not all head bleeds impose the same level of danger; in fact, some bleeds are simply left alone and go away without symptoms. The deadly nature of a head bleed depends on its size and location. In general, all brain bleeds in young people are bad news, but as we get older our brains shrivel up like raisins in the sun, creating a decent amount of extra space in the ol' cabeza. That extra space means that the brain shakes around more in a fall or trauma, making bleeding more likely, but it also creates more space for the blood to collect without affecting the brain tissue; so it's a lose-win.

Generally, the younger a person is, the less extra space between the brain and skull. One of the most important principles in understanding the dangers of bleeding within the brain is that the brain sits inside a fixed amount of enclosed space, like a nut in its shell, and increasing size is not an option. Think of it like increasing pressure inside a water balloon—actually, don't think about that.

Most people would need major head trauma to create bleeding in the brain, but blood thinners and bleeding disorders increase the risk of all bleeding. Blood thinners aren't run-of-the-mill antiplatelet medications, such as aspirin. Blood thinners are the big-gun medications that prevent the body from making clotting factors, used to treat blood clots and arrhythmias such as atrial fibrillation. Common blood thinners include Eliquis (apixaban), Xarelto (rivaroxaban), and Coumadin (warfarin). The number one rule of being on blood thinners or having a clotting disorder is, if you hit your head, go to the emergency department to get a CT scan to rule out bleeding.

The major types of brain bleeds, also referred to as intracranial hemorrhages, have fancy names but are simply named based on their

location in the brain: epidural, subarachnoid, intraparenchymal, and subdural hemorrhage.

Epidural bleeds are bad news and generally occur after trauma when blood collects in the epidural space between the skull and dura, a layer of tissue that covers the brain. This pocket of rapidly collecting blood is under pressure, like a blood blister, but when the pressure builds, the dam breaks and the blood rushes toward the brain, increasing pressure on the brain at a deadly rate that can cause brain herniation. Brain herniation is where the brain is smushed and tries to escape the skull, which is a *no-exit* situation. Epidural bleeds are treated with an emergency surgical procedure called a burr hole. This is a hole drilled into the skull that releases the blood bubble that's under pressure to the outside world, so it doesn't go into the brain.

The problem with epidural hematomas is that after the initial injury the patient often seems fine, and it is not until the epidural bursts that the patient has symptoms. That is how epidural hematomas gained the moniker "talk and die syndrome." Epidural hematomas are caused by major head traumas, most often with associated skull fractures, as seen in car accidents, assault, and skiing accidents, which is one reason why wearing a helmet in sports is important.

Subarachnoid bleeds are the most interesting intracranial bleeds, which does not bode well for this chapter. Most non-traumatic subarachnoid bleeds are due to an aneurysm that bursts in the brain. An aneurysm is a dilation of a blood vessel caused by a combination of genetic and environmental risk factors. Aneurysms have thinner walls and are thus prone to rupture—now picture the overinflated balloon. We know brain aneurysms are more common with certain genetic diseases such as Marfan's syndrome, Ehlers-Danlos syndrome, autosomal dominant polycystic kidney disease, hereditary hemorrhagic telangiectasia, and multiple endocrine neoplasia type I. Familial intracranial aneurysms are suspected when more than two blood-related family members have aneurysms.

It's estimated that up to 6 percent of the adult population is walking around with brain aneurysms, and most have no idea. A ruptured brain aneurysm leading to subarachnoid hemorrhage is fatal in about half of patients. Fortunately, most aneurysms are asymptomatic and will not rupture in a patient's lifetime, so how do you know you have a brain aneurysm that is about to rupture?

One way to know your aneurysm is a ticking time bomb is a *sentinel bleed*, which is how many dangerous brain aneurysms are found. A sentinel bleed is a small leak of blood cells from the aneurysm, like a pinhole spouting a scant sprinkle from that water balloon. The brain is very sensitive to blood outside of blood vessels, so even a tiny leak causes a thunderclap headache, which is a sudden-onset thunderbolt to the brain, causing the most severe headache in one's life. A thunderclap headache can bring patients to their knees in a second, causing vomiting and light sensitivity. This is not a regular headache.

This was the type of headache that actress Emilia Clarke experienced on February 11, 2011. After wrapping her first season of *Game of Thrones*, the then relatively unknown actress was working out with her trainer when a severe headache, nausea, and vomiting suddenly hit. Once she arrived at the hospital, she was diagnosed with a subarachnoid hemorrhage from the rupture of her first of two brain aneurysms. She was twenty-four years old when she underwent her first brain surgery, returning to the *Game of Thrones* set just weeks after being released from the hospital. She overcame vision deficits, speech difficulties, and unimaginable pain. She later wrote about her experience in an inspired piece for the *New Yorker*. The Mother of Dragons is way more badass than you ever could have imagined.

The best way to diagnose a sentinel bleed from a brain aneurysm is through a lumbar puncture looking for red blood cells in spinal fluid, but CT imaging of the brain can also be used. A severe, sudden thunderclap headache may be the only warning before a burst aneurysm causes a life-threatening subarachnoid bleed, so go to the emergency department immediately. If detected early, interventional neurosurgery can use a minimally invasive procedure, entering a blood vessel in the groin or wrist and traveling to the brain to perform endovascular coiling of the aneurysm, a procedure that cuts off the aneurysm's blood flow.

Another type of head bleed, an intraparenchymal bleed, is bleeding within the brain tissue. These bleeds can occur with head trauma or extremely high blood pressure. This type of bleed causes hemorrhagic stroke, and thus often manifests early neurological symptoms similar to those seen in ischemic stroke. Symptoms of intraparenchymal bleeding can include dizziness, one-sided weakness, vision changes, fainting, and confusion. This type of bleed is treated by controlling blood pressure, reversing anticoagulation, and, if indicated, performing brain surgery.

Subdural hematomas are caused by bleeding between the brain and the tissue lining of the brain called dura. The bleeds are generally due to head trauma. In young people, due to big brains and no extra space in their skulls, these bleeds become dangerous very quickly. This type of bleed is often seen with non-accidental trauma and child abuse. In the elderly, subdural bleeds are often seen with falls; given the extra space, the brain shakes around more with falls, causing the bleed. However, because there is extra space in the skull, small subdural bleeds can be a nonissue. The patients are generally watched overnight, and if the bleed remains stable on imaging, they can be discharged.

You may be wondering why brains shrink with age. Since age imparts wisdom, where are we storing it all?

Humans start out with way too many brain cells, or neurons. In humans, 50 percent of neurons die before birth, rounding out to a cool one hundred billion neurons per newborn baby brain. However, these neurons have little idea of what they are doing—newborns can't even see. Babies are legally blind at one month old and take up to three years to gain the 20/20 visual acuity of an adult. In order to develop skills like sight, learning is key through forming connections between neurons, and baby brains form about seven hundred new connections a second, which would make anyone tantrum-prone. After the first few years of life, young brains start the process of pruning, which is cutting the connections they don't need. As we age further, our brain volume shrinks, losing about 5 percent of its volume every ten years after the age of forty. The causes and effects of this age-dependent reduction of brain mass are still being studied, but it is likely influenced by diet, alcohol intake, and exercise. The most widely seen cognitive change with age is a decrease in memory, but nearly fifty years of research has shown that older adults who engage in memory tasks have significant improvement in memory, so break out your crosswords, sudokus, and Wordle.

No matter the size of the brain, bleeding is never a good thing, yet patients can live a completely normal life with early recognition and treatment. As always, prevention is key, so wear helmets and seat belts to protect every neurologist's favorite organ.

[GUILLAIN-BARRÉ SYNDROME](#)

Sometimes I have famous patients, but I can't tell you who they are, which makes these stories subjectively less intriguing. Given I completed my medical training in California and at the president's emergency hospital in Washington, DC, influential people did pop up from time to time.

I wasn't there for this one, because I wasn't alive yet, but on March 30, 1981, President Ronald Reagan, code name *Rawhide*, was shot in an assassination attempt and taken to George Washington University Hospital, where he was stabilized and underwent emergency surgery, opening his chest and saving his life. Before the surgery started, the president removed his oxygen mask and famously jested, "I hope you are all Republicans." After the surgery, while still unable to talk, Reagan was asked how he was doing. He scribbled down the immortal words of the vaudevillian W. C. Fields, as later quoted by *Gilmore Girls* quoting John McClane, "All in all, I'd rather be in Philadelphia."

Although high-profile individuals can be interesting to meet, in the emergency department everyone gets triaged the same—sickest first. Additionally, a patient is never more interesting to a doctor than their disease process. It's kind of like taking a classic 1964 Aston Martin DB5 to a mechanic—no one cares who the driver is, the mechanic just wants to check out the engine.

That being said, I may or may not have had a famous patient with this next disease. My bias is that this disease is far more interesting than the rock star.

During my medical training, one of my young, previously healthy patients presented for weakness. The weakness had started in the legs and was getting progressively worse to the point that walking was made impossible. Even more terrifying, the paralysis was slowly moving up the body. Somewhere along the line, the patient explained who they were, which was necessary as I have terrible name recall and facial recognition for celebrities. I would never have figured out who the patient was, but I did figure out the patient's diagnosis: GBS.

Guillain-Barré syndrome (GBS) occurs when a person's immune system targets and destroys peripheral nerve cells, usually following an infection. Peripheral nerves are all the nerves in the body not in your spinal cord or brain. For instance, the nerves in your muscles that allow movement are peripheral nerves. There are several different ways in which GBS attacks

nerves and their support cells to make nerve communication temporarily unavailable, one of which is through targeting Schwann cells.

Schwann cells support your nerves. If your nerves were connected to each other like telephone lines, Schwann cells would be the telephone line workers. They make sure the connection is clear by coating the nerves with a substance called myelin. In GBS, the primary target of the immune system destruction is often the Schwann cells or the myelin itself, which then stops the nerve's message from getting through.

A certain infection is infamously associated with GBS, *Campylobacter jejuni*, which is a bacteria found in undercooked meat, raw milk, and household pet kisses, and causes a diarrheal illness in humans. Within the twelve weeks following a *C. jejuni* infection, a small subset of patients can develop GBS. Other GBS-associated infections include COVID-19, influenza, and Zika virus. There may be a slight GBS risk associated with certain vaccines, but the research is unclear. One healthcare database study in California from 1994 through 2006 found no increased risk of GBS following any vaccination, but other studies have shown a low-risk association (not causation) with some vaccines.

Infections such as *C. jejuni* cause GBS through a concept known as molecular mimicry. In the jungle, certain animals develop camouflage to disappear into the surrounding environment; for example, the gargantuan stick insect of Australia's northeastern Queensland rainforest appears to be an exact replica of a stick—it's uncanny. A similar concept is true inside the jungle that is your body. Certain viruses and bacteria have adapted to shapes and sizes similar to structures present in the human body, possibly as a form of camouflage. The unfortunate result is that these infections can induce the body to attack itself, thereby generating autoimmune diseases like GBS.

There are variants of GBS, but to keep things simple, we will ignore variants and only focus on the symptoms of GBS. In GBS, the symptoms usually are progressive over two to four weeks and will cause a decrease in strength ranging from weakness to flaccid paralysis that starts in the legs and moves up the body. The weakness is usually symmetrical, including both sides of the body equally. There is also a loss of deep tendon reflex, so when the doctor hits your knee with the reflex hammer, nothing happens. Tingling in hands and feet is reported by up to 80 percent of patients, but 99.99 percent of patients with tingling in their extremities do not have GBS,

so don't go getting any ideas. As paralysis moves up the body and reaches respiratory muscles, patients may need respiratory support via a ventilator.

A lumbar puncture, blood tests, and MRIs are used to diagnose GBS. Treatment is supportive care and medications to suppress and modulate the immune system, which has gone temporarily haywire. GBS is generally only a transient paralysis, and eventually the Schwann cells recover and get the nerves back online. In 90 percent of patients, paralysis has reached its worst at one month and then resolves over the following weeks to months. One study showed patients took a median of thirty-six days to regain the ability to walk independently.

Although recovery is expected, GBS is a terrifying and life-altering experience. GBS is still a poorly understood disease, but it can affect anyone—porn stars, rock stars, and even Hollywood stars from the idyllic streets of Mayberry, as actor Andy Griffith once suffered from GBS. It is important to recognize symptoms of the disease early to seek treatment and lifesaving supportive care. And don't let Lassie kiss your face, I don't care how famous she is.

BRAIN-EATING AMOEBIA

Have you ever swum in the peaceful waters of a lake? Used a neti pot for a sinus rinse? Taken a dip in a river or stream? If so, this chapter will terrify you.

The *Naegleria fowleri* amoeba is a freshwater brain-eating amoeba that is nearly 100 percent fatal.

This single-celled microscopic organism lives in warm fresh water. The amoeba infects humans by entering through the nose when people submerge in contaminated water, or when neti pot water is not distilled and sterile. According to the CDC, in rare cases, people have contracted the amoeba in recreational water, like pools that didn't have enough chlorine. If you can't smell the chlorine, find another pool. Luckily, if you drink the amoeba, nothing happens, and humidifiers are OK. The amoeba requires direct contact to travel up the nose to the brain, where it causes primary amebic meningoencephalitis (PAM), a deadly infection of the brain.

The amoeba can be present in any freshwater body in the United States and is more common in warmer months. Most cases of PAM are from bodies of water with temperatures over 80°F (27°C), and the amoeba grows

best in temperatures up to 115°F (46°C), so thermal springs are a hotbed for *Naegleria*. If you have been swimming in warm water being discharged from a power plant, please stop, as this is another beloved location for this amoeba.

Now that I've scared you out of the under-chlorinated pool ... this disease is rare. In the past sixty years, only 157 people have been recorded to have contracted it in the US, with only three hundred cases worldwide. Symptoms start within two weeks of exposure, and then death ensues within eighteen days. Only four people have survived the disease in the United States.

Symptoms are similar to meningitis (inflammation of the tissue covering the brain and spinal cord) and encephalitis (inflammation of the brain) and include headache, nausea, vomiting, neck stiffness, fever, seizure, altered mental status, and hallucinations. Severe brain swelling eventually leads to brain herniation and death.

The current treatment used is a combination of antibiotics, antifungals, antiparasitic drugs, and steroids. Looking at the treatment protocol, it appears to be a bit of a Hail Mary regimen. These drugs have been used in the rare cases of survivors and are used empirically on new patients. In most cases, the care of patients is supportive, meaning the medical professionals treat symptoms and keep patients as comfortable as possible.

You are unlikely to come across *Naegleria fowleri*, but if you happen to be swimming in warm, unchlorinated fresh water, maybe keep your head above the surface. Also, sterilize water used for neti pots.

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BRAIN INFECTIONS: MENINGITIS & ENCEPHALITIS

Patients come to the emergency department with a chief complaint, the reason they walked through the door. Usually, patients present with symptoms such as chest pain, bleeding, or vision loss, but sometimes they present with a more complicated story or a presumed diagnosis. I've even had a patient hand me an extensive list of possible diagnoses for her back

pain from WebMD. If she could have seen her back, she would have known she had shingles.

Some of my favorite emergency department chief complaints include:

“Bit by a vampire.” It ended up being a bat.

“My voice sounds funny on the phone.” I hung up the phone.

“Other (it’s a long story).” You don’t want to know.

“I have a stiff neck. My doctor said it could be smiling mighty Jesus.”

That last one was not my patient, but I presume the patient was concerned about having “spinal meningitis.”

Meningitis is usually due to an infection that attacks the protective layers covering and surrounding the brain and spinal cord, known as meninges. Quick etymology lesson: The ending *-itis* comes from Greek, and in modern English means *inflammation*, making meningitis inflammation of the meninges. In the words of Gus Portokalos, *every word comes from Greek—there you go*.

Meningitis can be caused by bacteria, viruses, fungi, and noninfectious etiologies such as chemotherapy and autoimmune diseases. There are even parasites that cause meningitis, such as our warm-water, neti pot-loving friend *Naegleria fowleri*, the brain-eating amoeba. Most typical meningitis is viral or bacterial.

The most common type of meningitis is viral, and it can be caused by a multitude of viruses. Most cases of viral meningitis in the United States are caused by enteroviruses, are mild, and clear on their own. Other culprits in viral meningitis are vaccine-preventable, including the yearly flu (influenza), measles, and mumps. Unfortunately for all the lovers out there, the herpes viruses cause viral meningitis that is more severe and does require hospitalization and treatment.

Bacterial meningitis is always a problem and requires immediate treatment. Even with treatment, around 10 percent of adults die from the disease and one in four have long-term complications. Bacterial meningitis can quickly spread to the brain tissue itself and cause brain swelling, herniation, and death. The most common causes of bacterial meningitis in adults are *Neisseria meningitidis* and *Streptococcus pneumoniae*. The causes of bacterial meningitis in children, aka exotic creatures, are obviously different and complicated.

The major causes of bacterial meningitis in adults are vaccine-preventable, which is great news because these diseases are relatively common, painful, and quite deadly. After the invention of each of the major vaccines, the incidence of meningococcal, pneumococcal, and *Haemophilus influenzae* type b–related meningitis plummeted like the drop-off slides that made you pee your pants at the water park.

One vaccine that has saved many young lives is the meningococcal vaccine. The meningococcal vaccine fights against several forms of the *Neisseria meningitidis* bacteria, one of the most common and virulent causes of bacterial meningitis. From 1994 to 1997, there were forty-two meningococcal outbreaks reported in the US, three of which were at colleges, where the close quarters and questionable sanitation of dorm living put students at an increased risk. Since 2005, the meningococcal vaccine has reduced the incidence of targeted meningococcal disease in adolescents by over 90 percent.

The symptoms of bacterial meningitis include headaches, light sensitivity, high fever, altered mental status, and neck rigidity. Neck rigidity is a tough symptom because anyone who has a bad night with a pillow feels like they might have neck rigidity. Neck rigidity in medicine is a bit more pronounced. If you try to look at your feet but cannot because your neck spasms, forcing you rigidly upright, and you have a fever of 103°F (39.4°C), then that's concerning, and you should see a doctor immediately. Viral meningitis has similar initial symptoms, so how do you know which type of meningitis you have?

I knew you still needed me for something. See a doctor to discuss your symptoms to determine if you need a workup for meningitis, which often includes blood work and a lumbar puncture. The lumbar puncture procedure is like the epidural women receive during labor, but the needle placement varies slightly, and instead of injecting medication, a small amount of cerebrospinal fluid (CSF) is taken out and checked for infection. The mainstay of treatment for bacterial meningitis is intravenous antibiotics.

Sometimes meningitis can spread to the brain tissue, causing encephalitis. Encephalitis is inflammation of the encephala, a word that comes from the Greek *enkephalos*, meaning brain. Encephalitis is never good and always requires hospitalization whether bacterial or viral. Because encephalitis affects the brain itself, patients can have neurological symptoms like confusion, seizures, paralysis, hallucinations, and coma.

These patients often present as combative and can sometimes be mistaken for intoxicated.

There are other types of rare brain infections. And thanks to my baby black cloud, I see rare diseases in pediatric patients. The number of times I have heard colleagues say, “Well, that is interesting” during medical discussions of my patients is unnerving, and never something you want to hear a doctor say.

As we have established, adults tend to follow the rules of medicine. When adults are dying, they look like they are dying. Their vital signs don’t lie. The vital signs are the temperature, heart rate, respiratory rate, oxygen saturation, and blood pressure. They are the signs that a person is alive, and those signs are thus important, some might say vital.

Children are tricksters. They can have wildly abnormal vital signs, like a temperature of 104°F, and be fine, just a little virus. But they can also have relatively normal vital signs and be on the brink of death. Children can compensate for illness right up until the moment it all goes bad.

During my residency and before the release of the respiratory syncytial virus (RSV) vaccine, I spent a winter working at a children’s hospital where it seemed every patient had a cough and fever due to RSV. Among all the RSV kids I saw, there was the one patient who was about to crash—see if you can find him.

Jamie was three years old with congestion, fever, and stridor (noisy breathing) at rest that worsened when he was upset.

Patrick was a nine-year-old with a history of sinus infections who had been on Claritin and Augmentin for the past week and had continued sinus pressure and headache but no temperatures at home.

Obi, a strapping two-year-old gentleman, needed high-flow oxygen because he was retracting, meaning his respiratory muscles could be seen engaging as he struggled to breathe. This is a common sign of respiratory distress in children. His fever was as high as 104°F and he had not been eating, although he was drinking fluids.

Nicholas, seven years old, had been sick with a cough and headache for five days. He was given steroids and albuterol because his asthma caused difficulty breathing with a whistling wheeze.

There were twenty-five patients. I won’t make you see them all.

Which kid is about to make me crap my pants? Any ideas? It takes well over ten thousand hours of medical training in residency alone to be able to

determine the answer, and even then, many physicians describe it as a Spidey Sense: You can just tell when a patient is sick, because something doesn't feel right.

You can always collect more information through the physical exam, but Jamie and Obi had stranger danger and Nicholas had autism, making touch uncomfortable, so good luck with your physical exams. Another challenge in pediatric patients can be parents, but they can also be your biggest asset. Parents also have a Spidey Sense specific to their kids, so I usually cheat and make them help me figure out if a kid is sick.

One of these kids set off my Spidey Sense, so I asked the mom how her Spidey Sense was feeling, and she said tingly, so we got some blood work. We talked a lot about the risks and benefits of other tests, such as the CT scan.

A computed tomography scan, or CT scan, is used to take pictures of the inside of the body and requires radiation. Radiation, in young people, increases the risk of cancer later in life. If you're over sixty years old, most docs will send you luge-style through the ol' tube of truth, lighting you up like a Christmas tree if need be, because good news/bad news, you aren't going to live long enough for that CT radiation to harm you. But CTs are done sparingly in young people. After a discussion, we decided to do a head CT for this child.

Everything happened at once. The patient spiked a fever of 102°F, and his labs resulted in extremely elevated inflammatory markers and white blood cell count, which caused concern for a bacterial infection. And then I saw it: The CT showed a large frontal brain abscess, a rare complication of sinus infection. The patient had a normal immune system, no clear concerning symptoms, and no fevers at home. But there it was, and then he seized. His whole body shook, and he stopped breathing, making a choking sound, unconscious and dying. Like I said—crash.

He seized twice more but was quickly intubated, placed on a breathing machine, and given medications to stop the seizures. He was then taken directly to the operating room by neurosurgery.

That day, Patrick was the sickest patient. I diagnosed him just in time with the help of his mother, who also knew there was *something* wrong. Together we found Patrick among the crowd of patients with similar symptoms. Patrick spent several weeks in the hospital but eventually made a full recovery.

The specialty of emergency medicine is built on a foundational knowledge of calamities, and so a chief complaint may be the start of a story with an unexpected ending. Especially when it comes to the brain, it's not always what you think.

DEMENTIA (ALZHEIMER'S DISEASE)

The brain's souvenir box, the hippocampus, is not fully formed in early childhood, and thus it lacks the capacity to store long-term memories properly. Some children attain the ability to store memories faster than others, but apparently it took me a minute, as I don't remember much of my early childhood.

One of my first vivid memories was at five years old, exiting my kindergarten class at Jerabek Elementary School. My parents both worked, so a nanny waited outside my classroom, wheeling my newborn sister in a stroller. Halfway through our walk home I decided I didn't like the nanny. Who knows why, maybe she challenged my worldview? Maybe she said I couldn't watch my favorite '90s drama, *Murder, She Wrote*? The show featured a literary maven turned amateur sleuth and targeted a viewership demographic of those fifty and over, but even as a five-year-old, I just loved that crafty Angela Lansbury.

Whatever it was, a line had been crossed.

I asked her for our house key to run home and use the bathroom, then proceeded to lock her out of the house. When she went to try the garage door, which I had also locked, I pushed my sister's stroller inside and locked the nanny out again. That's where the memory ends. I'm not sure if she ever got in. I'm not even sure if I saw her again; she may have left.

Once the brain is fully developed, memories are stored much more effectively, but it is possible for the hard drive of the brain to be corrupted by diseases causing dementia. Tau proteins are normal proteins found in brain cells that may malfunction and become tangled. Additionally, the overproduction of a protein called amyloid causes plaques to form outside of the brain cells. Discovered under a microscope by Dr. Alois Alzheimer in 1906, together these plaques and tangles cause brain cell dysfunction and death.

While there are many types of dementia, Alzheimer's disease makes up 70 percent of the world's cases of dementia and is the seventh leading cause

of death in the world. All types of dementia are progressive degenerative diseases of the brain that cause impairment of memory and cognition, but certain types of dementia will target specific areas of the brain.

Alzheimer's disease targets brain cells in the hippocampus, disrupting the brain's storage of short-term memories. When you have an experience, whether it be a bad smell or a happy song, your hippocampus creates a short-term memory. If there is repetition, like your dinner date keeps farting, or you listen to the song on repeat one hundred times, then your brain moves the memory into long-term storage in a part of your brain known as the cerebral cortex, where you can access it later. For instance, even though you'll never use it, you can probably still remember your favorite TV channels as a kid. (*Murder, She Wrote* was on channel eight.) The progressive hippocampal degeneration in Alzheimer's initially presents with episodic short-term memory loss, with relatively preserved long-term memory.

The biggest risk factor for Alzheimer's disease is age, as 90 percent of diagnoses are after the age of sixty-five. In the United States, studies estimate that one in nine people older than sixty-five have Alzheimer's disease. Risk factors for Alzheimer's include depression, cardiovascular disease (clogged pipes), traumatic brain injuries, and family history of dementia. Having a first-degree relative with Alzheimer's increases the risk of having the disease by as much as 30 percent. Decreased risk of disease has been associated with use of estrogen by women, use of anti-inflammatory medications, higher education, leisure activities like reading and playing musical instruments, exercise, and healthy diet. Additionally, strong social connections and staying mentally active have been shown to decrease the rate of decline once diagnosed with Alzheimer's dementia.

For some time, there have been medications that help manage the symptoms of Alzheimer's dementia such as acetylcholinesterase inhibitors donepezil, galantamine, and rivastigmine. These medications are used to help brain cells communicate better for longer, but they do not prevent the progression of disease. There are promising new FDA-approved medications, including immunotherapies, such as lecanemab (Leqembi) and donanemab (Kisunla), which have been shown to slow the progression of early Alzheimer's. Immunotherapies use your body's own immune system to help destroy the amyloid plaques that build up in the brain during Alzheimer's dementia.

Statistically, we all have loved someone who suffered from dementia. It is a cruel disease, possibly even more so for the family and friends who are forgotten. Until science finds a better solution, the only methods of combating the development of this disease are those we often ignore: Eat healthy foods, avoid smoking and drinking, and have an active, healthy lifestyle.

As science continues to discover, the mind is a mysterious place, holding petabytes of precious memories alongside an overflowing dumpster of countless inane television jingles from *Murder, She Wrote*, *Folgers*, and *Meow Mix*. Appreciate your uncanny ability to remember each note, word, or *meow* and enjoy the privilege of having them stuck in your head for the remainder of the day.

TRAUMATIC BRAIN INJURY

Parents are crestfallen when they find out a CT scan cannot determine if their child has a concussion. CT scans are great for finding skull fractures and bleeding, but a head bleed, especially in a young person with a big brain, is very uncommon with a mild traumatic brain injury. Unless the child is agitated, confused, somnolent, or acting abnormally, or has a palpable skull fracture, the Pediatric Emergency Care Applied Research Network recommends observation over a CT scan in most children since statistically a CT scan in a child without these symptoms is more likely to cause future cancer than find a clinically important traumatic brain injury, but it is always important to make this decision with a healthcare provider.

A concussion describes the symptoms of mild traumatic brain injury (TBI), which is defined by the American Academy of Neurology as a trauma-induced alteration in mental status that may involve a loss of consciousness. Most mild TBIs do not cause loss of consciousness, but symptoms include headache, nausea, vomiting, confusion, and amnesia. Amnesia is usually only surrounding the traumatic event. Unfortunately, television often gets this wrong.

The character Michelle Tanner in *Full House* lost her memory completely after she hit her head falling off a horse. This classic nineties sitcom was likely trying to depict transient global amnesia, a rare, poorly elucidated disease, usually associated with older brains and blood flow issues, not ten-year-old equestrian accidents.

Another misconception popularized by television is that sleeping with a concussion is dangerous. I am not sure which television show began publicizing this myth, but patients with concussion symptoms can sleep; in fact, patients need sleep to heal. Additionally, concussion patients should avoid TV and all screen time, especially in the first forty-eight hours post-TBI, as avoiding screens can help shorten the duration of concussion symptoms.

Concussion symptoms will generally dissipate within six weeks, but sometimes postconcussion syndrome, causing prolonged symptoms, can occur. Once patients are feeling better, they could still have an ongoing TBI, and therefore they must be cleared by a medical provider to return to contact sports or any activity where head trauma could occur. Some of these activities are less obvious than others. The US Consumer Product Safety Commission tracks sports-related head injuries in children under fourteen years of age, and playground equipment is the number one cause of sports-related concussions, likely from falls over three feet.

The classification of a TBI as mild, moderate, or severe is based on the level of consciousness of a patient at the time of the trauma using the Glasgow Coma Scale (GCS) or Full Outline of UnResponsiveness (FOUR) score. These scores evaluate such parameters as reflexes and eye, motor, and verbal responses to determine the severity of the primary brain injury as a result of trauma, but secondary injury can occur later due to inflammation and brain cell dysfunction.

In moderate to severe TBIs treatment is focused on increasing brain oxygen, regulating the patient's blood pressure, and preventing brain swelling, herniation, and seizures, so the patient is hospitalized, often in the intensive care unit. One in four injury-related deaths in the US report TBI, and an estimated 10 percent of traumatic brain injuries also include diffuse traumatic axonal injury, which is when the shearing force of the trauma rips brain cells in half. It is important to note that patients do not always hit their heads or have direct trauma causing concussions—severe shaking, such as in a car accident, can cause TBIs as well.

One vital concern in healing concussions is second impact syndrome. Second impact syndrome occurs when a patient sustains a head injury while still healing from any degree of TBI, and this is the reason that concussion clearance by a medical provider before returning to sports is so important.

In 1984, second impact syndrome was described in the *Journal of the American Medical Association* by Dr. Richard Saunders and Dr. Robert E. Harbaugh, not to be confused with the football coaching Harbaughs of the Chargers and Ravens, although, allegedly, they are distantly related. Doctors Harbaugh and Saunders are physicians and concussion researchers who documented a nineteen-year-old male's death four days after returning to play following a relatively minor head injury during a football game. This was most likely due to second impact syndrome.

Second impact syndrome is rare but most often seen in those under twenty years old. In one case study, the latency between the first and second impact ranged from an hour to five weeks. Patients will develop altered mental status or loss of consciousness immediately after the second impact and can die within minutes. The mortality for this disease is estimated at 50 percent, with 100 percent of those who survive having permanent cognitive impairment.

The CDC estimates that there are as many as 3.8 million sports-related head injuries annually. Sports are a major risk factor for TBI, with the highest reported incidence of head injuries coming not from football but cycling, although this is likely in part due to a larger number of cyclists than football players. Boxing, cheerleading, skiing, baseball (catchers and pitchers), soccer, lacrosse, rugby, and, of course, riding ATVs also made the list of sports that can be dangerous for the brain. (The second highest cause of sports-related head injuries is football.)

In 2007, *The New York Times* published an article highlighting the life and death of an ex-NFL football player, Eagles safety Andre Waters, after he committed suicide at forty-four years old. His autopsy showed that Mr. Waters had severe deterioration of his brain, similar to what is seen in Alzheimer's disease, showing signs of chronic traumatic encephalopathy (CTE). Years later a case study was performed by Dr. Ann McKee, director of the Boston University Chronic Traumatic Encephalopathy Center, finding that 91.7 percent of post-NFL players studied showed signs of brain deterioration consistent with CTE.

CTE results from recurrent, even mild, TBIs and is most often seen in professional athletes, combat-related injuries, and car accidents, presenting as early-onset dementia, psychiatric illness, or decline in brain function. In both CTE and Alzheimer's disease, brain tissue has a buildup of abnormal proteins, such as tau protein and amyloid plaques. These proteins cause

brain cell dysfunction and eventually cell death, but in CTE the patients often present much younger. Currently, the only way to diagnose CTE is to examine brain tissue via biopsy or autopsy, but a brain biopsy is dangerous and often considered unnecessary since there is no treatment.

The NFL responded to the discovery of CTE by implementing rule changes such as kickoff modifications and the “Use of the Helmet” rule, in efforts to obviate potential risk behaviors, as well as employing biomedical engineers for a helmet-safety redesign. Guardian Caps, developed in 2010, are seven-ounce soft shell caps that go over helmets and have been proven to drastically reduce head impact. These caps were required for certain positions during the 2023 and 2024 NFL training camps, and the NFL saw a 50 percent reduction in preseason concussions. As of 2024, Guardian Caps are allowed in regular-season games, although I have yet to see many players using them. These caps should be considered as a requirement in all sports with helmeted players under eighteen years of age.

The brain is arguably the most important organ in the body, just don’t ask a cardiologist. The brain should be protected at all costs, certainly in young people, especially since we have the technology to do so. If your child plays a contact sport, consider a helmet cap, or consider lower-risk sports like swimming, tennis, cross-country, or chess.

If your child plays a contact sport, consider a helmet cap, or consider lower-risk sports like swimming, tennis, cross-country, or chess.

Chess, which is recognized by the International Olympic Committee (IOC) as a sport, has an exceedingly low number of TBIs.

SEX

Pregnancy

Syphilis

Sexually Transmitted Infections: Gonorrhea & Chlamydia

Human Immunodeficiency Virus (HIV)

Herpes

Human Papillomavirus (HPV)

Butt Stuff

PREGNANCY

I recently became pregnant, so it seems like an opportune time to tackle the chapter on the dangers of pregnancy.* I am not talking about the incessant slog of all-day “morning sickness” or losing your buttocks in the delivery battle; that’s child’s play. I am talking about the multitude of ways to die from being pregnant. For most women, pregnancy will be the most dangerous undertaking of their lives, unless they have an insatiable taste for pufferfish (see chapter on tetrodotoxin) or are avid spelunkers of volcanic caves (see chapter on volcanoes).

Why am I telling you about these dangers? For several reasons. First, women should understand the risks of pregnancy and make informed healthcare decisions. Second, society should understand what it asks of women.

FIRST TRIMESTER

In the beginning, there was nothing. Women squatted in fields and pushed, and a lot of them died in childbirth. For instance, from 1700 to 1750 in Great Britain, one in one hundred women would die in childbirth. Humanity has improved its survival statistics for birth, but they still aren’t great. According to 2020 Central Intelligence Agency worldwide estimates, the United States, the country with the world’s most expensive healthcare, ranks 122 in maternal mortality, just three spots ahead of the West Bank and Gaza Strip, and the US maternal mortality rate is on the rise.

While the first twelve weeks, or first trimester, of pregnancy are relatively safe, the fetus is making huge microscopic moves from fertilization to organ development, and growing from the size of a grain of sand to the size of a plum is a complicated process.

The first step is counting chromosomes—twenty-three from mom and twenty-three from dad. If there isn’t a correct pairing of chromosomes to create a human, the body will recognize this and abort the pregnancy. Some chromosomal abnormalities are survivable, such as Down syndrome (which has an extra copy of chromosome 21), but many are not. Chromosomal abnormalities are the most common reason for first-trimester miscarriage. While early miscarriage is not generally life-threatening, it is common: Up to one in four pregnancies result in miscarriage, with around 80 percent occurring in the first trimester. In conclusion, first-trimester miscarriage is

common and an unfortunate misnomer because the difficulty is generally not the carrier, but a biologically unviable embryo.

Bleeding in the first trimester is also incredibly common, but only about half of those with bleeding result in miscarriage. In many pregnancies, first-trimester light spotting of blood results from the implantation of the embryo into the uterus and will go on to be a conventional pregnancy. All bleeding should be reported immediately to a doctor, because it can be associated with ectopic pregnancy, the leading cause of maternal mortality in the first trimester.

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It is most common for sperm to enter an egg, in a process known as fertilization, in the fallopian tubes, which are the yellow brick roads between the Munchkinland ovaries and the Land of Oz known as the uterus. Ideally, the developing embryo should then travel through the fallopian tubes to the uterus to implant and grow into a fetus. In an ectopic pregnancy, the developing embryo implants in tissue outside the uterus. Most often this faulty embryo implantation takes place in the fallopian tubes. Symptoms of ectopic pregnancy include vaginal bleeding and lower abdominal cramping, almost exclusively during the first trimester, which always requires immediate medical attention. An ectopic pregnancy will be diagnosed with ultrasound and blood levels of the pregnancy hormone hCG. This is the same hormone that creates two lines on the at-home pregnancy test.

An ectopic pregnancy in a fallopian tube will divide and grow but never become a viable pregnancy. It will, however, rupture a woman's fallopian tube and result in copious bleeding and death in the absence of proper medical care. There is no other possible outcome, much to the surprise of the Ohio politician who introduced House Bill 413, requiring doctors to "reimplant an ectopic pregnancy" in the uterus or face criminal charges. This procedure does not exist. I will pause here to allow Michiganders to comment on the state of Ohio.

Ectopic pregnancies are unfortunately common, seen in about one in fifty pregnancies. If there are over six million pregnancies a year in the US

and one in fifty is an ectopic, why aren't over a hundred thousand women dying from ectopic pregnancies every year? Answer: Medical abortions. There is only one way to survive an ectopic pregnancy in a fallopian tube: Abort the pregnancy, most commonly with two sequential pills of methotrexate. If these pills fail, or the ectopic ruptures the tube, then emergency surgery must be done to remove the pregnancy, and this often results in the loss of the fallopian tube and future fertility challenges.

SECOND TRIMESTER

The second trimester is when pregnancy starts to ramp up, and it is full of weird rules.

During pregnancy, your body takes on an interloper. The body is very good at distinguishing self from non-self, which is how it fights off bacteria, viruses, and parasites. But this is one parasite you are willing to give a nine-month hall pass, so the body must get on board with baby. To do this the immune system shuts down a bit, just enough to make pregnant women vulnerable to a host of diseases, creating a long list of weird rules.

Weird Rule Number One: No lunch meats, hot dogs, soft cheeses, or unpasteurized dairy. Why? Listeria. *Listeria monocytogenes* is a bacteria found in food and soil that can grow at refrigerator temperatures. Listeria usually causes food poisoning symptoms, but thanks to decreased immune systems, pregnant women are much more vulnerable to all types of food poisoning and invasive disease from causative bacteria. While pregnant it is important to wash fruits and vegetables and avoid raw fish and raw eggs to reduce risk of food poisoning from *E. coli* and *Salmonella*, but your little lemon-size interloper is incredibly sensitive to listeria. Pregnant women are ten to eighteen times more likely to get listeriosis, which can cause invasive diseases from listeria such as brain infections, as well as miscarriage, stillbirth, and preterm labor.

Weird Rule Number Two: Stay away from cat poop. Toxoplasmosis is the leading cause of death from foodborne illness in the United States, but more than forty million people are unknowingly carrying this intracellular parasite. In those with strong immune systems who are not pregnant, toxoplasmosis is generally a nonissue, and most individuals clear the parasite without even knowing they were infected. In pregnancy, toxoplasmosis can cause symptoms in the mother but can also be

transmitted to the fetus, causing congenital hydrocephalus (water on the brain), microcephaly (small head), blindness, seizures, cognitive disabilities, and other complications.

Toxoplasmosis is caused by the *Toxoplasma gondii* parasite, which has multiple stages and hosts, and one of those hosts is currently curled up on the couch in 46.5 million American homes. If you thought Whiskers was plotting to kill you, you may be right. The toxoplasmosis parasite is found in food, such as undercooked meat, and cat poop. Why are people eating cat poop? Well, Whiskers' butt gets around and microscopic cat feces particles containing the toxoplasma parasite can contaminate food and water. Veterinarians can test cats for toxoplasma, which may be a good idea if someone in the home plans to become pregnant, or if your cat has symptoms.

Weird Rule Number Three: Stay away from anti-vaxxers. This is more of a general rule, but interact at your own risk, especially while pregnant. During pregnancy certain infections can cross from the mother through the placenta to the fetus; these are known as TORCH infections, and many are vaccine-preventable diseases that cause congenital abnormalities and death. TORCH stands for *Toxoplasma gondii* and *Treponema pallidum* (syphilis), rubella virus, cytomegalovirus, and herpes simplex virus (HSV) respectively. Like many very useless acronyms, the “O” in TORCH stands for “other viruses,” which includes hepatitis B virus, human immunodeficiency virus (HIV), measles, parvovirus, and varicella virus (chickenpox). Rubella, hepatitis B, measles, and chickenpox are all vaccine-preventable diseases. Remember you can catch the chickenpox virus from shingles, so keep your distance while pregnant. The TORCH infections are known to cause severe congenital disease or fetal death, which also creates risk for the mother.

A good part of the second trimester is that the fetus becomes viable. Viability is a tricky subject for many reasons. As of 2024, the American College of Obstetrics and Gynecology states viability is twenty-four weeks, when more than 50 percent of births survive to discharge in the United States, England, and Australia. A few have survived being born earlier, but this is rare. At twenty-three weeks 5 percent of births survive, 98–100 percent with significant and universal morbidity including physical and neurological deficits.

Fetal viability means something interesting in the world of emergency medicine. Once the uterus is above the belly button, we start to estimate that the fetus may have reached viability, so if a pregnant woman loses her heartbeat and needs CPR the fetus is removed in a unique style of emergency cesarean section (C-section) while continuing CPR. This is not easy to do. The C-section is performed because it gives the mother an increased chance of survival but can also give the fetus a chance of survival, and it works.

One day a colleague was doing an exam on a woman and saw the unique scar from a postmortem C-section. She confirmed that she had died while pregnant, and the baby was cut out and she came back to life. She then pointed to her son in the corner of the room, who was a teenager, and said, “That’s the baby.”

THIRD TRIMESTER

The third trimester is when things get a little dicey for mom. This is by no means an exhaustive list of dangers—for instance, a patient once brought in by paramedics was found in her shower with her intestines hanging out after an infection ruptured her cesarean section wound. There are plenty of life-threatening pregnancy-related events not listed here, but this is an abridged version: amniotic fluid embolism, cancer, cardiomyopathy, chorioamnionitis, choriocarcinoma, spontaneous coronary artery dissection, depression and suicide, dural sinus thrombosis, ectopic pregnancy, eclampsia, gestational diabetes, HELLP syndrome, hemorrhagic shock, hyperemesis gravidarum, electrolyte abnormalities, intimate partner violence, missed abortion,^{*} molar pregnancy, placenta accreta, placental abruption, postpartum psychosis, postpartum depression, pulmonary embolism, retained products of conception, sepsis, septic abortion, trophoblastic tumors, trauma, uterine abruption, and uterine atony.

Preeclampsia is a relatively common disease that can progress to eclampsia, causing life-threatening seizures. An amniotic fluid embolism is a devastating, catastrophic event, with mortality reported as high as 90 percent, that occurs during delivery, likely due to amniotic fluid entering the bloodstream and causing a sudden severe inflammatory reaction in the body. Postpartum cardiomyopathy causes heart failure in healthy pregnant women. This results in chronic heart failure in around 25 percent of young women affected, many requiring heart transplants, and has a twelve-month

mortality of 9.8 percent, meaning that one in ten women will lose their lives. There are even types of cancer caused by pregnancy. We don't know much about many of these pathologies, since the National Institutes of Health was not required to include women in research studies until 1989.

Many of the above-listed pathologies are rare occurrences, as the WHO states 75 percent of all maternal deaths worldwide are from just five causes: severe bleeding, infections, eclampsia, delivery complications, and *unsafe* abortions, which refer to abortions done improperly or in an unsafe setting, often due to the threat of legal prosecution or lack of healthcare resources.

If you're pregnant or planning to become pregnant, I am sure this information is overwhelming and somewhat terrifying, but many of these diseases are uncommon. Keep in mind, I knew all of this before I became pregnant, but I made an informed decision to put my health on the line in hopes of starting a family. All patients deserve the right to make this informed healthcare decision.

THE “FOURTH” TRIMESTER

In 2023, *The New York Times* published an article outlining the dangers of the “fourth trimester,” after the Centers for Disease Control released data from thirty-six states showing that most maternal deaths take place not during pregnancy or birth, but in the year following the birth of a child. As poignantly described by University of North Carolina School of Medicine professor Dr. Alison Stuebe, “The US approach to birth has always been that the baby is the candy and the mom's the wrapper, and once the baby is out of the wrapper, we cast it aside. We need to recognize that the wrapper is a person.”

According to the World Health Organization around three hundred thousand women die annually from pregnancy-related complications. In the US, mortality is much higher in African American and Hispanic populations. For example, preeclampsia is 60 percent higher in Black women, and they are more likely to experience poor outcomes. In their review of maternal mortality, the US Maternal Mortality Review Committees determined that more than 80 percent of pregnancy-related deaths in the US were preventable.

It is not all bad; the creation of a human life is a persistent miracle. How can a microscopic sperm find and fertilize a minuscule egg over such a vast expanse? Picture this: three hundred million people, roughly the population

of the United States, traveling over a mile in search of a single grain of sand. Did I mention everyone is blindfolded and hopping on one leg? If by some kismet a sperm does find an egg, the fact that one cell can grow into the over thirty trillion unique and functional cells required to create a human is a miracle. It may be science, but science can be miraculous.

Unfortunately, the gestation of this little miracle will be the total, life-threatening responsibility of the fairer sex until further notice, and that is intrinsically unfair. There will never be equality in the creation of a human being, but there can be equity. Women must fully understand the risks they take in choosing to be pregnant, and society must support their efforts, for there to be any semblance of fairness. The gender pay gap will never close and maternal mortality will not reach its nadir without societal support. For a civilization to flourish it must invest in the women who serve as the keystone of our society and the foundation of our humanity. Or just keep doing what you're doing; it worked out great for the early-twenty-first-century population economics of Japan and South Korea.

SYPHILIS

Syphilis is a bacterial disease caused by the *Treponema pallidum* spirochete bacteria. This curly little bacterium has corkscrewed its way into human history. Syphilis is primarily a sexually transmitted disease that transfers through skin-to-skin contact with an infective syphilitic sore.

Syphilis has a broad range of symptoms presenting over thirty years and is known as the *great imitator* due to its manifestations as anything from a skin sore to a brain infection. Syphilis plays a creative long game as a progressive disease.

Historically, everybody who's anybody had syphilis, from Oscar Wilde to Al Capone. Did you know Casanova was a real person? The Italian explorer, known for his artful seduction technique of paying sex workers, Casanova had syphilis, genital herpes, and a lot of gonorrhea. In his autobiography, aka diary, he states he didn't use condoms, because he didn't like "shutting [himself] up in a piece of dead skin in order to prove that [he was] well and truly alive." Right, like women haven't heard that before.

There are some accounts that Hitler might have had neurosyphilis, but by most accounts, he was just a disturbed fascist. Napoleon was said to have contracted the disease as well. Of note, when Napoleon was absent

from fighting and losing the battle of Waterloo, that was not because of syphilis, but because of hemorrhoids. While historically and medically astute to avoid wrongly implicating syphilis, I find it more important to note the poetic justice that a brutal twenty-three-year war was ended by the same asshole that started it.

Syphilis may have also inspired and ended the Impressionist era of art. Edouard Manet, Henri de Toulouse-Lautrec, and Paul Gauguin all had syphilis. I know what you are thinking: Two of those artists are actually Postimpressionists, and one is a racist sex offender. All true, but let us focus on syphilis.

The most famous Impressionist artist presumed to have had syphilis was Vincent van Gogh. According to the Public Broadcasting Service, van Gogh was a lover of brothels, where he was believed to have contracted the disease. Van Gogh's madness led him to cut off his ear, box it up, and send it to his favorite sex worker. While neurosyphilis would have certainly influenced his actions and art, Vincent's color choices were said to be due to another medical diagnosis. Digitalis, a heart medication derived from the foxglove plant (as discussed in the chapter on poisonous plants), was given to van Gogh. In high concentrations, this medication can cause a yellowing of vision and may have inspired the color patterns in his most famous work, *The Starry Night*.

Speaking of stars, the infamous mobster Al Capone began to show signs of neurosyphilis during his early days of incarceration on Alcatraz Island. Word on the street was Capone contracted the disease as a teenager. He was one of the first people in the US to receive the cure for syphilis, but his disease was too advanced. Once syphilis had destroyed his brain, Capone was allowed medical leave from Alcatraz to live the remainder of his life among other retirees, in Florida.

Syphilis was a major cause of death in the United States prior to World War II, when the lifesaving cure was found in the form of the very first antibiotic, penicillin. Since the discovery of penicillin, deaths from syphilis in the US are rare. More common are deaths from congenital syphilis, which is when this treatable disease is passed through the placenta to the fetus, sometimes resulting in stillbirth. This is an example of why prenatal care is so important, since obstetricians check for life-threatening diseases that may be asymptomatic.

Syphilis has three stages. The first stage is an ulcer called a chancre. Not to be confused with a painful canker sore, a chancre is a painless ulcer caused by syphilis that lasts three to six weeks. A syphilis chancre is full of spirochete bacteria and is extremely infectious. They are often found in the genital area, which is how the disease is transmitted sexually. Syphilis transmission requires direct contact with the chancre and is generally not passed through contact with objects. For instance, according to the CDC, you cannot get syphilis through casual contact with doorknobs. The Centers have released no statement regarding formal contact with doorknobs.

The second stage of syphilis involves a full-body raised red rash, which includes the palms and soles, as well as sores and flu-like symptoms. During secondary syphilis, a person is highly contagious. If the patient does not receive treatment at this point, the bacteria often enter a dormant stage. During the latent stage of syphilis, the bacteria can live in the body silently for up to thirty years.

In the third and final stage, syphilis infects organs such as the brain, causing neurosyphilis. During this stage, the bacteria can also cause blindness, hearing loss, and tabes dorsalis, when syphilis attacks the nerves of the spinal cord.

Given the diversity of presentations and propensity for prolonged latency, syphilis pops up when least expected. One morning, it burst through the doors of my emergency department:

“I need to speak to a doctor immediately!”

A distraught woman held a long skinny mouselike creature in front of her, her hands thrust under his armpits, his back legs dangling freely. The unamused ferret slipped slowly through her reluctant hold, his neck collecting in a triple chin beneath his tiny scowl.

“This ferret is an imposter!”

The admissions clerk searched through the dropdown for the appropriate patient chief complaint. While there was an option for *struck by orca*, *imposter weasel* was not found, so he entered the patient complaint manually.

When I arrived at the patient’s room, the ferret had taken to exploring the medical equipment. The woman was sitting on the bed with her arms and legs crossed. The conversation that followed went something like this:

“Hello, I am Dr. Alker. How can I help you today?”

“This ferret is an imposter!” She pointed accusingly at the weasel, who then surprisingly looked up, making eye contact, as if to say, *Who, me?*

“This ferret has been planted in my house in the place of my ferret by my neighbors who are spying on me. I have alerted the police, and they directed me to come here.”

This is a difficult, seemingly nonmedical patient complaint, but as a doctor, I must prove there is no medical ailment. Early on it was clear the patient wasn’t going to be much help in gathering a history.

I considered it might be easier to interrogate the domesticated weasel. An image popped into my head of shining an OR light on the ferret for questioning. Forget about the ferret. The ferret may or may not be a spy. Let us assume he is untrustworthy. I had the ferret removed by an ED technician, who offered him water. It was obvious the espionage weasel was going to get off with a warning.

I focused on my patient.

“Ma’am, do you have any medical problems?” Every doctor asking this question is hoping for low-hanging fruit. For instance, a history of schizophrenia would be an obvious cause for her symptoms. But she had no psychiatric history, no medical history at all. She was oriented to person, time, and place, but held a bizarre delusion about her ferret.

I hoped the physical exam would reveal some clues.

The patient had a grossly normal physical exam, but was slightly unsteady on her feet. Finally, the patient’s eyes told me what I needed to know. Ironically, the eyes that made her see her ferret as an imposter, changing her world into a waking nightmare, held the truth. Her pupils did not constrict with light—Argyll Robertson pupils.

The lumbar puncture confirmed a disease with the talent of an expert spy: *the great imitator*. She had neurosyphilis. Once treated, the patient was reunited with her ferret, who continues to report on her activities.

Although syphilis is easily treatable, this devious disease is not easily discovered without testing. Unfortunately, syphilis has been on the rise in the US, with 210,921 reported cases in 2023, including congenital syphilis passed from mother to fetus. Early pregnancy care with an obstetrician includes screening for syphilis. It is important to get tested regularly for syphilis if you are sexually active. Reduce exposure by wearing condoms and be sure that you and your partner(s) are treated and test negative for syphilis before resuming sexual activity.

SEXUALLY TRANSMITTED INFECTIONS: GONORRHEA & CHLAMYDIA

In the emergency department, you become desensitized to the horrors of humanity, because you see terrible things happen. When you are constantly confronted with life-threatening emergencies and the terrors of society, sexual escapades are no longer shocking. You can tell an emergency doctor your most ludicrous sexual act, and if everyone was a consenting adult, we do not care. We won't even blink. We have heard worse, and we didn't care about that either. You were at an anonymous orgy and had a eureka moment inspiring you to stick a light bulb in your butt? Don't care. We have thirty sick people in the waiting room, two heart attacks, three patients with sepsis, a stroke, and a ten-day-old who needs a lumbar puncture. The bright idea bulb comes out of the butt, and would you like sexually transmitted infection (STI) post-exposure prophylaxis with that? Discharge.

Understandably, patients are nervous about sharing sexual histories, but unless the findings are subject to mandatory reporting, your information is protected.* Doctors understand sexual emergencies are traumatic for patients, but the last patient put a gun in his pocket and accidentally blew his penis off, so whatever you have cannot shock the emergency department. We've seen it. We've heard it. We are too desensitized and exhausted to have an opinion about it.

In the US, there are around nineteen million new cases of sexually transmitted infections (STIs) every year, and half of those are in people fifteen to twenty-four years old. This is mostly because young people are not using condoms, which is mind-blowing. According to the CDC, less than half of unmarried men report wearing condoms with intercourse.

When used correctly, male condoms prevent more than 90 percent of gonorrhea and 50–90 percent of chlamydia infections. Surprise! Condoms are not 100 percent effective at preventing STIs. But we have bigger problems since people cannot figure out how to use male condoms correctly. Studies have shown that condoms may break or slip in up to 4 percent of cases; otherwise condom malfunction is a user error. Since statistically we are all idiots, anyone having sex should be screened annually for sexually transmitted infections, which is as simple as a urine test.

Speaking of the foolish things we do, one day a patient came into the ED after finding a creative way to avoid STIs, which sadly ended with his

hand caught in the proverbial cookie jar. He hobbled into the exam room and was very unenthusiased to see the doctor was a woman. The doctor did not care.

“I’m Dr. Alker. What brings you in today?” My usual opening line.

“I have an ... issue.”

“Go on.”

“It’s not something I want to say out loud. Can I just show you?”

“Yep.”

He then removed his gym shorts, and his penis was stuck inside a jar. If you’re thinking, “Oh my God, this is me!”—it is not you. This is not the first penis in a bottle I have seen. This is woefully common, which is how I developed a MacGyver-level tactic for disarming this bomb. I’m not giving up this medical secret, because, first, you’ll try it at home and cause grievous injury, ending up in the ED, and second, the magicians must keep some secrets. My trick is similar to pulling a rabbit out of a hat but less cute, and the rabbit is eternally grateful.

Though pickle jar escapades are inadvisable, the patient’s sexual preference did avoid exposure to the two most common STIs, gonorrhea and chlamydia, which can, surprise again, be deadly.

Gonorrhea competes with syphilis for the title of the oldest STI, having been described by the ancient Chinese, Romans, and Egyptians. The Bible even got in on it with Leviticus 15:1–3: “Speak to the People of Israel. Tell them, when a man has a discharge from his genitals, the discharge is unclean.” God was not wrong.

As time progressed, gonorrhea picked up many nicknames, the most famous being “the clap,” likely originating from its association with *Les Clapiers*, the red-light district of Paris in the 1300s. Gonorrhea, now known as an STI, was once known as a venereal disease (VD) and a sexually transmitted disease (STD), but the term *STI* was adopted by the World Health Organization in 1999, as it better incorporates asymptomatic infections. No matter what you call it, as the Bible proclaims, you don’t want it.

Gonorrhea is caused by the bacterium *Neisseria gonorrhoeae*, which usually infects the mucosal membranes of the genitals, throat, or rectum after sexual contact, but can also cause more invasive disease, which in some circumstances is life-threatening. While a large number of women with gonorrhea infections are asymptomatic, some patients may have

genital discharge; see Leviticus 15:1–3. Infections in both men and women can ascend to the upper genital tract, causing infertility.

With the WHO estimating eighty million new gonorrhea infections globally each year, this bacterium has quickly developed resistance to almost all antibiotic treatments, remaining sensitive to only one class of antibiotics, cephalosporins, which landed gonorrhea on the CDC's watch list for antibiotic-resistant bacteria.

But how does gonorrhea kill you? There are several ways, including bacterial resistance and pelvic inflammatory disease, which are discussed elsewhere, so we will focus on disseminated gonorrhea.

A disseminated gonococcal infection occurs in up to 3 percent of gonorrhea infections when the initial sexually transmitted bacteria spreads beyond local infection to elsewhere in the body. Increased risk of disseminated infection occurs with a weakened immune system, but genetic mutations in the bacteria also enable gonorrhea to attack the body more effectively. Dissemination is more common with asymptomatic genital infections, likely due to delayed diagnosis, and can cause painful pustular skin lesions, which can be mistaken for pimples. The infection can also spread to the heart, brain, joints, and bones.

Diagnosis is made through clinical suspicion and blood, skin, joint fluid, or genital culture positive for gonorrhea. Treatment employs our last remaining effective antibiotic class, cephalosporins. Once these sexual super-bacteria become resistant, we will need to beef up sex education classes to teach future generations how to use condoms correctly. Bring in the bananas.

If the condom breaks, gonorrhea might not be the only unintentional outcome. When babies are born in the US, states mandate that they receive erythromycin antibiotic ointment on their eyes; that is why you are handed a goopy-eyed baby, although who can notice with all the other stuff they are covered in? The reason for this is that bacteria, including gonorrhea, can be transferred from mom and can cause an eye infection called ophthalmia neonatorum, a disease that historically caused three out of every thousand newborns to go blind. In late nineteenth century Europe half of all children in blind schools had had ophthalmia neonatorum infections as infants. Erythromycin may also prevent ophthalmia neonatorum caused by chlamydia and other non-STI bacteria commonly found on the skin. Given

that there is very little downside to a topical antibiotic ointment, this preventative measure is universally offered at hospitals in the US.

Speaking of gonorrhea's crafty cousin, chlamydia is caused by the intracellular bacteria *Chlamydia trachomatis*, commonly transmitted through vaginal, oral, or anal sex, so commonly transmitted that there were over 128 million new infections in adults worldwide in 2020. These two STIs often travel together, with studies showing up to 40 percent of patients with one infection will have the other. Because of this statistic, when receiving STI postexposure treatment, patients are treated for both gonorrhea and chlamydia. Where there is smoke, there is fire, and those burning loins need treatment for both STIs.

Chlamydia infections are often asymptomatic, but both gonorrhea and chlamydia can cause pelvic inflammatory disease (PID) in women, infecting the uterus and fallopian tubes, and sometimes creating abscesses on the ovaries. This type of infection can be deadly if untreated and can result in future infertility. Additionally, PID-related inflammation in the female reproductive tract, specifically the fallopian tubes, makes future ectopic pregnancy more likely. So even after an STI is treated, it could still be deadly due to complications.

To avoid death by STI, which is uncommon but makes for an uncouth obituary, have yourself and your sexual partners checked for STIs before sexual contact and use a condom, correctly, for 50–90 percent prevention, better than zero. Gonorrhea and chlamydia are still easy to test for and treat, so why not get checked? And for God's sake, Leviticus 15:1–3: *When a man has a discharge from his genitals, the discharge is unclean.*

To avoid death by STI, which is uncommon but makes for an uncouth obituary, have yourself and your sexual partners checked for STIs before sexual contact and use a condom, correctly, for 50–90 percent prevention, better than zero.

HUMAN IMMUNODEFICIENCY VIRUS (HIV)

One day on shift while slogging through the pandemic, knee-deep in COVID-19, a fellow emergency doctor nearing his retirement recounted old war stories from his first pandemic when he served as a resident physician during the early days of HIV/AIDS.

In June 1981, the first cases of acquired immunodeficiency syndrome (AIDS) were reported in five young men in Los Angeles, but the cause and transmission of the disease were complete mysteries. People were terrified of contracting the disease because scientists had no idea how it spread: Air? Saliva? Stool? People were dying suddenly, emaciated, succumbing to terrible infections that were highly uncommon, and doctors could not identify why.

The stories from the early HIV/AIDS pandemic were terrifying and tragic: Young, previously healthy people would feel like they had the flu or a sinus infection, and four days later they would be dead. The diagnosis was a death sentence with an estimated lifespan of five years.

In 1984, the discovery of the human immunodeficiency virus took place simultaneously at the Pasteur Institute in Paris by Dr. Françoise Barré-Sinoussi and Dr. Luc Montagnier; and at the University of California, San Francisco by Dr. Jay Levy. They determined HIV was a retrovirus and the cause of AIDS.

Retroviruses are weird. Your DNA is like a long story written about everything you are, and HIV copy-pastes itself into your story. Once the retrovirus inserts itself into your human DNA, it uses your cells' own machinery to make copies of the virus. HIV might be odd because it jumped to humans from central African chimpanzees. This likely happened as early as the 1800s through contact with animal blood when hunting. In humans, HIV is spread through contact with infected blood, most commonly seen in intravenous drug use, sex, and previously through transfusions before we knew to check blood for the infection. Anal sex was especially risky because there is more likely to be small amounts of blood and less likely to be condom use. AIDS was originally named "Gay-Related Immune Deficiency" (GRID) because doctors saw a high percentage of homosexual men contract the disease, but this is a correlation, not causation. Heterosexual or bisexual individuals who take part in high-risk behaviors, such as anal sex without the use of a condom, are just as likely to contract HIV, and so the name was appropriately changed to AIDS.

HIV can also be contracted from the virus contacting mucosal surfaces, like the mouth or eye, but infection is less likely. You cannot get HIV from saliva, tears, sweat, hugging, shaking hands, sharing dishes, or from mosquitoes or ticks.

Initial symptoms of HIV infection are undifferentiated from flu-like illness. At this point, the next time you have a cold, you'll be terrified. After the flu-like illness, the virus may lie in wait for decades, or it could attack quickly. HIV targets certain immune cells called CD4 T cells, which are blood cells needed to fight infections. Once HIV forces the CD4 T cells below a certain number, the body has acquired an immunodeficiency known as AIDS, and opportunistic infections will attack. Opportunistic infections are viruses, fungi, and bacteria found in the environment that do not infect people with healthy immune systems but that can kill someone with a low immune system, as seen in AIDS. Even with antibiotics, an immune system is still needed to be able to fight off infections. The leading causes of death in AIDS patients are AIDS-defining illnesses, including these opportunistic infections.

In 1987, six years after the first cases of AIDS were seen in the United States, an HIV treatment was approved by the FDA: zidovudine, also known as AZT. If you have seen the Jonathan Larson musical *Rent*, you may remember when two of the main characters, Mimi and Roger, take an "AZT break" at the bar for their HIV medications. The original antiretroviral medication stopped the replications of HIV but came at quite a cost, with side effects including nausea, vomiting, diarrhea, insomnia, bone marrow suppression, nerve death, and liver failure.

Today, treatments are highly evolved in comparison, with lower side-effect profiles, providing a life expectancy similar to the general public. For those diagnosed with HIV, it was recommended that patients only start antiretroviral medications once their CD4 count dropped below a certain number, but today there are recommendations to start antiretrovirals as soon as possible after diagnosis.

There are also preventative medications for HIV. PrEP, or pre-exposure prophylaxis, is a daily pill that can reduce the risk of contracting HIV through sex by 99 percent and IV drug use by 74 percent. If you have a known exposure to HIV, such as unprotected sex, go immediately to an emergency department to get post-exposure prophylaxis (PEP). PEP should be started as soon as possible and is recommended within seventy-two hours of exposure. The therapy involves taking HIV-preventing medications daily for at least twenty-eight days.

Contemporary HIV medications target multiple stages of the virus in a regimen known as highly active antiretroviral therapy (HAART). AIDS

treatments not only target opportunistic infections but also target the human immunodeficiency virus itself, allowing the body to increase its number of CD4 T white blood cells and recover. The goal of these medications is to suppress the HIV virus enough to have an undetectable amount of virus in the blood, keeping CD4 counts high, which prevents opportunistic infections. Having an undetectable amount of HIV in the blood means, in theory, you cannot transmit the virus to others. For instance, in HIV positive pregnant or breastfeeding women, having an undetectable viral load greatly reduces the chances of passing the HIV infection to the fetus or baby.

There are extremely rare individuals naturally resistant to HIV infection because they carry a mutation to the receptor that the virus uses to get inside human cells. Additionally, there are three reported cases of patients cured of HIV after receiving bone marrow transplants for blood cancers. These patients happened to have bone marrow donors that carried the needed mutation for HIV resistance. That being said, bone marrow transplants come with substantial morbidity and mortality risk—it's one of the gnarliest procedures out there.

There may soon be a way to prevent the virus in the form of a vaccine. In 2023, a clinical trial funded by the Gates Foundation and VIR Biotechnology began in the United States and South Africa for a vaccine that could prevent and possibly eradicate HIV.

Today, 1.2 million people in the United States have HIV, and more than 10 percent of them don't know it, which amounts to an estimated 150,000 people unaware of their infection.

Today, 1.2 million people in the United States have HIV, and more than 10 percent of them don't know it, which amounts to an estimated 150,000 people unaware of their infection. Getting tested for HIV is a simple blood test, and PrEP, PEP, and early treatment save lives. Most people with HIV live normal lives with daily medication, but a lot of unwarranted stigma remains surrounding the disease. A great social commentary on this is Tony Kushner's *Angels in America*, which has an HBO miniseries starring Al Pacino and Meryl Streep, if you're looking for something to do after reading this chapter.

HERPES

“You have herpes” is never what a patient wants to hear, but most people have herpes. A CDC study on the herpes simplex viruses in 2015 showed that around 50 percent of the US population was positive for herpes simplex virus type 1 (HSV1) and 12 percent was positive for herpes simplex virus type 2 (HSV2). Doing the math, assuming some individuals carry only one strain, most people in the US have herpes. Unfortunately, 80 percent of those people don’t know they have herpes, and their ignorant bliss means problems for their partners.

Before the world starts shaming the US for spreading sexually transmitted infections, the World Health Organization estimates that 67 percent of the worldwide population under fifty is positive for HSV1, so everybody is doing it.

The herpes virus began in monkeys and was contracted by our hominin ancestors. If you want names, it was probably either *Homo habilis* or *Homo erectus*. Humans are the only primates to have managed to cultivate two different types of herpes simplex viruses: HSV1 and HSV2. The first human case of herpes was documented during Bronze Age migrations into Europe when kissing emerged as a social practice. Herpes made its way over to the US, probably on the *Mayflower*, and by the free-loving sixties there was a boom of genital herpes in the United States. Turns out love is not free.

HSV1 is oral herpes, contracted via kissing or contact with infected saliva, and most commonly causes cold sores. Most people will contract this virus during childhood through infected saliva contact. It is less common but HSV1 can be transmitted through oral sex and genital contact. A bit of good news, possibly, those with HSV1 oral herpes are thought not susceptible to HSV1 genital herpes. So, those with HSV1 cold sores shouldn’t get HSV1 genital sores ... YAY?!?

One out of four people infected with HSV1 will have cold sores, also known as fever blisters, from the virus, but the other three individuals will remain asymptomatic, unknowingly spreading the virus. Great planning by the virus. And just like that rock your fiancé gave you, herpes is forever. Like other herpes viruses, such as the virus that causes chickenpox and subsequently shingles, HSV spends a lifetime living in the nerves, waiting for its moment to shine, sometimes induced by sunlight to form a cold sore. HSV1 often lives in the trigeminal nerve that controls facial sensation. Most transmission of HSV1 will occur from an individual with an active cold sore, but the virus can be transmitted through the saliva of those carrying

the virus without any symptoms. This should make you think twice about sharing those game-day water bottles.

For clarification, cold sores appear on the skin of the face, usually by the lips, and begin as painful fluid-filled blisters full of herpes virus that will erupt, crust over, and then disappear. Sores inside the mouth are usually aphthous ulcers, known as canker sores, and unrelated to cold sores. Scientists are not certain what causes these ulcers, but they can be associated with trauma or oral chemical burns, such as eating an entire pineapple while on vacation in Hawaii.

Now on to the dreaded HSV2: genital herpes. This is the one everyone is trying to avoid. HSV2 is contracted through sexual contact and causes wounds on the genitals, buttocks, and thighs that start as extremely painful blisters, become ulcers, then crust over and disappear. During the first outbreak, patients can also have systemic symptoms such as fever, headache, and painful urination. The first outbreak also tends to be the most severe, especially in women, because they have not suffered enough. Symptoms generally last two to three weeks.

An active HSV infection not only increases the likelihood of spreading herpes to sexual partners, but the open wounds caused by the virus also put the patient at higher risk for contracting other sexually transmitted infections, such as HIV. Active HSV2 is extremely painful, so it should be a deterrent for sexual activity, but in cases where sex is a consideration: Do not have sex during a genital herpes outbreak. Although less likely, genital herpes can also be spread from asymptomatic carriers of the virus.

Treatment for HSV1 and HSV2 is simple, although it only improves symptoms and does not cure the virus. Just take a course of acyclovir, valacyclovir, or a similar antiviral pill. These drugs have low side effects and are safe and effective. Many patients will have an initial outbreak of herpes and then the virus will remain dormant and asymptomatic. For those who have recurrent outbreaks, or become immunocompromised, prophylactic antivirals can be taken daily to help prevent outbreaks. In the case of HSV2, daily suppressive antiviral therapy can reduce outbreaks by up to 80 percent.

Herpes simplex virus may seem simple compared to other more nefarious viruses, but it can turn deadly.

Since the herpes simplex virus lives indefinitely in the nerves, the virus can reactivate at any time, but it can also spread inside the body. Most often

seen in patients who have weakened immune systems, HSV can cause a disseminated infection, meaning the virus travels through the blood or nerves to organs and even the eyes to cause widespread disease, but the most dangerous destination is the brain.

One day I was taking sign-out on patients in the emergency department. Because some patients spend days in the ED, they must be passed off from physician to physician as the shifts change. The most commonly signed-out patients are psychiatric patients waiting for transfer to psychiatric hospitals.

When psychiatric patients come to the ED with confirmed suicidal ideation, homicidal ideation, or new-onset hallucinations, they need to be hospitalized by psychiatry. An emergency physician will see these patients to confirm they have no emergent physical medical issues to clear them medically for psychiatric hospitalization, at which point the psychiatrist will take over care. Due to an extreme shortage of psychiatric facilities in the United States, these patients will spend days, sometimes weeks, in the ED waiting for a psychiatric bed.

On this day, I received sign-out on a middle-aged psychiatric patient with hallucinations. His blood work and vitals were normal and he had been medically cleared for psychiatric admission, awaiting a bed. The patient was wildly psychotic and was physically fighting nurses and security, at one point requiring sedation for his own safety. He seemed to be a regular psychiatric patient; except he wasn't.

Several hours into my shift this man spiked a fever of 102°F. After speaking with the family, it was determined that the patient had no history of psychosis or schizophrenia. Most symptoms of schizophrenia will onset in adolescence. Although it is possible for schizophrenia to establish later in life, it is atypical, and new-onset hallucinations in adults are always suspicious for medical disease. Given the new fever and hallucinations, this patient's presentation was now concerning for a brain infection. I quickly obtained a lumbar puncture in the patient, removing a small amount of fluid from around the brain, which showed abnormal white blood cells. The patient was started on medications for a presumed brain infection and admitted to the hospital for concern for HSV encephalitis.

HSV is the most common cause of fatal encephalitis worldwide, and this brain infection is most often due to HSV1. This makes sense since HSV1, or *oral herpes*, lives in the trigeminal nerve that controls the sensation of the face, which connects to the brainstem. This infection is

seen in all ages, with a third of cases in patients less than eighteen years old. About 30 percent of encephalitis cases are seen with initial HIV infection, and the remainder are a result of viral reactivation. Symptoms include headache, fever, confusion, abnormal behavior, vomiting, altered speech, and seizures.

HSV is also responsible for deadly encephalitis in newborns. HSV brain infections in newborns can be caused by an active genital herpes infection during vaginal delivery; this infection is usually caused by HSV2. But HSV1 can also cause neonatal encephalitis, and most people have HSV1, so kissing newborns can cause brain infections. Please stop letting politicians kiss babies.

HSV encephalitis is treated with IV antiviral medications, hospitalization, and supportive care. In adults, without treatment about half of those with the disease will die. Treatment will cut mortality in half, but patients may still have significant disability from the infection, including seizures, amnesia, and lifelong cognitive impairment.

HSV1 can also cause neonatal encephalitis, and most people have HSV1, so kissing newborns can cause brain infections. Please stop letting politicians kiss babies.

Unlike other STIs, such as gonorrhea and chlamydia, HSV is not commonly tested for but rather is treated based on symptoms. But it can be tested for, just ask. It is always better to know. For instance, if a patient has asymptomatic HSV and is diagnosed with cancer, it may be best to start prophylactic antivirals before beginning chemotherapy. This can prevent unnecessary painful outbreaks, and possibly more deadly manifestations of the herpes simplex virus. Get tested, and may the odds be ever in your favor, although *statistically*, most people have the herp. I blame Homo erectus.

HUMAN PAPILLOMAVIRUS (HPV)

Wouldn't it be incredible if scientists created a vaccine to prevent cancer? Well, prepare to be amazed. The human papillomavirus (HPV) vaccine is the first vaccine to prevent cancer.

HPV is a sexually transmitted disease contracted through skin-to-skin contact. There are more than forty types, but types 16 and 18 cause about 70

percent of cervical cancer. HPV can also cause anal, penile, vaginal, vulvar, and oropharyngeal cancers, and genital warts—seems like a great thing to prevent.

The first iteration of the HPV vaccine only protected against HPV strains 16 and 18, but was quickly followed by the Gardasil vaccine against HPV types 6, 11, 16, and 18. The vaccine against HPV type 6 and 11 prevents genital warts, which was great for marketing, as no one wants to hear they have genital warts, and thanks to the vaccine they don't have to. The newest Gardasil vaccine, Gardasil 9, is nearly 100 percent protective against HPV types 6, 11, 16, 18, 31, 33, 45, 52, and 58, which is great because the latter five are responsible for another 20 percent of cervical cancers. That means Gardasil 9 prevents 90 percent of HPV-related cancer, and almost all cervical cancer.

Now, 2, 4, 6, 8, who do we appreciate? The answer should be the HPV vaccine, but it is surprisingly not the popular response.

When initially released in the US, the Gardasil vaccine was a three-dose vaccine recommended for women aged fifteen to twenty-six years, with emphasis on those who had not yet been sexually active.

These days only two vaccine doses are needed, and the CDC recommends the first dose of the Gardasil vaccine for both boys and girls at age eleven with a second dose up to a year later. Those who wait to start the HPV vaccine series after the age of fifteen still need three doses. The vaccine is meant to create immunity to the virus before sexual exposure. The vaccine is not recommended for most people over the age of twenty-six, because they have likely already been exposed to HPV. In fact, 85 percent of women and 90 percent of men will have HPV in their lifetime, because even if you aren't getting around, HPV is. And in more good news, you can still get HPV while wearing a condom.

HPV is a double-stranded DNA virus, for anyone interested. The virus injects itself into skin or mucosal cells, hijacking the cell, and in some cases causing it to turn into cancer. Picture the movie *Speed* taking place inside one of your cells—HPV is a high-speed hijacker, and Keanu Reeves is the HPV vaccine. Everyone older than thirty now wants the HPV vaccine, because Keanu, am I right? Unfortunately, the HPV vaccine's current target audience has likely never seen the cinematic thriller where *a fledgling police officer must prevent a bomb from exploding aboard a city bus by*

keeping its speed above fifty miles per hour. Gen Z, please get your HPV vaccine and watch the movie *Speed*. Thank me later.

Just like the magnificent *Matrix* movie star, the Keanu Reeves of vaccines does God's work. The HPV vaccine is a recombinant vaccine made of proteins found on the outside of the virus. The vaccine shows the body's immune system HPV's viral fingerprints, so the immune system is ready for an action movie star-style takedown of the villain virus at a moment's notice. Without the vaccine, the body has no information to identify the HPV hijacker, but with the vaccine, we know his height, weight, home address, and Social Security number, and also have his Tinder profile pic, in which, unsurprisingly, he is wearing a trucker hat and holding up a fish. We know exactly what the creep looks like holding a small bass, and we are ready to swipe left.

Pop quiz, hotshot: How many women are diagnosed with early cervical cancer every year in the US? Answer: two hundred thousand. For those not strong in mathematics, that is too many cervixes in peril. These precancers are mostly HPV-related, and found on pap smears, which is a procedure that uses a small brush to take cells from the cervix to be examined under a microscope for cancerous qualities.

It should be abundantly clear that HPV is the hottest new vaccine out there, so why are some communities not excited and ready to appreciate the miraculous modern marvel that is the HPV vaccine? The answer lies not in cinema but in another form of media, *the news*.

In 2006, public HPV vaccination began. In the years that followed scientists found patterns of mass psychogenic illness surrounding the vaccine. *Mass psychogenic illness* is a social phenomenon of collective anxiety due to a perceived threat that can manifest physical symptoms.

In 2013, though more than 170 million doses of the vaccine had been given worldwide, a select small community in Carmen del Bolivar, Colombia, exhibited mass symptoms of numbness and fainting after receiving the vaccine. In Japan, where vaccine hesitancy is high, fifty students walked around like zombies following the HPV vaccine, and after media of the girls circulated, Japan's government temporarily suspended the vaccine. Neither of these events were found to be caused by the vaccine. The HPV vaccine is now recommended in Japan, but the effects of these events are long-lasting, as Japan continues to report one of the lowest rates for HPV vaccination of developed nations.

Not all news is bad news. In 2024, Scotland released research on the HPV vaccine's effects on cervical cancer. Scotland's HPV vaccination program began in 2008, and fifteen years later, there have been zero cases of cervical cancer in fully vaccinated women in Scotland.

There are some CDC cautions and contraindications to receiving the HPV vaccine. For instance, the Gardasil 9 vaccine is produced using baker's yeast, *Saccharomyces cerevisiae*, so if you have an anaphylactic reaction to baker's yeast, this vaccine is not recommended. If you are allergic to *Saccharomyces cerevisiae*, you also cannot have wine, beer, cider, rum, vodka, whisky, brandy, sake, and most bread. The very least the rest of us can do for the poor souls allergic to baker's yeast is get the HPV vaccine. Cheers.

Scotland's HPV vaccination program began in 2008, and fifteen years later, there have been zero cases of cervical cancer in fully vaccinated women in Scotland.

BUTT STUFF

I was seeing a patient in the emergency department for a cough—the wrong end, I am aware. He ended up having pneumonia, but between his coughing fits he told me his neighbor was a proctologist who once did a rectal exam on a patient and encountered what felt like a bundle of blunt-ended pencils. He pulled it out and it was a bouquet. The doctor asked the patient, “How did these flowers get in there?” The patient said, “I don't know, they didn't leave a card!”

When the patient told me that joke, I replied that I had never removed a rectal bouquet before, but I have removed an aspirin bottle, a TV remote, a papaya, two light bulbs ... the list goes on.

If this makes you uncomfortable, please skip this chapter; it is not getting any cleaner. Now that I've written that, and everyone has continued to read out of curiosity, I am absolved from what comes next.

One thing every emergency department sees too much are rectally inserted objects. This throws nonmedical folk off, but honestly when you are tired, covered in coffee, and trying to save lives, the person with stuff in their butt is the least of your worries.

Think about it this way: A person bleeding to death in one room, the next patient has a heart attack, and then a guy walks in with a TV remote

stuck in his butt. This is a true story and shows doctors are too busy to be scandalized. The remote is removed quickly and safely so the focus can shift back to dying patients.

Doctors do not care how the TV remote you “sat on” got into your butt. Honestly, I have given zero consideration as to how or why these situations come to pass, but some folks are interested. So, for those interested, here is the story of the pool accessory gone dangerously deep.

It was a Friday night, and those are never good in a busy county emergency department. A woman around thirty years old was wheeled in on a stretcher. She was wiggling around and high as a kite. On what? We’ll never know.

She was brought into a room, and I followed closely behind to get a history from the paramedics. The EMS gentlemen were red in the face and wouldn’t make eye contact.

“Is someone going to tell me the story?” I needed to get back to a bleeding patient in room six.

The paramedic mumbled incoherently, but I heard only one word distinctly: *rectum*.

“OK, I will get the story from her. Thank you.”

I introduced myself to the patient as she tossed and turned.

“Hi, ma’am, I am your doctor. Can you tell me what happened?”

She began singing a medley by the musical group Queen. She even beatboxed part of it. I wasn’t even mad, I was impressed, but we were getting nowhere fast. At this point, there was only one thing to be said: “If you won’t tell me what’s in there, I will find out. But I’m not going in blind. It could be sharp. It could have teeth.”

I shot an X-ray of the patient’s abdomen, and what it showed would astound even the most unflappable pool boy. You know those spray cans of sunscreen? She’d “sat” on one. At least it didn’t have teeth.

This was above my pay grade. Sharp or large objects, especially something pressurized, can cause colonic perforation, infection, and death. I can handle a floaty or two, but this banana boat had repercussions that extended far beyond my metaphorical and physical reach.

I called in the colorectal surgeon, who whisked my UV protection enthusiast off to the operating room, where the sunscreen was removed quickly and safely.

I went back to the bleeding in room six.

I included this chapter as a public service announcement. There are safe items made for rectal stimulation. Be brave: Go to a sex shop, wear a hat and glasses, and pay in cash, or go online and use a friend's credit card. Do whatever you need to do to not clog up my department and your rectum with unnecessary emergencies.

DRUGS

MEDICATIONS

Over-the-Counter Medications

Herbal Medications & Dietary Supplements

Stevens-Johnson Syndrome

RECREATIONAL DRUGS

Methamphetamine

Cocaine

Opiates

Psychedelics: Lysergic Acid Diethylamide (LSD) & Magic Mushrooms

Party Drugs: Ecstasy, Gamma-Hydroxybutyrate (GHB), Rohypnol & Ketamine

Downers: Alcohol & Benzodiazepines

Nicotine: Smoking & E-Cigarettes

MEDICATIONS

OVER-THE-COUNTER MEDICATIONS

During residency I was working at a children's hospital, involuntarily, seeing the millionth child with gastrointestinal upset for the day as enterovirus was going around. The other doctors working saw similar patients that day, but there was one patient who was different from the rest. Hidden among hundreds of similar stomachaches was a child who was dying. The child was still in the waiting room when his nausea and vomiting resolved, so he went home with his family without being seen by a doctor.

The next day, I was in the children's emergency department again, and this child returned, but he was very sick. It was now evident that he was dying, and his initial ED visit gave no indication as to why. Upon speaking to him and his father, it was revealed the child had depression and had taken vitamins in his mother's medicine cabinet in an attempt to hurt himself. He likely did not understand the severity of his attempt at the time, as it had a high probability of being successful.

He had overdosed on iron. His labs showed that his liver markers were now sky-high, and he was going into shock, meaning his blood was not getting oxygen to his organs. Once shock and liver failure set in, the only treatment might be a liver transplant.

Iron poisoning is tricky because it occurs in stages. In the first stage, the patient has approximately six hours of nausea, vomiting, and diarrhea, which leads to the second stage, an apparent recovery. It seems like everything is going to be fine after the iron has been absorbed and the nausea, vomiting, and diarrhea abate, but now the iron has entered the bloodstream to wreak havoc on organs. The third stage begins a day or two later when the blood turns to acid, and the iron causes bleeding and liver, heart, and kidney dysfunction. By the fourth day, during the fourth stage, the liver may fail.

An abdominal X-ray can see iron pills for up to six hours in the stomach and intestinal tract before they are absorbed. As few as ten ferrous sulfate

iron tablets can kill a child. Certain multivitamins, such as prenatal vitamins, are more dangerous because of high iron content, while children's chewable vitamins purposely have minimal amounts of iron. If moderate or severe ingestion is suspected, an intravenous antidote, deferoxamine, can be used, but it must be used early, as iron toxicity has a rapid effect.

The American Association of Poison Control Centers (AAPCC) receives reports of about four to five thousand iron poisonings a year, about half of which are children less than six years old. Death from iron toxicity is dependent on a person's weight and the amount of iron ingested. There are only a few deaths reported a year, but sadly, they are mostly children.

Acetaminophen, commonly known as the brand Tylenol in the US and as paracetamol in Europe, is another ubiquitous, seemingly innocuous medication that is deadly in overdose, and is the most common cause of acute liver failure in the United States. No adult should ever take more than 4,000 mg, or 4 grams, of acetaminophen in twenty-four hours. Acetaminophen dosing is weight-based so it may be less for smaller people, and it is also less for adults with liver dysfunction. Children should only be dosed with acetaminophen based on current weight and the medication instructions. Note that acetaminophen, or Tylenol, is not the same drug as ibuprofen (Advil, Motrin) or naproxen (Aleve), which are nonsteroidal anti-inflammatory (NSAID) medications.

Acetaminophen, commonly known as the brand Tylenol in the US and as paracetamol in Europe, is another ubiquitous, seemingly innocuous medication that is deadly in overdose, and is the most common cause of acute liver failure in the United States.

Acetaminophen is processed by the liver, and under normal physiological and dosing circumstances, it is effectively metabolized and excreted in the urine without issue. If too much acetaminophen is taken, it overwhelms the liver's ability to break down the drug and it gets metabolized to a dangerous chemical that causes free radicals. Free radicals are exactly what they sound like—they cause violence and stress on the system in a guerrilla-warfare style that leads to liver tissue death and possibly liver failure.

Most acetaminophen overdoses I have seen are suicide attempts, but this is a slow and painful way to die. The overdose occurs in stages with the first stage being up to twenty-four hours of nausea and vomiting. In the second

stage, acetaminophen is in the bloodstream and the patient will have an elevation in his or her liver labs with right upper abdominal pain. Stage III starts at seventy-two hours, when the patient develops yellow skin (jaundice), confusion, and bleeding, especially from orifices. In this stage, liver failure and then multi-organ failure can cause death, but only days after ingestion. If the patient survives past day four, they will enter a recovery phase, or Stage IV, but may still have chronic liver dysfunction.

Luckily acetaminophen overdose does have a treatment, NAC (N-acetylcysteine). NAC works by rounding up the guerrillas and negotiating with them to put down their weapons, then binding any uncooperative free radicals, which greatly prevents liver injury and death if given within eight hours of a significant acetaminophen overdose. The medication is given through an IV in the emergency department based on the patient's history and their blood level of acetaminophen compared to the time of consumption. Acetaminophen overdoses lead to more than fifty thousand ED visits a year in the US, and half of these ingestions are reported as unintentional. Because of effective treatment there are only about five hundred deaths in the US from acetaminophen overdose annually, but this is still too many.

Another type of medication lethal in overdose is salicylates, the most common being aspirin, but aspirin can also be lethal without overdosing. The American Academy of Pediatrics, Centers for Disease Control, US Surgeon General, and the Food and Drug Administration all state that no one under the age of nineteen should be given aspirin, most commonly known by the brand Bayer, for fever-causing illness, so you know it must be bad. ("Baby aspirin" is named due to its smaller dose, not because it is recommended for children.)

Anything containing salicylates, including aspirin and bismuth subsalicylate—also known as Pepto-Bismol—should not be given to children as they are associated with Reye syndrome. Reye syndrome is a poorly understood, deadly disease that is associated with recovery from certain viruses, such as the chickenpox virus and influenza, as well as salicylate used in children. The disease causes rapid liver failure and brain swelling. Luckily, once aspirin was identified as a risk factor for the disease, the incidence of Reye syndrome fell dramatically. Therefore, aspirin should never be given to children unless prescribed by a doctor to treat a specific illness.

Anything containing salicylates, including aspirin and bismuth subsalicylate—also known as Pepto-Bismol—should not be given to children as they are associated with Reye syndrome.

Another class of medication to use with caution is antihistamines, most commonly diphenhydramine, known as Benadryl. An antihistamine blocks the effects of histamine, which is how it decreases allergies and gets its name. Unfortunately, diphenhydramine can have unwanted side effects, such as blocking acetylcholine receptors, which control heart rate, vision, and brain function. This means in overdose it causes wild and deadly effects.

Keep pill bottles and vitamins in locked cabinets, in childproof containers, and talk to your children about their mental health. The Centers for Disease Control found that one in five children have psychological or behavioral disorders, but only 20 percent of these children are getting the professional mental health help they need. Lastly, for any suspected poisoning or overdose, always call the local poison control and follow instructions, including heading to the closest emergency department for treatment as needed.

HERBAL MEDICATIONS & DIETARY SUPPLEMENTS

Each spring, the Baltimore Orioles baseball team travels to Florida to train for the new season. Spring training of 2003 was no different until the tragic death of twenty-three-year-old pitcher Steven Scott Bechler. While running training drills the player suffered heatstroke and died. The autopsy showed ephedra in his system, a then-legal dietary supplement that was linked to more than a hundred deaths before being banned by the FDA in 2004.

Ephedra, a plant known as ma-huang in traditional Chinese medicine, was sold commercially as an unregulated supplement in the US for weight loss and to enhance athletic performance. Ephedra may sound familiar, because ephedrine, which can be extracted from the ephedra plant, is used in the FDA- and pharmacy-regulated nasal decongestant pseudoephedrine (Sudafed). Both ephedra and ephedrine should be regulated because in overdose they can cause heart arrhythmias, stroke, and death.

Herbal medicines and dietary supplements have grown wildly popular in the past few decades. Some of this is likely due to the cost and lack of accessibility of modern medicine. When it is cost-prohibitive and

cumbersome to get a prescription, patients look for alternatives. The internet provides an easy place to purchase supplements. Additionally, modern medicine does not have all the answers, so some patients go looking for solutions in their grocery store aisles, whether through dietary changes or herbal and dietary supplements.

Many medications are derived from plants (see plant chapter), but when these compounds are used in prescription medication, the concentrations and ingredients are highly regulated by the Food and Drug Administration (FDA).

The FDA does not approve or regulate herbal medications in the United States. This means some herbal supplements use active ingredients similar to prescription medications without any regulation. A number of these herbal medications have been so dangerous that the FDA had to get involved, banning the sale of the supplements in the US.

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For instance, the alternative medicine uses for aristolochic acid vary widely, from treating snakebites to weight loss, but the herbal supplement was mostly marketed for arthritis and gout in the US. Unfortunately, the supplement can cause kidney failure and is associated with kidney, ureter, and bladder cancer. The US FDA recommends against its use, but it is still found in some herbal supplements.

The FDA also warns against the use of comfrey, androstenedione, chaparral, germander, kava, bitter orange, organ/glandular extracts, lobelia, pennyroyal oil, skullcap, and yohimbe. But despite the dangers, such as cases of liver failure after taking kava, the sales of these supplements earn hundreds of millions annually in the United States.

To add a further element of danger, many supplements can be purchased online. Social media, specifically an app with jaunty dance videos, became a platform for selling a weight gain supplement called Apetamin to create the curves required in the newest female body image craze. The syrup supplement was created and produced overseas and is still sold illegally in the US, often through social media targeting young girls. The supplement can cause hallucinations, seizures, and death.

Other common herbal supplements have been used for centuries, and science understands why they work because they share mechanisms and components with common prescription medications, from which they are often derived. But recall that the doses in herbal supplements are not regulated, nor is a healthcare provider checking for drug-drug interactions when supplements are bought off the grocery store shelves.

One example of an herbal medication with drug interactions is St. John's wort or *Hypericum perforatum*, a flowering plant that is effective at treating some forms of depression. But this plant interacts with a laundry list of medications, causing some dangerous outcomes and unwanted side effects. Selective serotonin reuptake inhibitors (SSRIs) are highly effective medications for treating depression with far fewer drug-drug interactions, low side effect profiles, and a generic option that costs as little as fifteen dollars without insurance, so the benefit to using an unregulated flower does not add up.

Other common herbal supplements include black cohosh, evening primrose oil, valerian root, licorice root, red clover, and phytoestrogens, which come with risks and benefits, just like prescription medications, but herbal supplement manufacturers have much less liability regarding the effectiveness and composition of botanicals.

The FDA regards dietary supplements as a food, not a drug, so supplement concentration and quality are not tested by the FDA before they are sold. This is true for vitamins, including prenatal vitamins. In the US, the prenatal vitamin industry grosses an estimated \$189 million a year, and yet when the US Government Accountability Office tested twelve prenatal supplement products, only one contained the nutrient concentrations as stated on the label. While the American College of Obstetricians and Gynecologists does recommend a prenatal vitamin, or more specifically a daily amount of key vitamins and minerals, many commercially available prenatal vitamins may not be meeting the standard.

Deficiencies in certain vitamins and minerals can have devastating effects on a fetus; for instance, a lack of folic acid (folate) can cause the baby to be born without parts of the brain or skull (anencephaly), spina bifida, and paralysis. With a healthy diet and some supplementation, this is not likely, but given the importance of folate during pregnancy, having the correct amount in a daily vitamin is preferred.

Some vitamins can cause overdoses. Most water-soluble vitamins, namely B vitamins and vitamin C, in excess, will create very expensive urine, which is probably where most B₁₂ shots end up. These water-soluble vitamins will be discarded by the kidneys if there is an excess. The exceptions are niacin (vitamin B₃) and folate (vitamin B₉), which can cause symptoms with an overdose. Fat-soluble vitamins, including vitamins A, D, E, and K, as well as minerals such as calcium, can cause symptomatic overdoses. A vitamin A overdose can cause nausea, vomiting, diarrhea, lack of coordination, and blurred vision. A calcium overdose can be lethal, so avoid exorbitant use of calcium carbonate, commonly known as Tums, and calcium supplements. It is not recommended to take more than 7,500 mg of calcium carbonate a day, but the exact appropriate dosage is weight-based. Calcium overdose can cause nausea, vomiting, kidney injury, confusion, and heart arrhythmia, and while calcium overdose is unlikely to kill you, it can.

The moral here is simple: Herbal medicines and dietary supplements can certainly work, but they are not regulated in the same way as drugs, having unknown concentrations of active ingredients. Many herbal medications work similarly to drugs, so getting the “natural form” should not change much on the molecular level, but you may be getting other unnecessary compounds along with the active ingredient, which can have unwanted side effects. Many herbal supplements, vitamins, and minerals have been shown to have health benefits but should be used with caution, and bought from established brands, not dancing social media influencers or celebrities. Always inform your primary care provider of herbal medications or dietary supplements you are taking to prevent interactions and unwanted side effects.

STEVENS-JOHNSON SYNDROME

Stevens-Johnson syndrome (SJS) is a disease that causes a human to shed skin like a snake. In SJS, the body creates a hyperactive response where the immune system attacks skin cells, causing blisters to form, and then skin loss, which includes mucosal surfaces, such as inside the mouth and lips, as well as the eyes.

SJS is associated with the use of certain medications including specific antibiotics like Bactrim, nonsteroidal anti-inflammatory drugs (NSAIDs),

allopurinol, and antiepileptics. Given the number of people who take these medications, there are very few associated cases of SJS. This disease can also occur due to certain bacteria and spontaneously, but medications are responsible for over 80 percent of cases.

When a patient is diagnosed with SJS due to a medication, the offending agent is then placed on the patient's allergy list, but this is not a typical allergy; it is a delayed-type hypersensitivity reaction. A typical allergy causes a reaction on the spectrum of hives to anaphylaxis, in which immunoglobulin E (IgE) antibodies floating around in the blood match up with an antigen from an exposure, let's say an ingested peanut, which then releases all hell in the form of activated mast cells. Mast cells are basically the party poppers of the immune system, if party poppers were full of histamine. The SJS hypersensitivity is more slow-moving, due to T white blood cells, but can be just as deadly.

Once the skin detaches from more than 30 percent of the body, Stevens-Johnson syndrome is then called toxic epidermal necrolysis (TEN), which is basically the same disease but covering more surface area. SJS/TEN is estimated to be seen in two to seven million people yearly, and up to one in a thousand people with HIV.

SJS patients are transferred to burn units for treatment with steroids and antibiotics, fluid support, and to be seen by a burn surgeon, as the skin loss seen in SJS is similar to burn wounds. Because SJS affects mucosal surfaces, including the lining of the throat and lungs, some patients need ventilators for respiratory support. In the US, mortality from 2009 to 2012 for SJS/TEN was 13 percent, but this number vastly changes based on the individual and percentage of skin involved in the disease.

The most important SJS lesson is to see a doctor immediately if a rash affects the palms, soles, eyes, or any mucosal surfaces, such as the lips or mouth.

SJS is distinct from erythema multiforme major and staphylococcal scalded skin syndrome, which are benign rashes that also cause skin peeling, usually seen in well-appearing children. But the differentiation between a life-threatening rash and "just a rash" needs to be made by a physician.

The most important SJS lesson is to see a doctor immediately if a rash affects the palms, soles, eyes, or any mucosal surfaces, such as the lips or

mouth.

RECREATIONAL DRUGS

METHAMPHETAMINE

Methamphetamine is also known as meth, crystal, crank, speed, ice, and Christina aka Chrissy aka Tina.

Tina sales are driven by the chemical that controls most things in life: dopamine. Meth moves through the bloodstream to the brain where it blocks dopamine reuptake in the limbic system, increasing the active supply. The limbic system is the brain's pleasure center, also referred to as the "lizard brain," because it is the primitive part of the human brain that accounts for the entirety of a lizard's brain. This is not the part of the brain that should be used in important decision-making. The limbic system is how your college roommate got chlamydia. At higher doses, meth also increases the release of dopamine, flooding the brain with the feel-good chemical.

A few things to consider: Too much of a good thing, in this case dopamine, causes schizophrenia. Also, what does life feel like when the brain cannot match artificially elevated levels of dopamine and the corresponding elation found in drug use? How does the birth of your child or falling in love feel? A person may be desensitized to happiness by drug-induced highs, and lose the joy of life's most precious moments.

A current pop-culture reference to meth was made in the TV show *Breaking Bad*, a story of a high school chemistry teacher making \$80 million off of meth sales in New Mexico, just in time to lose everything. In the 1990s, the meth hotspot was the southwestern United States or the "dry states." This may be because pseudoephedrine was more easily trafficked from Mexico. Meanwhile, across the border in the US, the practice known as smurfing began, consisting of buying controlled pseudoephedrine from several sources to stay below state-enforced limits.

More recently, manufacturing and use have moved to southern and midwestern states, such as West Virginia, Ohio, Kentucky, Tennessee, and Indiana. These are states that were also hard hit by the opiate epidemic. I moved from California to the South, so I have treated many patients under the influence of meth.

Do I have a meth story? I have many, unfortunately, and this particular story is about *death*.

During my years in medicine, I spent some time working in the South. I quickly discovered challenging new pathologies, low-country boil, and my Southern accent, much to my husband's dismay, bless his heart.

When I moved from an urban to a rural environment, stabbings were replaced by farming injuries, muggings were replaced by farming injuries, and tourists falling off scooters were replaced by farming injuries. Emergency trauma made a conspicuous shift to farming injuries. Unfortunately, there were still a decent amount of firearm injuries, but often self-inflicted, whether accidental or intentional.

One early morning I was ready to end my overnight shift in the emergency department. Rural emergency departments often have only one doctor, so every patient is my patient. With only twenty minutes remaining in my shift, I received an emergency medical services (EMS) radio call—a patient was coming in after being stabbed. This did not sound like a traditional farming injury, so my interest was piqued, but at the end of an overnight shift, no ED is hoping for new challenges.

However, this early-morning challenge quickly became enthralling as my new patient arrived and proceeded to tell me one of the most terrifying stories I've ever heard: It was the darkness before the dawn when a strange noise came from outside the house. When my soon-to-be patient looked out the window, he saw a light was on inside the barn. He descended the stairs and walked out to the barn only to find its door swinging in the wind. Approaching the barn to latch the door, he looked up and was confronted by an intruder. Standing just beyond the shadows, a skeleton-like form stepped into the light, buck naked, covered in blood, and holding a grim reaper's scythe. (A scythe is a farming tool used for cutting grass, harvesting grains, and collecting souls.)

Mr. Stephen King, you can bunk in my guest room when you visit.

I was in gun country, but as often happens, my patient did not have time to retrieve a firearm; there was only time to narrowly escape. I performed my examination, and after treatment, the patient was medically cleared to go home.

Unfortunately for me and victim number two, a second call blasted over the EMS radio.

The next patient who rolled in was injured in pursuit of the Scythe Bandit. According to the patient, the bandit was now hiding, but popped out like a rabid hide-and-seeker, *almost* naked, covered in blood, with a scythe. It turns out the reaper was Pooh Bear'ing it—he did have a shirt, but no pants. Police officers had shot several Tasers at the bandit, but the reaper could not be brought down by the mere power of electricity and took off with several stun guns in tow.

At this point, I smelled meth.

I got the patient ready for discharge with only minutes remaining in my shift. We were both exhausted from a long night and ready to go home.

Just then, another EMS call screeched over the radio—incoming patient.

Simultaneously, EMS burst through the doors with several police officers. With them was my next patient—almost naked, covered in blood, sans scythe. The Scythe Bandit had lost farm tool privileges, but several Tasers were still attached.

I was going to be here for a while. I introduced myself to my new patient and asked what happened. The bandit's handcuffs jingled as long fingers motioned for me to come closer to hear the whispered reply: "I think I did too many drugs."

Unfortunately ubiquitous, drugs, I have found, ruin lives everywhere.

Most meth stories do not end well. I'm sure that surprises no one. The first patient I lost as a physician was a young man who had packed (swallowed packets) or stuffed (the other end) and died after one of his packets burst in his abdomen. The packets were full of meth. In the ED, it's hard to not feel responsible for every person who is not saved. Some might say, "Don't do drugs," which seems simple, but our world has created an intricate economy based on addiction. It may be one of the most complicated problems humans have created.

In the United States, 5 percent of the population has used meth, and six hundred thousand people are reported to use the drug weekly. In one year, approximately \$150 billion is made from the sale of illicit drugs in the US alone. Other costs include the approximately thirty-four thousand Americans who died from meth overdoses in 2021.

Meth is a cheap drug. A gram costs approximately thirty dollars and makes up five doses lasting six to eight hours each. It's even cheaper to make, as dealers can make a 500 percent profit on the drug. I am not going

to “how to” this, but meth is made of common household items such as pseudoephedrine, hydrogen peroxide, drain cleaner, and batteries.

While it may be cheap to make, it is deadly. The fumes and byproducts of meth cooking are extremely toxic and unstable, which is why meth labs explode. Rolling meth labs, often found in campers, can move to avoid detection but also have increased explosion risks.

In the short term, the drug can cause seizures with possible brain death and destruction of muscles causing rhabdomyolysis and subsequent kidney failure. In the long term, meth decreases blood flow to the gums, leading to necrosis and tooth decay, a condition known as “meth mouth.” The drug can cause heart attacks and is infamous for causing heart failure. Heart failure happens when the heart no longer pumps blood effectively and blood pools in other places like the lungs, which effectively causes the patient to drown. Some of the worst hearts I have ever seen are due to methamphetamine use.

If you find yourself offered meth, say “no,” and feel free to share this chapter with the dealer. If you are addicted to meth, get help. Meth is the grim reaper of drugs, and it will take everything from its users.

COCAINE

In the 1980s the United States experienced a boom in cocaine consumption supported by organized smugglers from Latin America, often through Miami. The “King of Cocaine” was Pablo Escobar, head of the Medellín drug cartel, which, at its peak, was estimated to have earned \$420 million a week.

In the United States, the presumably pure cocaine went for as much as \$600 a gram, making it a drug of the elite. Concurrently, those in poverty, who were disproportionately African American, were being addicted to the much cheaper crack cocaine, which is cocaine diluted and mixed with a base such as sodium bicarbonate, forming crystals that make a cracking sound when smoked. In freebasing, there is an attempt to extract the cocaine from the sodium bicarbonate base using ammonia, making it pure again.

As the drug’s popularity quickly rose, the federal government began its War on Drugs, but this was a war targeted at a specific population rather than the drug itself. For instance, possession of 5 grams of crack cocaine, the dilute version of the drug, carried a minimum five-year federal prison

sentence, while selling a hundred times that amount in the form of pure cocaine carried the same sentence. The more expensive, potent version of the drug has historically had more lenient federal prison sentencing, which from a scientific perspective makes no sense, so there must be some other reason it was written that way. I believe the American Civil Liberties Union (ACLU) has some ideas as to why, if you check their webpage, or just read Michelle Alexander's *The New Jim Crow*.

Cocaine is derived from the coca plant—not the cacao plant; that makes chocolate. Coca is most often illegally cultivated in the illicit jungle laboratories of Colombia, Peru, and Bolivia. The coca plant grows naturally in the Andes mountain range of northwestern South America, and today roughly 75 percent of the world's cocaine is produced in Colombia.

Cocaine is a stimulant; it makes your heart race, your pupils dilate, and your mind elate. Cocaine creates a *high* by overstimulating a pathway in the brain called the mesolimbic dopamine system, the brain's reward center. This reward system releases dopamine into the brain cells to create a feeling of happiness. In the natural process, dopamine floods the brain with elation, then the dopamine reenters the brain cells where it is stored. Cocaine blocks the dopamine from reentering brain cells, so it continues to circulate in the brain, resulting in a high.

Meanwhile, the rest of the body is dealing with the side effects of cocaine. In the short term, cocaine can cause strokes, brain bleeds, and psychosis, and it can result in long-term complications similar to Parkinson's disease. Cocaine is famous for causing heart attacks, but if it doesn't, the drug can still cause heart failure. The substance constricts blood vessels, causing skin and tissue death, ulcers in the intestine, and nasal septum necrosis. When cocaine is snorted over a period, it can cause the tissue inside the nose as well as the roof of the mouth to die and create a permanent necrotic hole in the midface. When smoked, cocaine will destroy the lungs, and when injected, users are at higher risk for HIV, hepatitis B and C, and other blood-borne diseases. None of the disadvantages of cocaine were understood when it was first discovered and thus it was legally used in a variety of substances.

The drug was used for more than four thousand years in South America for its medicinal properties, then around 1886 it found its way to North America, where pharmacist John Pemberton created the original formula for Coca-Cola. He combined small amounts of cocaine and extract from the

kola nut to create the drink's name and flavor. Around the same time Pemberton was mixing cocaine into his soda, a man with a light bulb idea, Thomas Edison, found himself addicted to cocaine in the form of Vin Mariani, a Bordeaux wine infused with coca leaves, which interestingly was endorsed by Pope Leo XII. Edison's contemporary Sigmund Freud, the neurologist who brought you psychoanalysis and the disturbed Oedipus complex, also brought drugs to work. The doctor became interested in the "miracle drug" being given to German soldiers to revitalize the troops. Freud wrote a paper singing cocaine's praises, giving it in small doses to family and friends. It wasn't until the 1890s that he discovered the drug's addictive properties after nearly killing a patient. It took a bit longer but by 1929, Coca-Cola also removed the cocaine from its recipe.

Cocaine is a drug that has been weaved into many cultural tapestries and is a great example of how a drug can make anyone an addict; all humans have the vulnerability waiting to be exploited by chemical addiction. But there is a complexity to the type of isolation and loneliness created by drugs, especially uppers. Chasing an increasing high that is psychologically unattainable without drugs is a difficult way to live. Society's philosophy of addiction was built on a misinformed foundation that somehow it was all due to a lack of morals and personal conviction, but addiction is a disease much like type 2 diabetes or high blood pressure. Our body creates a response to formed habits, and this can change our very DNA, sometimes irrevocably. It is simple to say, "Don't do drugs," and while Nancy might have found a decent option, the issue is far more complex than a DARE slogan.

When examining other forms of addiction that society has deemed acceptable, or at least legal, the issue becomes less confounding. Why do people drink alcohol? Drink coffee? Smoke cigarettes? Eat sugary foods? Gamble? All human beings engage in unhealthy activities, often partaking because these activities provide momentary bliss via small dopamine payouts. Most people use drugs to find a similar relief, however fleeting, and despite the inevitable crash that follows. Given that those suffering from drug addiction are rich, poor, young, old, famous, and unknown, it seems the key to human happiness must not depend on any of these.

There is help for cocaine addiction in the form of programs such as Narcotics Anonymous (NA), a support group that is a lifelong commitment bolstering a patient's daily choice to remain drug-free. There is even a

promising new vaccine to help reduce cocaine abuse using antibodies to the drug itself, curbing its effect, reducing highs, and helping patients quit.

OPIATES

Let's clear something up before we start: No one is dying from touching fentanyl. After police bodycam footage showed an officer losing consciousness at a drug bust, the media went wild, stating the officer had absorbed fentanyl through his skin. I had family members aghast over the event, stating that someone's friend's nephew's cousin also accidentally overdosed on fentanyl by touching the substance. I hate to break it to you, Debra, but that is not what happened.

Opiates can be swallowed, snorted, smoked, shot, booty bumped, and in some cases do pass through the skin using the advanced technology of a very expensive patch that is worn continuously. When I Googled the correct terminology for booty bump, a helpline came up, and I am now on the DEA watch list, so you're welcome.

The media continued to cover alleged transdermal fentanyl overdoses, but multiple medical toxicologists agreed that these were not opiate overdoses, nor have cases been validated through drug testing.

This misinformation about opiates is dangerous for several reasons. First, it can be used as a scapegoat for drug addiction. Second, this misinformation incites mass hysteria among emergency services personnel, who already have the world's most stressful jobs, trust me. Lastly, unwarranted fear of topical fentanyl exposure may deter those considering aiding someone who is truly having an opiate overdose. When the media releases speculative, sensationalized information to boost viewership instead of confirming stories and speaking with experts in science and medicine, it is dangerous for public health.

OK, on to the task at hand. Opiates suck. They are arguably the most addictive, dangerous drugs out there. Opiates have been around since at least 3400 BC in lower Mesopotamia, where Sumerians were drinking beer and smoking *hul gil*, the joy plant. The drug was spread through time and space from the Assyrians to the Egyptians, down the Silk Road to China. The Chinese became major consumers of the drug in the 1800s after Great Britain started using opium instead of silver to trade, in order to support Britain's first addiction, tea. Opium addiction devastated the Chinese people

until their government tried to suppress trade during the First Opium War. China lost, Britain got to keep their precious tea, and opiates continue to be traded throughout the world today. I left out around a hundred years of history, but it drones on a bit, and blaming the British Empire seems like a fair placeholder. You are here for the science anyway.

Opium is cultivated from the seedpod of the opium poppy, *Papaver somniferum*, which grows naturally throughout Asia Minor. For many years Afghanistan produced over 90 percent of the world's opium, most sold for illicit use. In April of 2022, poppy cultivation in Afghanistan was made illegal, and by 2023 a United Nations survey showed a 95 percent decrease in opiate production in Afghanistan, making Myanmar the number one producer of opium. While I do not support fascist totalitarian theocracies run by abusive terrorist regimes, those are some decent reduction numbers. I will say there are those that believe that Afghanistan's numbers are pure poppycock.

Opium milk is extracted as a white sap from the seedpod of the opium poppy and then boiled with chemicals, removing plant matter to make morphine, which is then chemically treated to make brown heroin, which is further chemically treated to make white heroin. Morphine can also be used to make the commercially available drug codeine. Black tar heroin, primarily produced in Mexico, resembles roofing tar and has more impurities, making it cheaper and sticky.

Semisynthetic opiates, called opioids, are made from thebaine, an extract of Persian poppies, and include hydrocodone (Norco, Vicodin), oxycodone (Percocet, OxyContin), hydromorphone (Dilaudid), buprenorphine (Belbuca), and oxymorphone (Opana). Full synthetic opioids are made in a lab and include fentanyl, tramadol (Ultram), carfentanil, and methadone.

Carfentanil is reported to be ten thousand times stronger than fentanyl and was traditionally used by veterinarians to sedate elephants, but it's still not going to knock you out if you touch it. That being said, if you inhale it or squirt it in your eye or mouth, you are going down.

Heroin is the only opiate that is a United States Drug Enforcement Administration (DEA) Schedule I drug, meaning it has no acceptable medical use and high potential for abuse, while other opiates and opioids are currently used medically.

Opiate medications work by binding mu receptors on nerve cells to block them from sending pain signals. Although they have similar mechanisms, each opiate is also different, having varied potency, duration, and side effects. For instance, fentanyl is the preferred opiate for pain control in life-threatening trauma because it's short-acting and has less of an effect on blood pressure, and you don't want to drop the blood pressure of someone who is bleeding to death.

Opiates have a ton of side effects, and while they may make you nauseous and constipated in the short term, long term, opiates are highly addictive. When we hear the term *addiction*, the public mind goes directly to an incompetence of conviction, but addiction is due to a physiological change in the body called tolerance.

When opiates bind to pain receptors, the body notices that it cannot feel pain, which is dangerous. The body should be aware when it is in pain so it can make needed changes, like removing your hand from the fire. When your body sees that opiates have blocked your pain receptors, it builds more receptors, but then more opiates are needed to block them. This goes on and on, which is why dosages of opiate medications must continuously increase even when the source of the pain is improving, and then when opiates are stopped, even if the body shouldn't be feeling pain, it sends the brain pain signals. This is called opiate-induced hyperalgesia, and it ruins lives.

Now I'm no economist, but this looks like a supply and demand model that any business would jump to get behind, and big pharma did just that. In 1996, Purdue Pharma introduced the "less addictive" OxyContin in aggressive marketing campaigns, targeting physicians and patients, for use in chronic, non-cancer-related pain, leading to record opiate sales over almost a decade, until OxyContin became the number one drug of abuse in the United States in 2004. Anyone can be susceptible to the emotional bribery that is marketing, but physicians were also being incentivized financially, walking around on all-paid vacations wearing OxyContin fishing hats, which actually existed. This likely brought about the Sunshine Act, a federal law that requires drug companies to report on any financial relationship with physicians, which seems to be working well. I have never been offered a hat.

There were many high-profile settlements against Purdue and other opioid-producing pharma defendants. McKesson had to suspend sales of controlled substances for a time in several states, and Purdue was set to pay

the government \$225 million, so long as they executed the settlement plan, which seems like a screaming deal since they made \$35 billion in revenue from the selling of “less addictive” OxyContin.

The real economic powerhouse, with an estimated annual revenue of \$652 billion, is illicit drug trade. A good portion of these sales are *brown sugar, China white, junk, skunk, smack, doggie, doojee, dust, dorado*, also known as heroin.

Heroin is not a drug to try once. If you get it wrong, you die. You get it right and it’s a highly addictive drug, and you have a decent probability of dying the next time, or the time after that. Opiates kill more Americans than any other drug, causing 75 percent of overdoses in 2021, and killing more than one million Americans since 1999.

Fentanyl was created in 1959 and is fifty times more potent than heroin and a hundred times more potent than morphine, meaning you need a lot less to have the same effect. When opiates hit your mu analgesic receptors, they also hit a bunch of receptors in other places, causing low heart rate, low blood pressure, confusion, and respiratory depression. There are opioid receptors in the brain that regulate breathing and if the dose of fentanyl is off by a few micrograms, the user will stop breathing, causing death in a matter of minutes.

There is a way to save a person who overdoses on opiates: Narcan.

There is a way to save a person who overdoses on opiates: Narcan. Narcan, also called naloxone, kicks the opiates off the receptors so the person will breathe again, and it now comes in a nasal spray. Narcan’s effects only last about an hour, which means that a longer-acting opiate, like oxycodone, can continue to cause effects, so always call 911 after giving Narcan. An unfortunate effect of Narcan is it will cause opiate withdrawal symptoms, so my patients are not usually immediately grateful when I give it to them.

Withdrawing from opiates includes nausea, vomiting, goosebumps, diarrhea, yawning, abdominal pain, and pain everywhere, really. You feel like you’re going to die, but you’re not. Opiate withdrawal is not life-threatening in the way alcohol withdrawal or benzodiazepine withdrawal can kill you. Opiate withdrawal is uncomfortable, which is why doctors

often taper patients off opiate medications, but it is not inherently deadly. The most dangerous part is dehydration.

In summary, don't try opiates recreationally; it will ruin your life immediately if not sooner. If using opiates, get help; it's unlikely patients can stop alone. And always carry Narcan; it could save a life. Short-term opiates prescribed for extreme pain are probably OK, but if offered opiates as a solution to chronic pain, consider just saying no, unless you're on hospice as a terminal cancer patient, in which case break out the fentanyl patches, these drugs were made to ease terminal pain and suffering.

PSYCHEDELICS: LYSERGIC ACID DIETHYLAMIDE (LSD) & MAGIC MUSHROOMS

Apparently, no one has died from an overdose of LSD or magic mushrooms, so this chapter has placed me in quite a pickle.

Psychedelics are reported to cause a dissolution of ego, blending the self into the surrounding world, and creating new enlightening perspectives. There are many psychedelic drugs that have been used for centuries within cultural norms and religious rituals. When employed for these uses, psychedelics are referred to as entheogens.

The spineless peyote cactus native to Mexico and the southwest United States, containing the DEA Schedule I hallucinogen mescaline, is an entheogen that has been used by indigenous cultures in religious practices for thousands of years and is still legally used by the Native American Church. Ayahuasca, an entheogen of South America found in the ancient pouches of shamans from a thousand years ago, is now used by Western backpackers looking to be enlightened, barf, hallucinate, and then return to their lucrative nine-to-five tech jobs in Silicon Valley. Once people realized they liked entheogens, there became a market for recreational use, and eighty years ago LSD was just on time.

Lysergic acid diethylamide (LSD), aka acid, was first synthesized by Swiss chemist Albert Hofmann while he was trying to make something else. The drug became popularized in the US during the 1960s and is often associated with hippie counterculture. LSD has been associated with many artistic movements such as psychedelic art, literature, and rock music, including works by the Grateful Dead, Jimi Hendrix, Pink Floyd, and the Beatles. It was not until the late 1960s that LSD was made illegal by the federal government.

A synthetic chemical, LSD has a similar structure to psilocybin, the part of the mushroom that makes it magical. Both LSD and psilocybin have structural similarities with serotonin, the neurotransmitter that is lacking in those experiencing depression and anxiety. LSD and other psychedelics are proposed to use serotonin, dopamine, and glutamate in the pathways of the brain to create effects of dissociation, hallucinations, and euphoria, which together are referred to as a *good trip*.

There are also *bad trips* that cause fear and agitation. Most ingestions of LSD have effects for nine to twelve hours, and that is a long time to be chased by a pitchfork-wielding, devil-possessed, miniature Hugh Grant dressed as an Oompa-Loompa. Bad trips have been described as a feeling of losing oneself, due to a dissolution of ego, or the fear of losing one's mind. There have been instances of suicide or accidental deaths while taking LSD, and there is always the possibility that the drug is laced or swapped. For instance, 25I-NBOMe, a new psychedelic designer drug known as the Wizard, is not LSD and can kill you.

Because many psychedelics act on serotonin receptors, they can potentially cause serotonin syndrome, which causes high heart rate, arrhythmia, seizures, and death. This is even more likely if illicit drug users are taking prescribed serotonergic agents, such as selective serotonin reuptake inhibitors (SSRIs), like Prozac, or monoamine oxidase inhibitors (MAOIs), both commonly used to treat depression and anxiety.

There is a rumor that LSD can live in your spine and cause flashbacks. Flashbacks are brief drug-like experiences, generally described as pleasant, in the months to years following LSD use. There is no evidence that LSD remains in the spine, and the pharmacokinetics of the drug do not suggest this. I used a big doctor word, so you have to believe me. I attempted to determine the source of the sneaky spinal rumor, and it seems it started as an old wives' tale in the seventies, fabricated from thin air. Funny how that happens. Science doesn't know exactly why LSD flashbacks happen, but it may be as simple as recalling a memory made during a moment of altered perception due to the psychedelic.

At this point, it seems like I am promoting LSD. I am not promoting the use of illegal drugs, but there has been a scientific renaissance in psychedelic research. For instance, Johns Hopkins was granted \$55 million in funding dedicated to psychedelic research informing novel psychiatric treatments and ways to support thriving minds. Johns Hopkins's research,

headed by Dr. Roland R. Griffiths, showed unprecedented effects of psilocybin, and magic mushrooms, on decreasing clinical depression and anxiety, superior to our current medications. After just two doses of psilocybin, more than 80 percent of terminal cancer patients had improved mood at six months. Similar outcomes have been seen in recent LSD research. Griffiths also showed psilocybin can also help people stop smoking cigarettes, with a six-month abstinence from smoking at 80 percent among psilocybin users, compared to around 15 percent for the general population. But psychedelics are not all diamond skies and strawberry fields forever; there is obviously a dark past of misuse.

Charles Manson, a psychopathic cult leader who claimed to be a child of Christ, Hitler, and Satan combined, promoted LSD to his following, known as The Family, and then instructed them to go on murderous rampages throughout Los Angeles. Manson was definitely a psychopath before LSD. At the age of nine years old he set a school on fire, so there were early warning signs. There are theories that Manson used LSD to “reprogram” his followers using mind control. This sounds like a conspiracy theory, but according to documents released from the US Senate hearings, the CIA admitted to giving LSD to forty people as part of a thought-control experiment. Cults can be started without using LSD, but this is a proposed danger of the drug.

Psychedelics remain controversial drugs among the public for good reason, and unregulated drugs pose unique risks. The poisonous death cap mushroom, *Amanita phalloides*, looks a whole lot like the psilocybin magic mushroom, and the Wizard is not the same drug as LSD. It might be best to wait until the proper research is done by Dr. Roland R. Griffiths and friends.

PARTY DRUGS: ECSTASY, GAMMA-HYDROXYBUTYRATE (GHB), ROHYPNOL & KETAMINE

Trigger Warning: Please note that this chapter discusses sexual assault.

Methylenedioxymethamphetamine (MDMA) is the fancy chemical name for the illicit empathogen known as ecstasy, E, Scooby Snacks, or Molly. Empathogens are drugs that increase a person’s feelings of empathy and compassion, which a lot of people could benefit from, but this drug has some side effects, so the DEA made it a Schedule I narcotic. MDMA is

commonly taken in a colorful pill form, complete with nondescript playful insignia, but it can also be in liquid or powder form.

MDMA was first discovered by the pharmaceutical company Merck, who patented the drug but then decided it wasn't a problem they needed, so they threw the baby out with the bathwater. Over fifty years later a San Francisco biochemistry professor, Dr. Alexander Theodore Shulgin, found the baby and began research on the prosocial effects of MDMA. By the 1980s, MDMA had grown up and was frequenting the party scene before solidifying its tenure as the unofficial, official drug of raves. For those who stopped partying before the 1980s, a rave is a large dance party where DJs play electronic music and people take ecstasy, apparently. There are also participants attending raves to dance without taking drugs, in the same way some people actually do go to Hooters for the wings.

MDMA has structural similarities to mescaline, a hallucinogen psychedelic drug, and amphetamine, the world's most annoying stimulant drug. MDMA works by increasing the release and preventing the uptake of serotonin, the happy neurotransmitter, resulting in the brain swimming in a sea of serotonin, creating feelings of elation and togetherness.

Unfortunately, the massive burst of serotonin comes with a downside, and it's not just the emotional drop felt after recovering from the drug. An increase in serotonin can cause hyperactivity and hyperthermia, and more rarely, serotonin syndrome, which is life-threatening. However, the most common MDMA-related medical issues are due to overexertion and dehydration. In the 1990s classic film *Hocus Pocus*, the Sanderson sisters curse the crowd of party-going parents to "dance until they die." That's an actual possibility. When taking ecstasy, high body temperatures and muscle overuse can cause muscle breakdown causing rhabdomyolysis, which can kill the kidneys, and subsequently the owner of the kidneys.

MDMA users can also have life-threatening changes in bodily sodium. That is correct—your table salt can kill you. Enthusiastic shuffle dancers on MDMA lose sodium through sweating, increasing thirst, leading to drinking large quantities of often sodium-free bottled water, which continues to cause a decrease in the blood sodium concentration. Additionally, vasopressin, also called antidiuretic hormone (ADH), may be released as a direct result of MDMA, further reducing the body's blood sodium concentration. I'm sure nephrologists everywhere are diuresing, ready to pee in excitement, at the thought of discussing ADH's mechanism of action.

ADH increases the number of pumps called aquaporins in the kidneys, which augment water reabsorption from urine, thereby lowering the blood's salt concentration; it is not exciting to anyone other than kidney doctors. All this to say that MDMA can acutely lower the body's sodium, causing seizures and eventually brain swelling and death. More on how the elixir of life can kill you can be found in the *99 Ways to Die* chapter on water.

MDMA as a street drug clearly has many faults, but with controlled synthesis at the right doses it is being studied at Stanford University as a treatment for certain psychiatric diseases, such as PTSD. For those who illegally use MDMA, choosing electrolyte-infused water such as Pedialyte or Gatorade as a shuffle dance partner could save a life.

Unfortunately, MDMA is not the most dangerous drug at the party. Like any party, uninvited guests show up, and these ones could kill you.

In the United States, a person is sexually assaulted every sixty-eight seconds, with full or attempted rape being experienced by up to one in four women and one out of twenty-eight men. Most rape happens near the home, involving a perpetrator the victim knows, yet rape continues to be the most underreported crime in the US, with only a 63 percent reporting rate.

The reasons rape is unreported are obvious, as victim shaming runs deep in our society. Even the medical billing code for rape contains "alleged," while other forms of assault do not carry this modifier. For instance, the medical billing codes Y04.8: Assault by bodily force, W56.22XA: Struck by orca, and T63.443S: Bee envenomation by assault, don't use the modifier "alleged." But Z04.41: Encounter for examination following alleged adult rape, makes it clear that the burden of proof is on the victim.

Date rape, so named because the victim encounters the perpetrator as an acquaintance with perceived potential for a sexual relationship and has sometimes gone on a date with them, is a critical problem on US university campuses, where 13 percent of students will become victims of sexual assault.

Date rape often involves employing drugs and alcohol to initiate the assault. Date-rape drugs include gamma-hydroxybutyrate (GHB), Rohypnol, ketamine, Ambien (zolpidem), Xanax (alprazolam), and Valium (diazepam). Ambien is a sleeping pill, while Xanax and Valium can be found in the chapter on benzodiazepines. The latter three medications are prescriptions, while GHB and Rohypnol are Schedule I illicit drugs and

ketamine is a sedative mostly used in hospitals by licensed medical professionals.

Gamma-hydroxybutyrate is an illegal depressant, but there is a GHB-containing medication, Xyrem, that is used to treat narcolepsy by forcing sleep at night. GHB is usually a colorless powder that dissolves in liquid and tastes slightly salty. The drug causes a sedative effect fifteen to thirty minutes after taking, lasting three to six hours. Many of these drugs are fast-acting, so if you start to feel abnormal, act fast to get help and do not second-guess yourself. GHB can be detected for only eight to ten hours and is not in a standard toxicology test, but testing can be sent to an outside laboratory. A recorded chain of custody for the blood sample must be legally documented, so it may be best to transfer the sample to police custody and forensic lab testing. Outcomes of testing can be complicated by failures to identify the drug used in the assault while finding other drugs and alcohol in the bloodstream, which is admissible in court. Note that it is possible to request only date-rape panel testing.

Rohypnol, also known as roofies, is a benzodiazepine that is used as a sleep aid in some countries but is illegal in the US. The drug causes sedation and often amnesia, with effects commencing twenty minutes after taking and lasting up to twelve hours. The drug's producer, Hoffmann-La Roche, responded to concerns about the date-rape drug by changing the pill formulation to a blue tablet, as it originally dissolved clear in liquids, making it difficult to detect, but the blue tablet can still be difficult to see in blue or darker drinks. According to the DEA, this drug is still found in an odorless, colorless, and tasteless form on the black market. Rohypnol can be detected in the bloodstream for up to sixty hours following ingestion, and in the urine for seventy-two hours, with new technologies detecting Rohypnol metabolites for as long as fourteen days. There is also new hair testing for drugs of abuse, including Rohypnol, which can detect these drugs up to ninety days after ingestion with varying certainty.

Ketamine, or the street version, special K, is a dissociative anesthetic, historically used for medical sedation and acute pain, now also being used for refractory depression and chronic pain. As a recreational drug, special K can be a clear liquid or a white or brown powder, and often tastes bitter. In the 1950s, Parke-Davis's laboratories in Detroit accidentally invented phencyclidine (PCP) on the path to creating ketamine. Ketamine was largely used to sedate animals in veterinary medicine but became a favorite

sedative for medical procedures, because unlike most sedatives, ketamine does not cause respiratory depression—meaning people keep breathing. This is the reason ketamine became a popular field anesthetic for wounded soldiers during the Vietnam War.

While targeted sexual homicide is reported as rare according to the analysis of the National Violent Death Reporting System, unexpected deaths occur as a consequence of date-rape drugs that cause decreased breathing and other complications. There are also psychological consequences that result from rape, as about one-third of female rape victims contemplate suicide, and 13 percent of victims attempt suicide. Help is available through the Rape, Abuse & Incest National Network (RAINN) and the National Sexual Assault Hotline (800-656-HOPE [4673]).

Things to look for in a spiked drink include changes in color, taste, cloudiness, and fizziness, but these indicators cannot be trusted, so when in doubt, throw it out. Suspected drink spiking can be reported to police and campus police at universities. Some cities even have local watch lists, such as Booze in Boston, a group that keeps a public self-reported warning list on Google Maps of bars where people have suspected they were roofied.

To decrease rape globally, the UN suggests creating a culture of enthusiastic consent, redefining masculinity, promoting active bystanders, and a zero-tolerance policy for rape, including in leadership, which seems obvious but is currently poorly executed in the United States. The passive approach to sexual-assault convictions is dangerous for everyone and provokes Lorena Bobbitt-esque outcomes. To keep everyone safe, rape needs to be reframed as a societal issue, not a women's issue.

There are companies attempting to prevent date rape through new technologies. Undercover Colors is a nail polish that changes color when dipped into a drink containing date-rape drugs. There are also similar products being developed for straws, coasters, and cups. Drink caps and seals for the tops of cups at parties have also been created to prevent drink spiking. These products need to be promoted not by the victims, but by the communities, such as Greek life, college campuses, bars, clubs, and even raves, because it's easier to shuffle when you know you're safe. In an ideal society, the epitome of masculinity would involve standing up vehemently against sexual violence and rape. Past generations have failed to meet this standard, but there is hope for the future. I really like how Gen Z is shaping up.

DOWNERS: ALCOHOL & BENZODIAZEPINES

When I started writing this chapter I completed three entire days of *dry January*, so it seemed like a safe time to speak on the dangers of drinking alcohol.*

If I were to drink alcohol, the ethanol component would travel to my small intestine, where it would be absorbed into my bloodstream. The alcohol in my blood would pass the barrier to enter my brain, where it binds to GABA receptors, inhibiting certain neurons from firing and resulting in relaxation effects and the urge to dance on tables.

A similar mechanism is used by benzodiazepine drugs, namely Xanax, Ativan, Valium, Halcion, and Klonopin, in the brain. The brain sees alcohol and benzodiazepines as the same drug, in that they work on GABA receptors and create depressive calming effects, which is why they are known as “downers.” For our purposes, barbiturates can be considered long-acting benzodiazepines, and are thus included in this drug class. So far these drugs probably sound great, but clearly, there’s a catch or I would have nothing to write about.

Around thirty million Americans are alcoholics, a term used by Alcoholics Anonymous (AA). The US Department of Health and Human Services would say thirty million people in the US have an “alcohol use disorder.” It doesn’t really matter what it’s called—we have a problem that affects over 10 percent of Americans twelve years and older, kills three million people worldwide every year, is the seventh leading cause of death and disability, and it’s sitting in your glass. This is what you call a gotcha moment.

Alcohol is a dirty drug, and what I mean by that is alcohol has a ton of unwanted side effects, interacts with other drugs, and is highly addictive. Remember that addiction is motivated by physiological dependence driven by drug tolerance, a process that changes the body’s hormones, neurotransmitters, and cell receptors.

In the brain, GABA receptors inhibit neurons from firing, calming them. When alcohol constantly binds the brain’s GABA receptors, inhibiting the neuron from firing, the brain cell eventually takes the receptors down so that it can get some work done. But this is like removing the brakes from a car—the neuron won’t be able to slow down its firing. After persistent alcohol abuse, there are fewer GABA receptors on brain cells and the GABA receptors that remain must be attached to alcohol or the neuron will

become overstimulated. If you remove alcohol suddenly, the brain cells will fire constantly, causing alcohol withdrawal symptoms, including possible seizures and death. Alcohol and benzodiazepine withdrawal are the only recreational drug withdrawals that are intrinsically life-threatening.

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Alcohol withdrawal begins approximately six hours after the last drink. For the heaviest drinkers, withdrawal can even start when the person still has alcohol in their blood. Minor withdrawal symptoms include tremors, nausea, vomiting, sweating, headache, and palpitations. These symptoms can be confused with a hangover, but hangovers are symptoms due to a buildup of acetaldehyde (more on that later). If symptoms do not progress, they usually dissipate within forty-eight hours. In moderate to severe alcohol withdrawal, the initial withdrawal symptoms worsen, causing seizures and hallucinations, like seeing pink elephants on parade and Lilliputians. This can then progress to delirium tremens, which encompasses all these symptoms and more, killing 5 percent of patients, even with treatment.

There is a colloquial term *alcohol poisoning* that isn't really used in medicine, but it does exist. Alcohol poisoning kills people, but patients must attain a high concentration of alcohol quickly enough to lose consciousness, choke, or stop breathing. I have never personally seen a patient achieve this with the ethanol found in beer, wine, and hard liquor, although I have seen it with isopropyl alcohol, also known as rubbing alcohol, found in hand sanitizers. These patients are placed on ventilators—we don't pump stomachs. There is a reversal agent for alcohol and benzodiazepine poisoning, flumazenil, but doctors try not to use it, as it can cause seizures and withdrawal in chronic alcohol users. Most alcoholics in the emergency department are chronic drinkers who are placed on a monitor with fluids as they get sober through metabolism.

Metabolization is a part of digestion where the body breaks down ingested products into pieces called metabolites for use and excretion. When it comes to ingestion of toxic alcohols, ethylene glycol and methanol, the metabolites will kill you. Ethylene glycol, found in antifreeze, will take out your kidneys and then kill you. Methanol, used as a solvent for cleaners,

paint thinners, and gas, will blind you and then kill you. Both require emergency treatment, but you'll never guess what it is. I'll give you a hint: *It's Miller time*. That's right, the treatment is ethanol, but any form of booze will do, it doesn't have to be Miller.

When toxic alcohols are ingested, the enzyme that breaks down all alcohols inadvertently metabolizes ethylene glycol and methanol into poison. For instance, methanol breakdown creates formaldehyde. Since the enzyme that metabolizes methanol and ethylene glycol is the same enzyme that breaks down ethanol, if you give the enzyme booze, you can keep it busy working on beer breakdown while doctors get the methanol and ethylene glycol out of the patient's bloodstream, usually by dialysis. Doctors used to give beer to these patients and make them drink until we could get the toxic alcohol out of their blood, but not everyone can beer bong like a college student, so we now use a drug called fomepizole, which blocks the enzyme. Whether ethylene glycol or methanol ingestion is an accident, a suicide attempt, or an attempt to get drunk, it always needs immediate emergency treatment, so call poison control and go to the emergency department.

The long-term effects of ethanol use are not great. Alcohol causes something called oxidative stress on the body, which destroys cells, causing a corrosive effect, like rust in an engine. There are organs that take big hits from this, such as the liver, heart, and brain. A third of alcohol-related deaths are due to liver disease. This is the most common cause of death from alcohol use disorders and it causes the liver to shrivel up like a raisin and die in a process called cirrhosis. The liver is an amazing organ that can regenerate if the cells are still alive, so if liver labs are elevated and there are signs of liver inflammation, it's important to stop drinking alcohol so the liver can regenerate. Once the liver cells die, cirrhosis scars the liver and there is no coming back. You can't live without a liver, hence the name.

It is clear that soaking the brain in alcohol is not a good look. Wernicke-Korsakoff syndrome is a swelling of the brain due to thiamine (vitamin B₁) deficiency, often caused by alcohol. The reasons why alcohol causes thiamine deficiency are boring, so just trust me on this one. In this syndrome, the patients' eyes are crossed, they can't walk straight, and they're talkin' nonsense. These patients seem drunk, but they aren't drunk, their brains are swelling, and if thiamine is not repleted correctly, they will die.

Alcohol use is associated with dementia, high blood pressure, heart disease, stroke, stomach ulcers, gastrointestinal bleeding, aging, spider veins, low testosterone, infertility, depression, anxiety, weakened immune system, and cancer of the breast, mouth, throat, esophagus, voice box, liver, colon, and rectum. Most of this list is from the party poopers at the CDC.

How do you know if you have a drinking problem? A drink is twelve ounces of beer, five ounces of wine, or one and a half ounces of liquor. The CDC defines drinking in moderation as less than one drink a day for women and two for men. Heavy drinking is defined as consuming eight or more drinks for women and fifteen drinks or more for men per week. Binge drinking is four or more drinks on a single occasion for women and five for men. As a woman, I feel a bit targeted, and I think this should be recalculated based on height and weight, but I'll save that argument for a different book. I will say, for all people sixty-five and older, drinking in moderation is one drink a day, regardless of sex (sorry, boomers).

One way to tell if you have an issue with alcohol abuse is the CAGE questionnaire, which your doctor may have secretly used on you.

- C—Cutting Down: Have you ever felt you should cut down on your drinking?
- A—Annoyance by Criticism: Have people annoyed you by criticizing your drinking?
- G—Guilt: Have you ever felt bad or guilty about your drinking?
- E—Eye-Openers: Have you ever had a drink first thing in the morning to steady your nerves or get rid of a hangover?

If you answer yes to two or more of these questions, it is possible you have clinically significant alcoholism. The CAGE questionnaire has a 91 percent sensitivity for detecting alcoholism, but is only 77 percent specific, meaning there are false positives. Alcoholism is sneaky, it's like accidental weight gain over time—you know something is different, and you can feel it, but it happens so subtly that you are completely unaware until you step on a scale.

There are drugs that can help curb alcohol cravings, like naltrexone (Vivitrol), and even punish you for drinking, like disulfiram (Antabuse). Antabuse is a drug that blocks the enzymes involved in the final breakdown

of alcohol metabolites, causing a buildup of acetaldehyde, the hangover molecule, that will make you vomit like Regan MacNeil in *The Exorcist*.

Getting help with alcoholism requires personal acknowledgment of the disease and addiction. One of the best ways to quit is through Alcoholics Anonymous—friends of Bill W. know what they are doing. The acute alcohol withdrawal phase can be deadly, thus may require medical attention, so if you are going to stop drinking, speak to a physician first to get proper medications.

NICOTINE: SMOKING & E-CIGARETTES

If you are under thirty, you might not remember the Marlboro Man, but he was basically the Kylie Jenner of cigarettes, but with a cowboy hat, horse, and smokes instead of a lip kit and skin care. The Marlboro Man was the OG influencer. It wasn't until years later that the Marlboro Man actor, Eric Lawson, sadly died of respiratory failure from smoking-related lung disease.

Throughout its history, the tobacco industry has run some of the most successful marketing and lobbying campaigns of all time, at one point converting half of all Americans into smokers. But the product is one of the world's most addictive drugs, so it was like shooting fish in a barrel. Tobacco company marketing campaigns in the 1940s began with physician and dentist endorsements and shifted to celebrities in the 1950s when the research studies of Doll & Hill and Hammond & Horn showed cigarettes to be correlated with lung cancer. Cigarette companies responded, but instead of removing some of the seven thousand chemicals found in cigarette smoke, sixty-nine of which cause cancer, they changed marketing campaigns. One company promised “the greatest health protection in cigarette history,” by improving cigarette filters and adding asbestos. Today the largest tobacco companies spend \$8.2 billion on advertising, with smoking finding its way into 41 percent of video games and 61 percent of PG-13 movies, where teens are influenced to pick up lifelong addictions as “replacement smokers,” the term used for youths in tobacco industry strategy documents.

As one of the world's most addictive drugs, nicotine works on receptors located all over the body, but most importantly for addiction, in the brain. Nicotine releases the pleasure hormone dopamine and works quickly, taking

only ten seconds to reach the brain. In a world of instant gratification, this is an ideal drug.

In 1964, the US Surgeon General published a report linking smoking to cancer. Because prohibition did not work on alcohol cessation, the US government changed its approach and did not make cigarettes illegal; instead, the FDA created its own marketing campaign focused on smoking effects and public health education. These campaigns worked, and today, 75 percent of Americans view cigarettes as “very harmful” to their health, and cigarette smoking in the United States is at a historic low.

Besides providing health information, state and federal antismoking campaigns hit people where it really hurts: their vanity. Instead of making cigarettes illegal, they made smoking unattractive. I still remember a television ad of a cancer survivor smoking through a hole in her neck—it scared the crap out of an entire generation of Californian teens. Debi Austin was a smoker who developed throat cancer, requiring her vocal cords to be removed, after which she became a tireless antismoking advocate.

The dangers of secondhand smoke, such as heart attack, stroke, lung disease, and cancer, eventually made smoking in public places illegal in many states, although there is no federal ban. States showed up in varied fashions, with California banning smoking within twenty feet of any public building, and Illinois outlawing giving your dog a lit cigar. Thirty-five states have state-wide 100 percent smoke-free indoor laws, while Alabama, Georgia, Kentucky, Mississippi, Missouri, Oklahoma, South Carolina, Texas, Virginia, West Virginia, and Wyoming have no statewide law on separation, ventilation, or a smoke-free indoors. Because some states are loosey-goosey, the federal government banned in-flight smoking on all domestic and international planes, but not until 2000, which is why armrest and bathroom ashtrays are still present on many planes.

Today, around twenty-eight million Americans smoke cigarettes, and almost half a million die of smoking-related causes each year. Globally, tobacco kills eight million people a year. Smoking causes tarry tooth decay, kills the nerves that allow for smell, increases blood carbon monoxide, damages blood vessels (causing heart attacks and strokes), ages skin, and causes erectile dysfunction and infertility. It’s hard to find a type of cancer that isn’t increased by smoking. Smoking causes leukemia, skin, mouth and throat, voice box, esophageal, stomach, pancreatic, liver, kidney, bladder, cervical, colon, and rectal cancer. Chewing tobacco causes a lot of these, as

well. And that's not even the big one—smoking causes 85 percent of lung cancer, the leading cause of cancer deaths, causing 350 deaths a day and one in every five deaths in the US. So, it makes sense that smoking was complicit in the deaths of Walt Disney, Desi Arnaz, Humphrey Bogart, Nat “King” Cole, T. S. Eliot, Sigmund Freud, a few kings of England, and Groucho Marx. Even with the decrease in smoking within the United States, it will still take decades for smoking-related cancer deaths to decrease, because cancer takes years to form.

Cancer is a disease where a cell loses control and pathologically replicates. In *Harry Potter and the Deathly Hallows*, a heroic trio of young wizards visits the Lestrage vault at Gringotts Wizarding Bank in London, searching for the Voldemort Horcrux hidden inside Helga Hufflepuff's cup. That is a lot of information, but I consider Harry Potter prereading for this book. When they touched items in the vault, they found a Geminio doubling curse had been used, so any item touched would replicate out of control. Cancer is just like that, and the curse is smoking. There are tumor suppressor genes inside human cells that control replication, and when they are mutated or changed by carcinogens, such as cigarette smoke, they break, allowing the cell to divide out of control, causing cancer. The reason it can take years of smoking for cancer to develop is that there are often multiple genes that must break for the cell to become cancerous, unless a patient is genetically predisposed and born with gene mutations already present. This is why we see most cancer in the population over the age of fifty but see specific pediatric cancers in those born with genetic mutations.

Cancer isn't the only disease caused by smoking. Chronic obstructive pulmonary disease (COPD), which includes emphysema and chronic bronchitis, is caused by years of smoking that kills the cells that clean the inside of the lungs, called cilia. Eventually, the lungs' airways narrow, and they lose their elasticity, becoming nonfunctional. Bacteria become trapped in these airways and patients have chronic infections and many die by asphyxiation.

There is good news, finally. The effects of smoking cessation are almost immediate. After just minutes, the heart rate drops, at twenty-four hours the body's carbon monoxide level goes back to normal, by nine months the lungs recover cilia, and in one year the risk of heart attack sharply declines. After ten years, the risk of stroke and colorectal cancer of previous smokers is equal to nonsmokers. From ten to twenty years, the risks of heart attack,

cancers of the larynx, oral cavity, pharynx, and pancreas drop to nonsmoker levels, and finally, at twenty years the risk of lung cancer falls to nonsmoker levels. These numbers may vary slightly depending on the studies reviewed, but the results are a drastic decrease in complications with smoking cessation.

Quitting is tough. Addiction is a physiological chokehold, but trying for thirty days may be enough to get started. The initial withdrawal symptoms of headache, cravings, anxiety, constipation, and cough will dissipate in the first week and then it becomes a mental game bolstered by nicotine replacement therapies. Make the goal small and sustainable: Start with a month, because those thirty days might lead to forever, and quitting will give you longer to appreciate forever since quitting can add ten years to life expectancy.

A new nicotine vessel marketed as a “healthier” alternative to smoking is e-cigarettes. This is also known as vaping or JUULing, and uses e-liquid with lead, chromium, and many other chemicals, as well as high doses of nicotine, some equal to a full pack of cigarettes. Vaping is marketed as “safer” than smoking cigarettes, but in reality, science does not have the years of data to know the harms of e-liquid. For instance, e-cigarette or vaping product use–associated lung injury (EVALI), possibly associated with vitamin E additives in e-liquid and vaping of THC, is a new disease and is still being studied. EVALI starts with shortness of breath and chest pain and often ends in hospitalization and sometimes death.

Because we don’t have data on the long-term effects of vaping, the FDA is critically concerned about the epidemic of vaping among American youth. Vaping e-liquid comes in thousands of kid-friendly flavors, like bubble gum and sour candy, which supported a 900 percent increase in youth vaping from 2011 to 2015, meaning two million American kids are smoking e-cigarettes. This is the ideal nicotine market, as 90 percent of smokers start prior to eighteen years old. We have already begun to see the life-threatening risks of vaping. Diacetyl is a flavor enhancer in e-cigarettes that causes popcorn lung, or bronchiolitis obliterans, which, again, sounds like a curse from Harry Potter but is a disease that permanently destroys lungs.

We all pick our poison, but this smoking is nearly guaranteed to affect your health. Consider a safer vice, like cage diving with great white sharks. At a policy level, societal protections to prevent nicotine addiction in young

minds are critical. The FDA is currently working to restrict the nicotine levels and therefore addiction potency allowable in commercially available products. If you want to try to quit smoking, start small, cut back, and seek the help of a medical professional. If you need an extra boost, there's always California, where it's illegal to smoke almost everywhere.

ANIMALS

Snakes

Spiders

Sharks

African Fauna

Jellyfish

Scorpions

Australian Fauna

Other Ocean Creatures

SNAKES

There is a good reason for Indiana Jones's ophidiophobia, or fear of snakes. Over centuries these ancient creatures have inspired fear, art, and antivenom.

Snakes are cold-blooded, unable to self-regulate their temperatures through metabolism, requiring them to live in environments where they can seek heat. While the smallest living snake, the Barbados threadsnake, can fit on the tip of your finger and isn't much to fear, the largest living snake, the reticulated python, can reach over twenty feet.

Despite the absence of legs, snakes get around, being found on every continent except Antarctica. Interestingly, several islands have managed to remain devoid of snakes including Hawaii,^{*} Ireland, Greenland, and New Zealand. One island that did not escape this reptile is Ilha da Queimada Grande, Brazil, also known as Snake Island.

Ilha da Queimada Grande is home to the densest population of snakes in the world. Legend states that the snakes were placed on the island by pirates to protect the treasure. The island is also home to the endangered and deadly golden lancehead pit viper. While this beautiful snake's venom can kill a human in under an hour, there has never been a report of a human being bitten. I imagine this snake personified as the six-foot-four, 275-pound male with whom everyone wants to pick a fight, but he just wants to be left alone to write poetry in a tree.

There are more than three thousand species of snakes in the world. Only 10 to 15 percent of snakes are venomous, meaning they produce venom injected through biting. But it is safer to assume that every snake is all bite and no bark, except for the rattlesnake, which may at least give a sonorous warning.

The deadliest snake in the world is, unsurprisingly, in Australia. It is estimated that the venom in one bite of the inland taipan snake can kill one hundred humans. Luckily this snake is fairly shy and nonaggressive, thus it is not the snake with the most kills. The snake that has killed more humans than all other snake species combined is the saw-scaled viper, found in Africa, the Middle East, and Asia. Honorable mentions go to the black mamba, king cobra, and boomslang snakes of Africa, as well as the barba amarilla of Latin America.

In the United States, there are two families of venomous snakes, crotalids and elapids. These snakes are found in every state except Alaska and Hawaii, though they may also be extinct in Maine and Rhode Island.

The crotalid family includes pit vipers, like rattlesnakes, and cottonmouths. The venom these snakes deliver is cytotoxic, causing initial swelling and tissue death at the bite site. Systemic symptoms of venom include disseminated intravascular coagulation (DIC), which is where all your blood basically turns into Elmer's glue. Progressive disease can result in bleeding, as well as kidney, respiratory, and cardiovascular failure.

Since that isn't horrific enough, elapids, including coral snakes and cobras, have neurotoxic venom. This venom attacks your nervous system. Initial symptoms can include euphoria, nausea, confusion, vomiting, and headache. The venom can progress to cause paresthesias (tingling), double vision, paralysis, and decreased breathing. The venom works to block nerves as they meet the muscles, eventually removing the muscle strength needed to breathe.

There is some good news. In the US, up to a quarter of pit viper bites and half of coral snakebites develop no symptoms. These are referred to as dry bites, meaning that they don't deliver poison. Regardless of the odds, the best treatment for a snakebite is prevention.

Snakes come in two forms: venomous, also known as a "nope-rope," and nonvenomous, also known as a presumed "nope-rope." There are fallible ways to determine if a snake is poisonous, which include bright color, thin pupils, and a triangular-shaped head, but it is safest to respect and avoid all snakes.

If you are bitten by a snake, here is what to do: Contrary to poorly researched TV, tourniquets and sucking out venom are ineffective. Tourniquets are too tight and cut off arterial blood flow, causing loss of oxygen to limbs. (A constriction band or clothing wrapped loosely proximal to the bite will slow venom's movement through venous systems without compromising oxygenated blood flow to the limb.) Call 911 and get to the nearest emergency department. There are antivenoms for snakebites, but they are not without risks, so they are given only in cases where patients have a progressive local reaction or systemic toxicity (whole-body symptoms).

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Antivenom is made of antibody fragments that bind the snake venom to render it inactive. Think of the venom and the antivenom as two puzzle pieces, and when they snap together, they inactivate each other. Antivenom should ideally be given within four hours of the bite but is effective up to twenty-four hours from the bite time. Antivenom is made by purifying the antibodies that animals, like sheep, make in response to a snakebite. Over the years, antivenom has been further purified to reduce the incidence of medication reactions.

The most feared reaction to antivenom, serum sickness, is caused by an allergic response to the animal proteins within the antivenom. This can be a delayed response up to two weeks after antivenom administration. The reaction is akin to an anaphylactic allergic response and can be life-threatening. Serum sickness is treated in a similar way to anaphylaxis, with such medications as steroids and discontinuation of the medication.

Snakes are captivating ancient creatures, but a very unpleasant way to die. Luckily it is rare to die from snakebites, especially if you seek prompt emergency medical attention. Whether you encounter a threadsnake or a reticulated python, a little ophidiophobia could save your life, especially if it keeps you away from a saw-scaled viper.

SPIDERS

Our next guest has eight eyes, eight legs, comes in fifty thousand species, and can live up to forty-three years. That is correct. The world's oldest spider, a female trapdoor spider, lived forty-three years until she was killed by a parasitic wasp that injects larvae into other insects, which then feed on their host. What a way to go. R.I.P. Lady Gaius.

Spiders are ancient creatures and have evolved over three hundred million years into a highly variable species. Found on every continent except Antarctica, arachnids get around, and some can even take flight in a process known as *ballooning*. The blue-blooded creatures can be as small as a grain of sand, are sometimes vegetarians, and may live in social communities, which is so gross. Don't look up *Anelosimus eximius*.

In South America lives the world's biggest tarantulas, the Goliath birdeater, *Theraphosa blondi*, which can grow to over a foot long and eats

birds. I'm literally gagging. According to Google, people also asked, "Is the Goliath birdeater friendly?" This is the type of question that gets you killed. Goliaths are poisonous and noted to be one of the "least friendly tarantulas." If their size and venom aren't enough of a deterrent, the spider will rub its hairy legs together to create a hissing warning before detaching its long leg hairs to fling them like ninja throwing stars. It's an advanced move.

Pro survival tip: You don't need to know if a spider is friendly; it's akin to asking if the stove burner is hot. It doesn't matter; do not touch it.

Another South American spider, the banana spider, *Phoneutria boliviensis*, actively hunts its prey. That's right, no waiting in the web for this lady. Banana spiders are highly aggressive, highly poisonous, come in a charming yellow color, and like to hide in bananas. Meanwhile, the bite of a related Brazilian wandering spider, the deadly *Phoneutria nigriventer*, causes a Chiquita banana-size problem: a persistent painful erection known as priapism. This stuff writes itself.

Spiders are a highly matriarchal species. The females tend to be much larger, can live twenty times longer, and often have more venom. In fact, some little male spiders have completely nonfunctioning venom sacs. So sad. It's basically the 2023 Barbie movie but make it spiders. Barbie Spider has a great day every day, but Ken Spider only has a great day if Barbie Spider doesn't eat him. It makes you really think about the importance of equity in a society based on evolutionarily granted disproportionate power, or maybe not.

Lunchtime ladies: Enter the widow spiders. Widow spiders got their names because they sometimes eat the male spiders after mating. A smart male black widow will often bring insect snacks to the web in offering, in hopes of avoiding having his head bitten off. Like a good widow, she wears all black, but she has a distinct marking of a blood-filled hourglass on her tummy. To be fair, she comes with a pretty clear warning. So, what if she bites?

Well, the male spider is a goner, but humans are usually not. Black widows live in dark cool places like garages, sheds, and woodpiles. The bite causes localized pain and swelling within hours and can progress to latrodectism, which is just a fancy name for black-widow-spider-bite symptoms. The widow spider venom binds to neurons to increase the calcium in the cells, causing nerve cells to dump all their neurotransmitter

chemicals at once, resulting in nausea, vomiting, muscle rigidity, sweating, and severe abdominal pain, aka latrotoxicism.

Treatment for black widow spider bites includes wound care, tetanus shot, muscle relaxers, and pain management. There is a black widow antivenom but there have been severe allergic reactions to the drug, so it is often reserved for patients who are refractory to pain control. The pain can be so severe one patient in a medical journal stated, “I would rather die taking the medicine than feel the pain the way I do.” In this circumstance, the antivenom may be more deadly than the bite itself, but that’s because the black widow spider’s bite isn’t very deadly. There are conflicting reports, but it is unlikely that anyone in the US has ever died from a widow bite.

The black widow is found on every continent except Antarctica. The widow family comes in an assortment of colors, including brutal brown and rancorous red. The redback spider is basically Australia’s upside-down black widow, with its red spot flipped to its back. While not technically a widow, it’s still a killer. It is unclear what happened Down Under to make the insects so vindictive, but Australia is also home to standard black widows, bird-eating spiders, jumping spiders, and the world’s most poisonous spider, the funnel-web spider. There is an antivenom for funnel-web spider bites, so if you get to a hospital, you should survive.

Another commonly known poisonous spider is the brown recluse. Native to the southeastern United States, the spider is usually dark, reclusive, and has a little violin shape on its head—a very tortured-artist vibe. The initial painless bite packs a poisonous punch that causes a blister and local tissue necrosis. There is no antivenom but deaths from bites are exceedingly rare.

In the emergency department, almost every “spider bite” I see is an abscess. An abscess is a big pimple. People get them for a variety of reasons, but the culprit is much smaller than a spider; abscesses are caused by bacteria. These giant pimples need to be lanced by a professional and sometimes require antibiotics if there is surrounding infection, so you should seek medical care.

To avoid a run-in with an arachnid, keep your garage and sheds clean. If your garage looks like mine, it’s a spider haven. Get rid of the broken lawn mower and the old boxes, minimize space between stack materials, or use my solution: Never go in the garage again. Especially when stored

outdoors, shake out gloves and shoes before putting them on, or keep them in storage bags. Wear protective clothing when gardening, don't muck around in wood piles, and use outdoor spider repellents near homes. If you're bitten by a poisonous spider, call your local poison control center and go to the emergency department for care if needed.

If you do encounter a spider, before you take your shoe off and start squishing, remember that spiders have saved more lives than they have taken. By night these nocturnal creatures keep disease-carrying insects at bay, and by day they ... well, they sleep, but they also save lives.

For example, the same wandering spiders that scare the crap out of Brazilian banana eaters are helping cure a terminal brain cancer known as glioblastoma multiforme. On another continent, the venom of the orange-fringed tarantula could hold the answer to a nonaddictive painkiller, and spiders may even contain the elixir of eternal youth. Researchers asked the question "Why do female spiders live so much longer than male spiders?" and the answer was "oxidation reduction." The female spiders in question had reduced amounts of mitochondrial superoxide production and increased ... You know what? It doesn't matter, just try not to kill spiders; they could save your life.

[SHARKS](#)

When my little sister was five years old, I decided it was time for her *Old Yeller* moment, so I showed her the movie *Jaws*. What a core memory! For those without televisions, *Jaws* is the fictional 1975 Spielberg classic where a marine biologist and shark hunter team up to take down a homicidal shark. Prowling the beaches of a sleepy Martha's Vineyard-esque town, the shark, Bruce, develops a thirst for human blood. It was the highest-grossing film of all time, until *Star Wars*. I thought it would be a great movie to show a five-year-old who wouldn't stop following me to swim practice.

I come from a family of athletes, including a San Francisco 49er. I was a swimmer and eventually played Division I water polo for the University of California, Santa Barbara. When I was growing up, my parents wanted to drop off two birds with one car ride, so, much to my dismay, they put my younger sister in swimming. I didn't get around to telling my sister about the *Naegleria fowleri* amoeba, but after I introduced her to *Jaws* she was terrified of swimming pools and dolphins. At her young age her resulting

fears were based on a misinterpretation of the movie's messaging, but I hit my mark, and my parents pulled her out of swimming. Needless to say, she is still a terrible swimmer, though she did go on to play NCAA Division I college volleyball. She is an incredibly successful and resilient person, due in no small part to my guidance and terrorism.

The lead actor and antagonist of *Jaws*, Bruce the Shark, was based on the great white shark, probably because they have been presumed guilty in most recorded human shark attacks. "Presumed guilty" because it is challenging to determine a shark species while you're being attacked. "He was tall, gray and white, and had black beady eyes" leaves a lot of room for error. According to the International Shark Attack File, great whites have only 351 recorded human attacks worldwide, with 59 deaths in total, ever.

I should note that the International Shark Attack File only records "unprovoked" shark attacks. Provoked attacks, including chumming the water with blood and food, are not filed here, but if you're in the business of appe-teasing sharks, you're probably going to FAFO.

According to the CDC, every day, more than 300 people are shot in the United States, with 111 of them dying daily. My point is the great white shark will never be our biggest problem.

Sharks have been on Earth for more than four hundred million years, predating dinosaurs. This fishy family includes the megalodon, a sixty-foot shark whose hand-size fossilized teeth can still be found in coastal waters. There are five hundred species of sharks, one-third of which are ranked vulnerable to critically endangered. Humans kill up to one hundred million sharks every year, some as bycatch during fishing, but mostly due to overfishing and illegal fishing of sharks for their fins. The creation of shark fin soup involves the notoriously wasteful practice of shark finning, where millions of sharks are killed annually, fins removed, and bodies discarded back to the ocean.

It seems like sharks aren't really the problem here, but if you are trying to avoid shark attacks, there are a few rules:

1. Do not provoke a shark.
2. Swim in a group, preferably with slow swimmers.
3. Avoid swimming in twilight or dark hours.
4. Don't go in the water if you're hemorrhaging blood.

There is some patriarchal crap out there about menstruation attracting sharks. There is no evidence of this; furthermore, 80

percent of shark attacks have been on men. The total amount of blood lost in an average menstrual cycle is 2.7 ounces, because most of the menstrual fluid is water. There is also no evidence that menstruation attracts grizzly or black bears. There was a crappy study suggesting polar bears might be interested, but I remain unimpressed.

5. Avoid New Smyrna Beach, Florida, named one of the bitey-est beaches and the shark attack capital of the world.

It should be noted that as of 2012, the International Shark Attack File has no recorded fatalities here. It's more of a shark's tasting room than a dinner joint. None of the recorded shark attacks were great whites.

6. Depth of water matters, but not in the way one would think ...

A study of Florida beaches showed a majority of shark attacks happen in less than six feet of water. In a study following eight great white sharks vacationing in Cape Cod, the fish spent 47 percent of their time in less than fifteen feet of water. Great whites love eating seals and sea lions, which spend half their time on beaches. That means when you stand ankle-deep in ocean water, hoping to avoid becoming a shark snack, you actually stand on the takeout counter for the ocean's oldest predator. No one wants to die in a puddle—just take the plunge.

It is clear that these ancient creatures continue to be misunderstood and vilified. Hopefully, after reading this chapter you've seen that dying from a shark attack is highly unlikely, but if you are attacked, tourniquet any bleeding immediately and call 911.

[AFRICAN FAUNA](#)

The deadliest animal in Africa is one of the most annoying, the mosquito, followed by snakes including the puff adder and black mamba, and then the world's most fatal species of crocodile, the Nile crocodile. I'm really hoping the baby in the basket Bible story was allegorical.

Surprisingly, not many people die on safari, which is weird because it is basically food trucks roaming the Serengeti for the animals to peruse. This might be because the king of the jungle got lazy. In the past, lions reigned supreme. In 1932 in the Njombe District in southern Tanzania, a group of lions were actively hunting humans, killing fifteen hundred people in fifteen

years. And in Kenya, there was a pair of maneless male lions who earned the title of Tsavo Man-Eaters after spending time picking off railway workers. Lion attacks become prevalent with the expanding human populations encroaching on lion territory. These days, attacks against humans are rare, but not unheard of, so stay inside the food truck.

In the shallow lake waters of the African continent lies the world's deadliest mammal. Well, the second deadliest, behind humans. The uncontested runner-up is not who you might think, but I'll give you a hint: He's hungry, hungry. The deadliest nonhuman mammal in the world is the hippo. Hippos don't even eat meat; they are herbivores, making human-hippo homicide an incredibly wasteful practice. If hippos aren't trying to eat humans, why are they attacking?

Hippos are sneaky. What starts as a pair of small eyes and tiny ears can end with some two-foot-long teeth surprisingly quickly. Lord knows how that dump truck of a mammal can manage to move thirty miles an hour, but hippos are quick. Hippos are also territorial and aggressive, most often attacking fishermen, killing approximately five hundred people a year. Attacks became an even bigger problem in Kenya after rain from the 2020 wet season increased the footprint of Lake Naivasha, moving hippos into areas more densely populated with humans. It's notoriously hard to get a hippo head count because they go underwater when you try to count them, but the Lake Naivasha region has between 700 and 1,250 hippos. You are generally safe from hippos if you stay out of water and away from lake shores, but many people fish as their livelihood, so human-hippo conflict continues to be an ongoing issue.

The most dangerous mammal in the world exists on every continent: humans.* Hippos aren't even a close second. One of the unfortunate ways humans have become dangerous in Africa is through medical and religious mission trips.

When I was completing my undergraduate degree at the University of California, Santa Barbara, I participated in a medical mission trip to Tanzania. At the time, I was focused on my goal of becoming a doctor and enamored by seeing the beauty of the world through travel. I did not think of the deeper implications of medical missions.

On the medical mission trip, international doctors and nurses provided the medical care, and the student volunteers were props. Arguably the money we spent to be there would have been better spent solely on patient

care. We provided mobile clinics in churches and schools and took those who needed more extensive medical care to hospitals. I believe we all had good intentions, but retrospectively most mobile medical missions are Band-Aids for bullet holes, and what these communities deserve is medical infrastructure and long-term care solutions. Although this wasn't the most effective organization, they were licensed and physician-run.

In 2009, a nineteen-year-old homeschooled Christian missionary from Virginia with no medical training moved to Uganda and opened an unregistered pediatric healthcare facility called Serving His Children. The procedures performed at the facility included blood transfusions, oxygen administration, and care for critically ill children, with 105 children dying at the facility. She was a nineteen-year-old home-schooled American with no medical license practicing medicine on Ugandan children, and yet she was never charged criminally. There are no US laws to protect other countries against these types of crimes; low- and middle-income countries often do not have the infrastructure to prosecute and are also concerned about losing international aid if they do so.

There is inadequate oversight in international medical mission work worldwide. When people are destitute, they will often accept whatever they are given. If someone is dying of thirst, they will accept dirty water, but if that water has typhoid in it, they will only die more quickly. Poor people do not deserve poor healthcare, and if it is all that can be offered, it is not enough. Resources should focus on fixing upstream issues that cause public health problems. When Serving His Children started, it was a feeding program to help prevent malnutrition, and this was a more appropriate use of resources.

There are programs led by trained medical professionals that are doing it right. Doctors Without Borders (Médecins Sans Frontières) and the late Paul Farmer's Partners in Health are examples of physician-led medical organizations that provide care in a structured, regulated environment. Doctors can volunteer with Doctors Without Borders after completing residency with a full medical license and after practicing independently for two years in their home country. This means that if you have full practice authority as a physician in the United States, Doctors Without Borders still won't take you for two years. The organization keeps high standards to protect the world's most vulnerable populations.

My medical mission trip to Tanzania as a student was eye-opening in many ways. For one, I learned about the dangers of hippos. I think, in the end, it was more beneficial for me than the patients. I later worked with another medical nonprofit organization that focused on supporting local doctors by using funds to create permanent medical infrastructure in the communities we served. I believe this is a much more effective way to deliver medical care.

I have been fortunate to visit the continent of Africa multiple times since my first trip. In my humble opinion, it is a wondrous and kind continent. The world's investment in the well-being of Africa is not misplaced. We should care about the hardships of others. This is humanity's most redeeming quality and could be our salvation. But if you choose to donate money, research the organization to understand the mission and structure. If you are looking to donate to a medical nonprofit, I recommend Doctors Without Borders and Partners in Health.

Finally, if you are ever lucky enough to be on safari in Africa, stay in the food truck and avoid hippos.

JELLYFISH

Jellyfish predate dinosaurs because they keep things simple. Most jellies just go with the flow, since they can't swim, drifting like colorful balloons into the stratosphere. As the late great Mr. Hendrix said, "It's so groovy to float around, sometimes, even a jellyfish will tell you that." Another great Jimmy was just jealous that *they don't pay rent*.

They are spineless creatures, but only because they have no bones. Jellies are little blobs of gelatinous goop called mesoglea without brains or hearts. They are missing the Wizard of Oz trifecta. Even without a heart, brain, or spine, these bizarre creatures still do amazing things.

Jellyfish can glow in the dark using bioluminescence. Immortal jellyfish, *Turritopsis dohrnii*, are the size of your pinky nail, and when under stress or injured they revert to their early developmental stage and start life over again. Immortal jellyfish are unique in their Benjamin Button-esque lifestyles, but many jellyfish can regenerate tentacles.

As resilient as they are, jellyfish have a sensitive side, and their population patterns are used as bioindicators for ocean health and plastic

pollution. Jellyfish blooms can be dangerous and are thought to be related to rising ocean temperatures and overfishing.

Unfortunately, these weightless water dancers can be deadly.

The deadliest creature in the sea is the Australian box jellyfish. There is some dispute over this title, but this bad squishy is always a top contender. Sometimes referred to as sea wasps, they have a box shape and tentacles that can reach up to ten feet long. These odd jellies have twenty-four eyes and can swim, unlike their free-floating jelly counterparts. Found in the Indo-Pacific region and northern Australia, they are a transparent ocean blue, almost invisible adrift in the ocean waves. They are pretty easy to run into. A warning color would have been nice.

For years swimmers in northern Australia would meet suspicious sudden deaths, and no one knew why, as there was nothing seen in the ocean waves full of ghosts. The deaths were initially blamed on the Portuguese man-of-war, but the man-of-war maniacs are distinctly colored and often seen after stings. Hugo Flecker, an Australian toxicologist, was perplexed by the deaths uncharacteristic of known marine stings and, after some scientific sleuthing, outed the box jellyfish as the culprit. The jellyfish was named *Chironex fleckeri*, which roughly translates to “hand murder,” and then Flecker’s last name.

Chironex fleckeri can bring a watery death to its victims in less than five minutes. The venom collapses the cardiovascular system, causing the lungs to fill with fluid and stopping the heart. Never swim alone in box jelly waters, as victims can become incapacitated, drowning before reaching the shore. There is an antivenom for Australian box jellyfish, so if stung, call 000 immediately, which is 911 in Australian.

The efficacy of the current Australian box jellyfish antivenom is widely disputed, and some experts don’t think it works. What does work is a brand-new treatment discovered by researchers at the University of Sydney. The science squad discovered an antidote that blocks the Australian box jellyfish sting if injected within fifteen minutes, which will hopefully be created into a spray. They have a cure for the sting and will soon determine if it blocks all effects of the venom.

The tentacles of the jellyfish, and sometimes their umbrella-shaped bodies, are covered in tiny stinging cells called nematocysts. When the nematocysts encounter an object, the mechanical stimulation triggers the firing of a microscopic barb that injects venom. The nematocyst can also be

triggered by chemical changes—for instance, fresh water or your friend’s urine. It is estimated that only 1 percent of the nematocysts are fired with the initial painful sting, so that means 99 percent can still be detonated by chemical or mechanical stimulation. Things could get a whole lot worse if you don’t finish this chapter. Nematocysts can fire even if the jellyfish is dead, so jellyfish washed up on the shore should not be touched, not even with a stick. Put it down.

Other deadly jellyfish include Japan’s box jelly, *Chiropsalmus quadrigatus*, and *Morbakka fenneri*, the fire jellyfish of Queensland. The *Carukia barnesi*, or Irukandji jellyfish, causes Irukandji syndrome. The Irukandji jellyfish venom causes the release of massive amounts of catecholamines, the fight-or-flight hormones, causing an impending sense of doom, heart failure, and in two recorded cases, death. These tiny predators, the size of a pencil eraser, are found on the northern coast of Australia, but their global distribution has been expanding, which is another reason you may not want your ocean water warmer.

Postpandemic, my husband and I went to the Bahamas. For my birthday my husband surprised me with a snorkel tour, but things got a little dicey. The happy tourists jumped off the boat one by one, hitting the water, shouting in glee. We were all having so much fun. As I prepared to jump in, I realized the surface of the water was covered in tiny thimble jellyfish. People were screaming because they were getting stung.

There are an estimated 150 million jellyfish stings every year; almost none of them are life-threatening. Tentacles deposit the little nematocysts on the skin of victims. Rinse the area with ocean water or vinegar for thirty seconds. Vinegar stops unfired poison pouches from detonating but only works on select jellies; for instance, vinegar is not recommended for Chesapeake nettle stings. A single test tube–type study in 2014 showed that although vinegar stops nematocysts from firing, it may increase venom from nematocysts that have already discharged. However, as of 2023, the Northern Territory Government Information and Services of Australia and the Red Cross of Australia still recommend vinegar for box jelly stings. Check with beach authorities to confirm vinegar works for local jellyfish.

Urine will not help a jellyfish sting. Add some vinegar and tweezers to your beach bag and pee in the ocean like everyone else.

Do not brush nematocysts off with your hand, or you'll just get a jellyfish sting on your hand. Remove all tentacles with tweezers. Do not rinse stings with fresh water, as this can detonate the nematocyst grenades. Lastly, I wrote this entire chapter to keep you from peeing on each other. Consenting adults, it's up to you, but urine will not help a jellyfish sting. Add some vinegar and tweezers to your beach bag and pee in the ocean like everyone else.

Once all tentacles containing nematocysts are removed, soak the wound in hot clean fresh water. According to the 2006 Atkinson et al. fancy science meta-analysis, the standard advice is to soak the sting in clean water at 107–113°F (42–45°C) for thirty minutes or until pain resolves. The hot water deactivates the enzymes and proteins in the jellyfish venom. Do not burn yourself when soaking—you have enough problems. People can have allergic reactions to jellyfish stings, so if you develop a spreading rash, hives, or swelling, or have difficulty breathing, contact emergency medical services immediately.

When considering ocean swims, be aware of local marine wildlife and look up local jelly seasons. For instance, box jellyfish tend to be more prevalent in northern Australia from October to April, and they like to hang out near river mouths and come closer to shore when waters are calm. Wearing jellyfish sting-resistant protective swimming gear, like a wetsuit, is also advised. Many beaches use nets to protect swimmers, but it's the ocean—she's notoriously unpredictable.

In closing, not all squishies are bad squishies. Most jellyfish are not deadly, some don't even have tentacles, but like a toilet seat at a gas station, it is best not to touch.

[SCORPIONS](#)

When I graduated from medical school, my then boyfriend, Matt, insisted we take a cross-country road trip from Washington, DC, to California; I reluctantly agreed and then proceeded to plan every detail. The trip I planned included a night at Arcosanti, an experimental town in the Arizona desert, dedicated to reimagining the architecture and ecology of modern urbanism. When we arrived and checked into our dwelling, Matt sat down to reconsider our relationship, while I found a visitor—a little orange scorpion with a brown back. Like a good tourist I took a picture—and later

found out it was deadly. Shockingly, Matt and I are still together. In fact, he married me.

The Arizona bark scorpion, *Centruroides sculpturatus*, is found in Southern California, Arizona, New Mexico, and Mexico. Bark scorpion hideouts include shoes, closets, and behind toilet tanks. They can grow up to three inches long, have tan to orange coloring with a darker back, and have the distinctive ability to lay their poison-tipped segmented tail down flat.

The venom of bark scorpions activates sodium channels found in the nerves and brain. The first symptom is pain at the envenomation site, like a bee sting, but this pain can spread all over the body. Most stings cause intense pain usually lasting less than twenty-four hours, with less than 10 percent of stings causing severe systemic symptoms. Those with severe disease, often children and the elderly, can progress to high fevers, muscle spasms, drooling, and rapid tongue movement, followed by respiratory and organ failure.

While the bark scorpion is the most common scorpion envenomation in the US, where the total number of reported scorpion stings is upward of sixteen thousand annually, a US poison control study from 2005 to 2015 reports only 276 cases of life-threatening symptoms with only one death, in 2013. You may be unimpressed by these numbers, but most people with concerning symptoms received medical care and therefore pulled through.

Most stings occur in the summer months since scorpions hibernate in the winter. If stung, clean out the wound, call poison control, and seek medical care. Most scorpion stings are not dangerous, but if stung by a bark scorpion, remain vigilant of any symptoms requiring immediate medical care, such as double vision, difficulty breathing, drooling, fever, or loss of coordination. Hospital treatment includes pain control, supportive care, and antivenom. Always keep in mind that allergic reactions to stings are also possible and are just as life-threatening, so keep a lookout for hives, wheezing, and swelling.

If I could go back to Arcosanti, I would probably smack myself. Ways to avoid stings include staying away from scorpions and not taking photos. Scorpions are nocturnal and they can be difficult to see at night when they are hunting; if they weren't creepy enough, scorpions are fluorescent under UV light. That's right, they light up like Ross's bleached smile in the

Friends episode “The One with Ross’s Teeth.” Taking a UV light on Arizona camping trips to check the tent before bed is not a bad idea.

In areas where scorpions are prevalent, schedule a home inspection and scorpion control service, remove standing water, and inspect dark cabinets and closets regularly. Essential oils such as lavender, cedar, and peppermint have been shown to be good repellents for these particular ground-dwelling pests. And if it doesn’t work, your house will smell great. Some extermination websites recommend sprinkling cinnamon around baseboards, which starts to feel like an evil-repelling salt circle. Borax under sinks may also be a good idea, but it is poisonous when ingested so keep it away from kids.

There are more than fifteen thousand species of scorpions on all continents except Antarctica, with only twenty-five being lethal to humans. While the bark scorpion is the most dangerous scorpion in the US, these arachnids have a diverse and deadly international presence.

The spitting thick-tailed black scorpion of Africa, *Parabuthus transvaalicus*, hocks a loogie of venom into the eyes of aggressors before administering a lethal dose of venom. Yellow fat-tail scorpions, *Androctonus australis*, of Southeast Asia and the Middle East cause paralysis and respiratory collapse in as little as two hours if antivenom is not administered. If you thought that was fast, the Indian red scorpion, *Hottentotta tamulus*, can cause death in as little as fifteen minutes if antivenom is not administered. In Trinidad and Tobago, the thick-tailed scorpion, *Tityus trinitatis*, has not only been lethal but can cause pancreatitis, an inflammation of the pancreas, which is weird. Keep in mind that antivenoms exist for many scorpion species, so timely medical care can be key to survival.

For scorpions it seems that “kill or be killed” has worked out, making them the world’s oldest arachnids. They clearly want to be left alone. These arthropods are not hunting you; think of it like a run-in with your high school ex in a grocery store—neither of you wants to be there. No touching, back away slowly, and go immediately to the spice aisle to create a cinnamon circle.

[AUSTRALIAN FAUNA](#)

Over 80 percent of the plants, mammals, and reptiles in Australia are found nowhere else on Earth. Many of Australia's most dangerous inhabitants occupy other chapters in this book, including the taipan snake, blue-ringed octopus, box jellyfish, Sydney funnel-web spider, great white shark, redback spider, and more. Australia's geographical isolation may have led to the evolution of a particularly formidable animal kingdom. I could not give all deserving Australian fauna their due, thus Australia earned its own chapter.

One of Australia's most famous inhabitants, thanks to the late great wildlife conservationist Steve Irwin, is the largest living reptile, the crocodile. Australia has two species of crocodiles: the saltwater crocodile, *Crocodylus porosus*, known endearingly as *salties*, and the northern Australia freshwater crocodile, *Crocodylus johnstoni*. There are no alligators in Australia.

The saltwater crocodile tends to live in coastal waters but can also be seen in brackish and fresh water. They have transparent eyelids, which are better for seeing underwater, where they can remain for over an hour, reducing their heartbeats to two beats a minute while waiting for prey. The perfect hunters.

In 1995, Val Plumwood, an Australian ecofeminist, was taking a canoe trip on the East Alligator River in Australia's Kakadu National Park. In her essay "Being Prey" she states she felt an unease of being watched, perhaps hunted, throughout the day. When she passed a floating log, it morphed, golden eyes emerging to confirm her worst fear, before the crocodile began to ram her canoe. She waved her arms and shouted, "Go away!" Plumwood was taken into the water and underwent three death rolls by the creature. She fought like hell, and she won. The crocodile relented and sank back into the murky depths.

After her recovery, she was reluctant to share her story for several reasons. She feared the real monster, the mass media, would sensationalize the story and instigate a vendetta against crocodiles, a previously endangered species. In the past, such stories had ended in a mass slaughter of crocodiles in North Queensland and she feared putting these creatures at risk. Secondarily, she refused to perpetuate the "Crocodile Dundee mindset" that said that the bush was no place for a woman. After all, she had survived what many men before her had not.

“Being Prey” is a beautiful essay Plumwood wrote years later, reflecting on the attack. Humans naively insist that we are not part of the food chain; she even remembers thinking, “I am not food!” We separate ourselves from the earth even in death, hoping a wooden box will maintain our sanctity as we reject becoming a part of the circle of life, becoming food for other species. Val Plumwood passed away many years after the attack in 2008, but “The wonder of being alive after being held quite literally in the jaws of death has never entirely left [her].”

If you’re attacked by a crocodile, it will likely try to drag you underwater. Scream, fight, and go for the eyes, stuffing your thumbs into its eye sockets. Crocodiles have sixty-six teeth and the most powerful jaws in the world, so your only chance is if the croc lets go. But the croc is not the only Australian to watch out for.

Growing up, I remember the odd refrain “A dingo ate my baby!” I thought it was from a television show, but turns out, the truth was much more horrifying. It was the claim of Lindy Chamberlain in one of Australia’s most infamous murder trials. Chamberlain said she had seen a dingo take her infant child while camping, but instead she was convicted of the child’s murder. Later, new evidence was found, and Lindy was pardoned when the courts determined that a dingo was in fact responsible for killing the child. The story is tragic and brings attention to the previously ignored dangers of dingoes.

Dingoes are Australian wild dogs that rarely attack, but the risk increases as the dogs become more familiar with humans. The Department of Environment and Science for Queensland warns to never feed the dogs, always keep children close, walk in groups, and never store food in tents. They also recommend never running and carrying a big stick, which has a very Theodore Roosevelt vibe.

Another surprisingly dangerous Australian animal is the platypus. This duck-beaver is one of the few venomous mammals on Earth and lays eggs, hatching babies called puggles. The whole thing is gloriously weird. The male platypus has venomous spurs on his hind legs like a vengeful cowboy. The spurs pack a painful punch but have never been recorded to kill a human. These confusing creatures are adorable and unfortunately endangered, so if you’re ever lucky enough to see a pandemonium of ... platypi? platypussies? platypuses?... platypuses, protect them by being respectful and you won’t get spurred.

Australia's most unique inhabitants might be marsupials, which are mammals that give birth to underdeveloped young, often growing them in pouches.* I'm not sure how they came up with this, but other mammals should be jealous. It looks way more comfortable and only requires a month of pregnancy. Apparently, opossums are marsupials, so marsupials exist outside of Australia, but we'll focus on the Aussies.

Kangaroos pack a punch, and unfortunately that right hook has killed humans. Roos seem to really focus on leg day, but their tiny T. rex arms are also shockingly strong and equipped with claws. The males can stand at an impressive six feet ten inches, yoked to the max with rippling muscles. But when they fight they look like tiny-armed teenagers in a slap fight, until they kick and bust the opposition's spleen.

How to avoid getting smacked by a kangaroo? It is best to never feed kangaroos and to keep a distance, but for those who just must get a pic for *the 'gram*, kangaroos often start to show signs of aggression before attacking, such as rubbing their chests on the ground, pulling out grass, or standing at maximum height and urinating for all to see. If you're still trying to feed it a carrot at this point, you're about to get punched.

If you are being peed on by a kangaroo, authorities suggest showing submission by giving a short deep cough, bowing your head to avoid eye contact, and walking away slowly. Do not turn your back and run, as roos run faster than thirty miles per hour and can cover twenty-five feet in a single hop, so they will catch you. If a kangaroo does attack, drop to the ground and curl into a ball, protecting your head. The good news is that kangaroos are vegetarians, so they won't eat you.

If you are being peed on by a kangaroo, authorities suggest showing submission by giving a short deep cough, bowing your head to avoid eye contact, and walking away slowly.

Koalas are lovers, not fighters, and that love has resulted in a whole lot of chlamydia. This sexually transmitted disease differs in bacterial species from human chlamydia and causes blindness and infertility in koalas. The rapid spread of the disease, infecting up to 100 percent of some koala populations, along with brush fires and deforestation, has caused koala populations to plummet by 50 percent in the last twenty years. This has landed Eastern Australian koalas on the endangered species list. Hope for

koalas comes in the form of a chlamydia vaccine as well as Australia's dedication to protecting the species. If you are lucky enough to see a koala, their form of chlamydia has been reported to transfer to humans, causing pneumonia, so do not touch these animals.

The last Australian death trap is a tiny predator, the tick. Australian tick paralysis is most common in children under five years old and is caused by toxins from the *Ixodes holocyclus* tick bite. The disease starts with balance difficulty, vision changes, weakness, slurred speech, and difficulty swallowing, progressing to respiratory failure. The removal of the Australian tick can sometimes worsen symptoms acutely but eventually results in a full recovery. Australian tick paralysis can be lethal, so, despite the possibility of temporary worsening symptoms, tick removal and antitoxin are needed immediately upon diagnosis.

If you are a fan of the early 2000s hit drama *Lost*, in the season three episode "Exposé," two characters are taken for dead and buried alive after being temporarily paralyzed by a fictional spider bite, as seen in tick paralysis. The show's cocreator, J. J. Abrams, is dedicated to using a scientific basis for his intelligently crafted work. I know this because I was fortunate to work with Mr. Abrams on another TV show to ensure the integrity of medical information during the creative process.

There is a lot of false information floating around about Australia. For instance, a hoop snake is a legendary snake that fits its tail into its mouth, shaping its body into a hoop to roll down hills at top speeds, springing through the air to attack its prey. There is a snake that can do a cartwheel, but it lives in Southeast Asia.

The reality Down Under is that Australia is no more lethal than any other continent, but in this country, disrespecting the wildlife comes with heavy repercussions. To stay safe, respect Australian wildlife, read Val Plumwood's essay "Being Prey," and appreciate the wonder of being alive.

OTHER OCEAN CREATURES

In response to this chapter, I expect to receive a battery of soaking wet letters from infuriated marine biologists, since each species deserves its own chapter, but my editor cut me off.

FLAMBOYANT CUTTLEFISH

The flamboyant cuttlefish is not to be confused with the flamboyant cuddlefish, which does not exist. The cuttlefish, *Metasepia pfefferi*, looks like an orchid that ran away from its stem to become a fish. Everyone has dreams.

Found in the shallow sands of tropical waters of Australia and Southeast Asia, male flamboyant cuttlefish live up to their name by putting on an ostentatious show to attract the ladies by changing the colors and psychedelic patterns on their skin. It's OK to show off when you are one of the most poisonous animals in the sea. The good news is, as long as flamboyant cuttlefish isn't on the menu, you'll be just fine. These marine mollusks are poisonous, not venomous, so you would have to ingest them to die. There are many places where cuttlefish is on the menu, just make sure it's not the *flamboyant* one.

STRIPED PYJAMA SQUID

We need to work on the names of deadly marine life. For instance, this guy is named like he's ready for a sleepover but is a serial killer. Additionally, the striped pyjama squid is not even a true squid. The nomenclature is absurd.

While the name may be incongruous, the choice of clothing is slightly more appropriate, as this mollusk is dressed in black-and-white stripes, like a 1920s chain-gang escapee. This striped cephalopod is having his *O Brother, Where Art Thou?* moment, except this convict has no problem getting caught. Like many cephalopods, the pyjama squid can camouflage by changing color, but if he doesn't feel like changing colors, he'll just hit you with his venom. The striped pyjama squid is both poisonous (so don't eat it) and venomous, secreting a toxic slime that can paralyze humans. I suppose I should mention that the striped pyjama squid is found in Australia, but it feels redundant. I will abstain from describing the bizarre way these Indo-Pacific cephalopods breed. This is not one of your BookTok romance novels, this is lifesaving literature.

BLUE-RINGED OCTOPUS

After surviving a lethal pandemic, a Virginian woman took a relaxing trip to Bali. She posted a video to social media of her and her friends passing around a tiny octopus with blue-ringed spots, and the video quickly went viral as the internet collectively shouted, "Put it down!"

She was holding a blue-ringed octopus, and she was lucky it was having a good day. As adults, these potent portables never get much bigger than a kiwi fruit, but they have enough toxin to kill twenty-six humans in a matter of minutes.

Their painless bite delivers tetrodotoxin, similar to the poison in pufferfish meat, causing paralysis of important muscles like the diaphragm. There is often no sign you've been bitten until it is too late. But thanks to this book, your next Bali vacation is less likely to be ruined by this blue-ringed baby.

BARRACUDA

Ooh, barracuda,
Heart's infamous carnivore,
Little Queen of seas.

It felt like the right moment for a haiku. No fish inspires music and death poetry like the barracuda. This sawtooth predator is often cast as a maleficent villain, and that is because it is. The great barracuda grows to six feet, but the smaller species can be just as deadly, living in groups called batteries. The slender fish have torpedo-like speed, going from zero to over thirty miles per hour in seconds, attacking their prey in a self-explanatory method known as ram-biting.

Barracuda prefer clear, warm coastal waters, hunting near reefs and seagrass. This big kahuna is present in Hawaii as well as the Eastern Seaboard, frequenting the coasts from North Carolina to Florida. Attacks by barracuda are rare but have been documented, including attacks in Key West and North Carolina. While they don't attack humans often, it's best not to test a barracuda.

And if the barracuda's bite wasn't vicious enough, this vindictive fish will come back to haunt you even after death. If you manage to catch and eat a barracuda, they can carry a type of fish poisoning known as ciguatera, which is a whole 'nother chapter.

These saltwater fish are not to be confused with South American freshwater piranhas, which have also killed humans. Piranhas are carnivorous fish, native to the Amazon, which hunt in schools participating in feeding frenzies. They are attracted to splashing water and blood. Actually, go ahead and confuse the two types of fish—they have similar

styles, just different salinity. To avoid an attack, stay away from these fish with sharp teeth, and exit the water when bleeding.

CONE SNAIL

Sally sells seashells by the seashore, but purchase with caution because one of those shells could kill you. Turns out Sally is a bit of a sociopath. This particular shell may be Mother Nature's retaliation for humans absconding with millions of shells from her sandy shores to decorate ocean-themed bathrooms.

It's not actually the shell that's lethal but what's inside: the cone snail. Found in tropical waters of the Indo-Pacific, nothing about this snail is slow. In fact, this carnivorous snail shoots a lightning-fast harpoon full of a toxic cocktail that paralyzes victims instantly. The harpoon is generally meant for fish, since the five-inch snail has yet to eat a human, but the snail slightly overshot the potency of its toxic cocktail, so if a human is harpooned, it can cause total body paralysis, including paralysis of the muscles needed to breathe, resulting in death. With immediate medical care, breathing can be supported with a ventilator and the toxin effects reverse in several days.

The shells of the cone snail tend to be intricately patterned and beautiful, so you'll want to pick them up, but don't do it. It's a trap. If diving or swimming in the tropical waters of the cone snail, you should know what they look like and avoid them. It is also recommended to wear shoes at the beach, so everyone knows you're a tourist but also to avoid stepping on a cone snail. Lastly, there is an old adage that if you hold a seashell to your ear, you can hear the ocean, but you can also get a deadly cone snail harpoon in your ear, so leave the shells on the sand and keep swimming.

ELECTRIC EEL

The electric eel is catfishing you, because this Amazonian river knifefish is not even a real eel. But it is electric. This freshwater fish is so hot it managed to boogie-woogie its way into a chapter for ocean creatures.

These eels can grow up to eight feet long and emit a constant ten volts but can quickly power up skin cells called electrocytes. Electric eels can generate up to eight hundred volts of electricity, meaning they have the same shocking electrical potential as a car battery. Currents above five

hundred volts are considered high voltage, meaning they can cause deep burns and cardiac arrhythmias.

A standard household power outlet is 120 volts, and while I was Googling this simple fact for comparison, I became concerned by the number of Reddit threads dedicated to questioning the safety of sticking cutlery into power outlets. The answer is “no,” it is not safe to stick a fork in a power outlet.

There are documented human deaths by electric eels, usually due to drowning or cardiac arrest after multiple shocks. The probability of encountering an Amazonian electric eel for many is slim to none, but most people have unfettered access to power outlets and forks, so maybe I should do a chapter on that?

NUDIBRANCH

Nudibranchs are tiny colorful sea slugs. They are extremely festive, decked out in elaborate neon-colored ruffles, tassels, and fringe. In the wild, if an animal is easy to see, it is usually because it has no need to hide. These kids are the wilderness equivalent of RuPaul’s pride parade float: there to be seen, but the background music is blaring loud and clear, “Can’t Touch This.”

Nudibranchs steal jellyfish toxin, ingesting it and adding it to their arsenal. They take the jellyfish stinging cells, swallow them, then excrete them onto their backs. Some nudibranchs make their own toxins, but when you are this good-looking, someone will let you copy their work. Ask any high school student.

The high school quarterback of nudibranchs is *Glaucus atlanticus*, but all his friends call him the blue dragon. He copies the homework of one of the deadliest creatures in the sea, swiping stinging cells from our next guest, the Portuguese man-of-war.

PORTUGUESE MAN-OF-WAR

The Portuguese man-of-war is often confused with a jellyfish. Not only is the Portuguese man-of-war not a jellyfish, but it is a they. The man-of-war is a siphonophorae, which is a complex of multiple organisms living together as one being. Colonies of genetically identical clones called zooids join together to create one living organism, like a homicidal flash mob.

The P. war looks like a floating kidney with tentacles, colored in translucent purple and blue; well, actually, “It’s not just blue, it’s not

turquoise, it's not lapis, it's actually cerulean." And for macabre style points, the man-of-war fills up its cerulean floaty with carbon monoxide, because why use air when you could use a poisonous gas?

They float on the surface of the sea buoyed by gas-filled bladders called pneumatophores that resemble eighteenth-century warships, which is how they got their name. These warships are reliant on atmospheric pressures to sail. Ocean currents create *armadas* of thousands of man-of-war pneumatophores, drifting together on the sea surface, with deadly tentacles swaying up to 165 feet below.

If a human touches a tentacle, which is not uncommon on the US Eastern Seaboard, the sting will cause pain, swelling, and rope-like hives. Symptoms can progressively worsen, with the venom causing the collapse of the cardiovascular system and death.

If stung, remove the tentacles with tweezers or a gloved hand. The next steps have some conflicting studies, but a 2017 study by the University of Hawaii showed vinegar stopped further discharge of the man-of-war stingers and recommended soaking the affected area in hot water. Alternatively, the US Department of Defense paid Alatalab to develop StingNoMore spray that works for man-of-war envenomation but then didn't tell anyone about it, so now you know.

POISON

Cyanide

Carbon Monoxide

Mold & Yeast

Poisonous Plants

Water

Health Influencers

CYANIDE

The Peoples Temple, founded in Indiana in the 1950s by Jim Jones, was a cult that masqueraded as a Christian socialist organization with a mission “to create an egalitarian society free of racial and social problems, and to help the poor and needy.” The cult gained traction and financial support through the next twenty years but also garnered enough suspicion, due to human rights violations, that it was forced to move its main operation abroad.

In 1974, the Peoples Temple Agricultural Project, also known as Jonestown, was founded on infertile land in rural Guyana. Indoctrinated American men, women, and children moved to communal shacks on the property where they worked six days a week and were given minimal food. As Jim Jones’s health failed and the cult came under increasing scrutiny for inhumane practices, Jones called for a “revolutionary suicide,” where more than nine hundred cult members, including two hundred children, drank Kool-Aid (actually FlavorAid) laced with cyanide in the largest mass murder-suicide in history. Jones then reportedly shot himself. This horrific event popularized the phrase “drinking the Kool-Aid,” which originally appeared in the unrelated New Journalism work *The Electric Kool-Aid Acid Test*.

Cyanide is a drug that has been an accomplice to many abhorrent acts. In 1982, a serial killer laced Tylenol tablets with cyanide, resulting in the deaths of seven people. A man was later convicted of extortion after sending Johnson & Johnson a letter demanding a million dollars to stop the murders, but no one was ever convicted of the poisonings.

Cyanide is a chemical that has also been used in war and crimes against humanity throughout history. The cruel Roman emperor Nero used naturally occurring cyanide in cherry pits to poison his enemies. The troops of Napoleon III topped their bayonets with cyanide poison. Cyanide gas, known as Zyklon B, was used in gas chambers by the Nazis to murder Jewish men, women, and children during World War II. In the 1980s, Saddam Hussein used poisonous gas, likely including cyanide, against his own people to silence more than thirty thousand Iraqi citizens. This includes the 1988 Halabja Massacre, where poisonous gas was used on an entire town, killing five thousand people and leaving ten thousand injured.

During World War II, British and American espionage organizations developed instantly lethal cyanide suicide pills, or L-pills, used to avoid capture and painful torture. These pills were often in the possession of agents going undercover behind enemy lines. Cyanide pills continue to be used worldwide to evade enemy apprehension. For instance, a previously secret CIA report approved for public release in 2018 detailed the use of cyanide pills by Argentinian terrorist groups. The Argentinian government deployed a special emergency medical detachment to arrive and promptly pump the stomachs of these individuals, which had some success in reviving terrorists for interrogation. The lethality of cyanide is clear in its exploitation, with only 250 mg causing death in under thirty minutes.

Cyanide was initially isolated in 1786 by Swedish chemist Carl Wilhelm Scheele from Prussian blue dye, which is used to make blueprints. It was later shown that cyanide is a naturally occurring compound in bacteria, fungi, algae, plants, almonds (especially raw bitter almonds), and many fruit seeds, such as peaches, cherries, and apples. More precisely, fruit seeds contain amygdalin, which is converted to cyanide after ingestion, so do not let your pets eat peach pits. There are many commercial uses for cyanide including photography, pesticides, plastic and rubber manufacturing, and as a jewelry cleaner for gold.

Despite the variety of exposures and nefarious applications of this compound, the most common cause of cyanide poisoning is fires. This is how cyanide poisoning generally presents to the emergency department, most often after house fires where plastics are burned. There are also medications used in the hospital that can cause cyanide poisoning. Sodium nitroprusside, a medication used to treat hypertensive emergencies and rapidly lower blood pressure to prevent stroke and heart attack, is composed of five cyanide groups. For this reason, the dose and duration of sodium nitroprusside is limited.

Cyanide is a simple molecule made of a carbon atom triple bonded to a nitrogen atom. It can be a gas or liquid when attached to hydrogen, or a solid when attached to potassium. Some cyanide compounds, usually in liquid form, can be absorbed through the skin.

When cyanide enters the body, it makes its way inside cells. Once inside cells it vigorously binds to an enzyme needed for our cells to use oxygen, creating a functional lack of oxygen. Although there is plenty of oxygen available in the blood, the body cannot use it due to the cyanide blockade.

This is why a patient poisoned with cyanide will be gasping for breath while the blood oxygen machine reads normal at 92–100 percent, and the patient appears flushed red instead of blue. Initial symptoms include headache, confusion, vomiting, high heart rate, flushed red skin, but quickly progresses to cellular asphyxiation, organ failure, and death. Additionally, chronic low-level cyanide poisoning, seen with cigarette smoking, has been linked to multiple neurological disorders.

There is no rapid blood test for cyanide, so doctors must diagnose the disease based on the patient's story and surrogate testing. Because the patient's cells cannot use oxygen, they switch to a system that produces energy without oxygen, known as anaerobic respiration. This is similar to what happens in muscle cells during exercise, when oxygen in the blood becomes scarcer. Just like during exercising, anaerobic respiration builds up lactic acid. Lactic acid is one of the tests that doctors can quickly check when concerned for cyanide poisoning. Even when in doubt, with a clinical suspicion, the antidote is given.

Treatment includes rapid decontamination and stabilization of the patient. For those patients poisoned with ingested cyanide, this seldom means stomach pumping because it is unlikely that the pills are still in the stomach, especially if symptoms are already present. The antidote is simple: hydroxocobalamin, a precursor of vitamin B₁₂. Yes, the same B₁₂ that is injected into preperformance butt cheeks of pop stars everywhere, only much more of it. Hydroxocobalamin binds and inactivates cyanide to be excreted safely in the urine.

Cyanide can cause death within minutes of exposure, so even with rapid treatment, outcomes are bleak. But there may be opportunities to save lives after exposure, and we will never know unless we try. Many historical cyanide exposures are deplorable, inhumane events, unavoidable by victims, but patients have survived with treatment. If you do have a possible cyanide exposure, such as a house fire, always go to the emergency department ... and keep your dog away from peach pits.

If you do have a possible cyanide exposure, such as a house fire, always go to the emergency department ... and keep your dog away from peach pits.

[CARBON MONOXIDE](#)

What is tasteless, odorless, colorless, and can kill you in minutes? Carbon monoxide. Get your canaries out, kids, it's time to find out why this gas is deadly and how to prevent it.

Before we knew what carbon monoxide was, we understood that it was deadly. Canaries were used in coal mines to detect carbon monoxide before lowering miners down into otherwise unsafe working conditions. Since the birds were smaller, they would die first, alerting the miners it was time to get out.

Animals are often involved in identifying this silent killer. Since carbon monoxide is in the air, it affects everyone exposed, so when a family comes into the ED with symptoms of headache and dizziness and the family pet mysteriously died yesterday, carbon monoxide is the leading suspect.

Carbon monoxide is a gas that is inhaled, passes through the lung tissue to the blood, and binds to red blood cells, kicking out oxygen, and then doesn't let go. Red blood cells do all the work of bringing the necessary oxygen to vital organs, whereas carbon monoxide brings nothing to the table, and more importantly will not let oxygen do its job. Do you remember doing group projects in high school? There was always that one kid who showed up, did nothing, and distracted everyone else, preventing the group from getting work done. He was carbon monoxide.

Carbon monoxide (CO) kills by concentration. Like all poisons, there is a lethal dose, which is why the gas is most dangerous when trapped indoors. The solution to pollution is dilution, or just not polluting in the first place.

CO is released by fire or combustion, so anything that burns fuel creates the deadly gas. This includes cars, stoves, fireplaces, and furnaces. Machines created for indoor use have CO vents or filters. It is important to never use any fuel-burning machine indoors that was created for outdoor use, and to never burn fires inside unless properly vented, such as in a working fireplace.

House fires also release carbon monoxide. There is a misconception that carbon monoxide collects near the ground during a fire. CO actually mixes freely with the room air, given its similar molecular weight. Even if you escape a fire feeling fine, it is prudent to go to an emergency department to have blood levels of carbon monoxide checked.

When checking blood CO levels, smokers will have unnaturally high levels of carbon monoxide in their blood due to the tiny cigarette fires they

hold. While this CO level won't kill, it is never good to reduce the amount of oxygen blood can carry.

In the 1990s, many countries began to require that cars have catalytic converters to decrease carbon monoxide emissions, with hopes of reducing the probability of poisoning from car exhaust in enclosed spaces, such as garages. Following the implementation of catalytic converters, there was also a reduction in car exhaust-based suicides.

The first symptoms of carbon monoxide poisoning are headache, dizziness, nausea, and vomiting. Like many things that can kill you, it presents like the flu. Comforting, I know. The biggest difference is the progression of symptoms. All organs require oxygen to function, and the brain and heart are especially sensitive to decreased oxygen. Decreased oxygen to the brain can cause a stroke; decreased oxygen to the heart can cause a heart attack. Carbon monoxide can cause all these problems and more. If left untreated, carbon monoxide poisoning leads to confusion, loss of coordination, brain damage, and death.

In June 2023, a couple vacationing at a luxury American hotel chain in Mexico felt flu-like symptoms and believed they had food poisoning. They went to a local hospital and received fluids, feeling much improved. The next morning, they were found dead in their room. This was reported to be due to CO poisoning. Leaving the toxic air of the hotel room likely made them feel better, but when they returned to the high concentrations of CO, they continued to worsen. This heartbreaking story is unfortunately not unique but rather ubiquitous, with similar stories all over the world. A study of US hotels showed more than nine hundred poisonings with twenty-two deaths in just over a decade.

Only fourteen US states require hotels to have CO detectors, and this does not apply to home rentals. Even daycares aren't federally required to have them, leading to the 2022 poisoning of twenty-four children at Happy Smile Learning Center in Pennsylvania. Twenty-eight states now require CO detectors in homes, but many of these laws only apply to newly built homes, which is why more than half of US homes do not have CO detectors, meaning you probably don't have one. Smoke detectors, present in more than 90 percent of US homes, often do not include CO detectors. It seems ridiculous to have only a fire alarm in a structure, since most people can eventually figure out the building is on fire, but there is no other way to detect CO.

More than half of US homes do not have CO detectors, meaning you probably don't have one.

Luckily, it is easy to test patients for carbon monoxide poisoning using a simple blood test or a co-oximeter, which is a painless light that goes on the finger.

Carbon monoxide poisoning is treated with high-flow oxygen and hyperbaric oxygen, when indicated. A hyperbaric oxygen chamber, also known as a dive chamber, is an airtight room that increases the pressure of oxygen, so it can kick out the carbon monoxide that is bound to a patient's red blood cells. It's the moment when pressure builds and everyone gets so frustrated with the high school group project guy that he gets kicked out of the group.

The best advice for avoiding carbon monoxide poisoning is to get a carbon monoxide detector. It's like twenty bucks. When you are done reading, you can sell this book and get one. The detector is portable and can easily go on vacation with you. Plug it in and go back to your group project.

MOLD & YEAST

Fungi is the overarching kingdom that contains mold, yeast, and mushrooms. This kingdom is differentiated from plants, because fungi reproduce through spores and cannot perform photosynthesis, often decomposing organic matter to make fuel. Both processes are gross and tedious, but a necessary foundation for this chapter.

Mold is a type of fungus that grows in multicellular filaments called hyphae. It is a fuzzy, slimy organism, thriving in humid environments. It comes in puke green, pimple-head white, and black-eye blue. Mold has gotten a lot of hyphae-hype in the past ten years, some of which is not backed by science. Still, it is unwanted, unless it is *Penicillium roqueforti* mold in gorgonzola or blue cheese, then it's valued like an elementary school first-prize science experiment.

Before we start there is a caveat to mold. If a patient has asthma or an allergy to mold, it can cause illness, usually congestion, cough, and eye redness. In those with asthma, mold can cause asthma exacerbations, and a mold allergy can kill you through anaphylaxis, but this is not a slow process, often less than fifteen minutes, so you'll know quickly. Given only around two hundred people die a year from anaphylaxis in the US and mold

doesn't even make the list of associated allergens, this fungus is far less lethal than one would think.

The most infamous mold is black mold, *Stachybotrys*, most commonly *Stachybotrys chartarum*, a mold that can produce toxins. In 1938, in Russia, an overgrowth of this bacteria on hay eaten en masse by livestock was associated with necrosis of the gut and death in animals. Important lesson: Do not eat hay covered in mold.

Years later in Cleveland, Ohio, there were eight cases of infants with life-threatening bleeding into the lungs, known as pulmonary hemorrhage, over five years, which was above the baseline disease rate expected for that period by five cases. This caused the Centers for Disease Control (CDC) to investigate, and the homes of the children were found to have *Stachybotrys chartarum*, but, as of 2024, the CDC states that it was not the proven cause of the pulmonary hemorrhage, only an association. Other diseases can cause pulmonary hemorrhage, and mold is present in an estimated 47 percent of US homes, so this continues to be a correlation, not causation. The media had a field day with the horrific Ohio story, as they do, and this may have been where the public's obsession with black mold began. Other molds are far more deadly. Why don't they get any press?

With only a correlation between black mold and deadly illnesses, the science is still uncertain, so the CDC still recommends removing *Stachybotrys chartarum* from homes and workplaces. Note there are other species of molds that are black and known to be nontoxic. Mold grows due to damp areas, so if any type of mold is seen it should be cleaned up and the moisture problem should be fixed.

The CDC recommends wearing protective gear and cleaning the mold with one cup of household bleach in one gallon of water, then drying the area completely. Remember to never mix bleach with any other household cleaners, as you can accidentally make chloramine gas, which can kill you. The CDC does not recommend home mold inspection, because it is expensive with no set standards, and all molds should be removed regardless of its species.

There are molds that are much more deadly than black mold statistically, but are generally opportunistic pathogens, preying specifically on weak immune systems.

Aspergillus is an omnipresent mold, with spores found in soil, dust, food, and homes, that usually does not cause any issues. In those with

weakened immune systems, such as people with acquired immunodeficiency syndrome (AIDS) and organ transplant patients, the fungus can cause lung, brain, heart, or blood infections that can be deadly, and must be treated with antifungal medications. An *Aspergillus* lung infection is famous for creating a necrotic ball of fungus within the lung. For severe diseases such as *Aspergillus* heart infection, known as endocarditis, even with treatment, most will die, but these patients tend to have extreme life-threatening illnesses aside from the fungal infection. For those blessed with an active immune system, this mold is encountered often without consequence.

Mucor is another environmentally ubiquitous mold that manifests disease in the immunocompromised, including those with poorly controlled diabetes, since this mold thrives in sugar. While most encounter *Mucor* constantly without issue, these fungi can infect the airways of the aforementioned populations. The mold spores inhaled through the nose get stuck in the sinuses and cause the surrounding tissue to die and then the infection extends to the orbits and brain, creating a giant black ball of mold necrosis.

Histoplasmosis is a mold that changes to yeast when it enters the body. It is prevalent in the soil, especially containing bird or bat droppings, in the midwestern and central United States. Although healthy people can contract this infection, most people are exposed without incident. Severe lung infections and death are most often seen in those with AIDS.

The Environmental Protection Agency estimates that a hundred thousand species of mold exist, most of which are inconsequential to human health. Contemporary alternative healthcare gurus often exploit the prevalence of mold to correlate the fungi with chronic vague patient symptoms, such as chronic fatigue, pain, or concentration issues that are not backed by science. I get miffed over charlatans taking advantage of patients for personal gain, but I am never mad at patients for attempting to better their health. It is your life, so you get to choose what healthcare treatments you have. If it is not dangerous, I tend to tell my patients to do what they want—I'll give you the science, or lack thereof, and you make the decisions.

Related to mold is yeast, a single-celled fungi, known to cause a good time by converting sugars into alcohol and carbon dioxide, a process known as fermentation. Beer is brought to you by the yeast *Saccharomyces*

cerevisiae, *cervesia* being the Latin for beer. Yeast is not particularly deadly but can be a bothersome overgrowth.

Candida is the yeast present on skin that can cause infections and is a cause of diaper rash in babies. This yeast can cause extreme skin irritation and a white film-like overgrowth. The best way to prevent this is to keep skin clean and dry. Once an infection has taken hold it may need treatment, such as antifungal ointment or pills. *Candida* can show up in other places such as the mouth, causing thrush. This is seen in infants and those with weakened immune systems. It can cause pain, change in taste, and difficulty swallowing, so adults are treated with antifungal mouthwash or pills, while in infants it may be treated with medication or by increasing sanitation practices, such as boiling pacifiers and bottle nipples before use. *Candida* generally causes deadly disease only in those with a severely compromised immune system.

Another skin-based yeast, *Malassezia*, causes tinea versicolor. *Malassezia furfur* causes a transitory, treatable lightening of spots on the skin. It isn't considered contagious and can be treated with antifungals. This is not to be confused with vitiligo, a permanent genetic or autoimmune lightening of portions of the skin, as seen in the stunning fashion model Winnie Harlow as well as the late pop singer Michael Jackson.

Cryptococcus is another yeast that lives in soil, and most people have been exposed to it without consequence. While a few may develop a lung infection from breathing in the spores, this can be treated with antifungals. This yeast becomes life-threatening when it moves from the lungs to the brain, where it can cause deadly meningitis, most commonly seen in those with AIDS. This yeast, like most fungi, is an opportunistic infection that waits to kick a man when he is down.

These fungal organisms don't put up much of a fight against a well-functioning immune system, which is good because they are everywhere. If you see mold in your home, sterilize it and take special care for those with compromised immune systems, but for most of the population, these fungi are nonfatal.

POISONOUS PLANTS

There are more than three hundred thousand species of plants on Earth, and more than half are edible, but humans have focused on cultivating only a

few hundred in agriculture. Conversely, an estimated one-third of plants produce toxins as a means to avoid consumption and as natural pesticides, but not all toxic plants are poisonous to humans.

Plants have developed all types of skills to avoid being plucked. Carnivorous plants, such as the Southeast Asian pitcher plant, *Nepenthes attenboroughii*, can eat prey as large as a bird. But this real-life version of Audrey II isn't quite as terrifying—in its current form, it could not eat a human. The corpse flower, *Amorphophallus titanum*, found in the rainforests of Indonesia, is not particularly deadly, but the twelve-foot flower smells of death. Fortunately, it only blooms for a day every few years. Many other plants have evolved to avoid being eaten and thus have created a little lethal flower shop of horrors.

There are over a hundred thousand poison control calls about toxic plant ingestions in the US every year. Most calls are concerning people's kids who found a tasty flower, but most life-threatening exposures tend to be weekend-warrior mountaineers, believing they can identify all three hundred thousand species of plants, except the one that was just eaten, which was not a wild carrot—it was hemlock.

Get out your foraging gloves and floppy hat; it's time to learn ways to die from plants.

OLEANDER (*NERIUM OLEANDER*)

The 2002 drama *White Oleander* starred the deadly flower as the murder weapon of the free-spirited artist Ingrid, played by Michelle Pfeiffer, who poisons her cheating boyfriend. This pretty pink, red, or white flower is found in front yards across the southern United States from Florida to California, as well as in parts of Australia, India, and China. Luckily the leaves are bitter because just one leaf can be lethal to a child. This is not a great plant to have around kids or pets.

Ingestion of white oleander can cause nausea, vomiting, diarrhea, seizures, erratic heartbeat, and death. The lethal component of this plant is a cardiotoxic glycoside, a chemical that can be found in other plants as well, like foxglove. The glycoside changes the flow of electrolytes in and out of heart cells, increasing calcium, which increases contraction strength and the heartbeat rate. Unfortunately, glycosides also increase the amount of potassium in the blood, sometimes to lethal levels, causing life-threatening arrhythmias and eventually stopping the heart.

WATER HEMLOCK (*CICUTA DOUGLASII*)

The Athenian government charged Socrates with poisoning the minds of youths with his “think for yourself” Socratic method and with blasphemy against the Greek gods. Socrates was sentenced to death for his infractions, but as a thought leader he was not going to indulge someone else’s idea of the death penalty, so he did it himself, reportedly using hemlock. Socrates’s plan was well-researched, as water hemlock is one of the world’s deadliest plants. With petite white bouquets stemming from a central stock, water hemlock can be confused with wild parsnips. If you need another reason to avoid parsnips, there you go. The entire plant is poisonous, but just two centimeters of the root of this plant can be lethal to an adult, causing violent seizure and death from a neurotoxic cicutoxin.

NIGHTSHADE (*ATROPA BELLADONNA*)

The nightlock berries that Katniss and Peeta use to end the Hunger Games bear remarkable similarities to belladonna. The real nightshade is part of a big flower family related to tomatoes, potatoes, and eggplant, but unlike its edible distant cousins, this pretty lady is deadly with a lethal dose of only 600 mg. Five-petal purple flowers adorn a bushy plant with plump dark berries that, frankly, look delicious. Even if you do not plan on eating them, picking the berries is a bad idea, as the toxins can be absorbed through the skin. All parts of the plant are toxic, containing atropine, hyoscyamine, hyoscine, and scopolamine, which causes anticholinergic poisoning by blocking the body’s acetylcholine receptors, resulting in rapid irregular heartbeat, hyperthermia, hallucinations, vomiting, seizures, and death, similar to a diphenhydramine (Benadryl) overdose.

WOLFSBANE (*ACONITUM*)

This beautifully unique, often purple flower was originally named by the Greeks, possibly for its utility in tipping poisonous arrows to kill wolves, a practice that evolved in the Middle Ages into a belief that the flower could repel werewolves from the gardens of superstitious homes. You have seen wolfsbane before, since it is the flower on this book cover. Wolfsbane, also known as monkshood, is not to be trifled with, as the roots and leaves contain aconite, which can stop the heart and is so potent that honey made from wolfsbane nectar can be toxic.

There are many more poisonous plants, including angel's trumpets (*Brugmansia suaveolens*) and rosary peas (*Abrus precatorius*), with their poisonous seeds that look like friendly ladybugs. Know which plants are toxic and do not plant them in your yard if you have children or pets—and certainly do not bring them into your home.

HOUSEPLANTS

Just assume anything with *lily* in it is poisonous: calla lily, peace lily, lily of the valley. These are traditional funeral flowers in many cultures, which is oddly appropriate, and they do smell lovely. In case you were considering it, do not eat them. Lily of the valley contains cardiac glycosides while calla and peace lilies contain calcium oxalate crystals that cause pain and swelling of the mouth and throat with ingestion, blocking the airway. Other poisonous houseplants include tulips, irises, and rhododendrons—know what you are bringing home in your bouquet.

HOLIDAY HORROR HORTICULTURE

Poinsettias bring holiday cheer with their bright red leaves, and apparently no death toll in humans. Rumors leading to the flower's defamation may have been circulated in 1919 when a child of an army officer died after eating the plant, but there was no causal relationship established. In fact, in the more than twenty-two thousand cases of poinsettia ingestions examined in an *American Journal of Emergency Medicine* article, there were no deaths, and 96 percent of ingestions required no treatment. According to the Washington State College of Veterinary Medicine, poinsettias are also not very toxic to pets, causing only mild mouth irritation. Even so, there are plenty of other, less controversial, red flowers.

The rumors about the danger of poinsettias may have been started by another Christmas plant jockeying for a position as a seasonal ornament. Mistletoe is a parasitic poisonous plant, not regarded as deadly in human ingestions, but it can kill the trees it infects. Mistletoe is the Grinch of plants. The tenacious plant was associated with fertility in Celtic mythology because it was the sole plant that could thrive in the depths of winter, by stealing water and nutrients from trees. Similar folklore was present in several cultures until eventually the poisonous plant was associated with Christmastime kisses.

PESTICIDES

Most pesticides we consume are made by the plant itself, but in small amounts, and these are generally unharmed to humans. More dangerous than most plants are the chemicals we place on the plants we eat. Over the years the US government has wised up to the potential side effects of herbicides and pesticides on the environment and human health.

From the 1940s to 1960s, the “miracle pesticide” dichloro-diphenyl-trichloroethane (DDT) was used to control bugs, including mosquitoes and lice carrying malaria and typhus, protecting soldiers from these diseases during World War II. As highlighted in Rachel Carson’s *Silent Spring*, DDT had unforeseen consequences in nature. The canary in the coal mine was the bird population, specifically birds of prey, which saw a sharp population decline, with thinning eggshells causing reproductive failure. This may have been a driving force behind the sharp decline of the bald eagle in the US. Later it was found that DDT accumulates in humans and is linked to low sperm count, miscarriage, and cancers. The risks for some associated cancers have now been shown to persist for generations.

These toxic effects eventually resulted in the 1972 Environmental Protection Agency (EPA) ban on this pesticide’s use in the US, but DDT is still used internationally in certain countries for malaria control. Once the pesticide was banned in the States, things improved and our national bird bounced back, basically becoming the pigeon of northern Michigan.

A pesticide class that is still used in the US is organophosphates. Also used in manufacturing solvents, organophosphates irreversibly bind to an enzyme in the body that breaks down acetylcholine. This increases the amount of active acetylcholine, which augments its effects, making the body oversecrete pretty much anything that it can secrete causing SLUDGE: salivation, lacrimation (tearing), urination, defecation, gastrointestinal upset, and emesis (vomiting). Medicine loves its acronyms. Acetylcholine causes the lungs to secrete fluid as well, drowning victims of organophosphate poisoning from the inside.

In this type of poisoning, decontamination of victims is a key component of treatment, removing clothes and showering off the skin to avoid further poisoning, while taking care not to touch the victims. Organophosphate poisoning can occur by inhalation, ingestion, or contact with the skin. The last thing needed in such a crisis is five more victims—very unhelpful. This type of poisoning can kill swiftly, but there is a

treatment for organophosphate poisoning, and it is found in another poisonous plant.

PLANTS THAT HEAL

The treatment for organophosphate poisoning is atropine, lots of it. One patient with organophosphate poisoning can empty an entire hospital store of atropine during their treatment. The medication is given continuously until lung secretions, and thus breathing, improve.

Atropine was originally discovered and synthesized from *Atropa belladonna*, or nightshade. Before exterminating plants containing poisons, they should be checked for utility, because in the right dose the same plant might save a life.

Foxglove (*Digitalis purpurea*) is poisonous due to containing cardiac glycoside toxins, but it is also the basis of a drug used for arrhythmias and heart failure. Sir William Withering, a 1700s English scientist, reported that the digitalis plant treated “dropsy,” the swelling often associated with congestive heart failure. The plant was later used to create the drug Digoxin, which is still used today.

The white willow (*Salix alba*) was the first source of aspirin, a medication used to save lives during heart attacks and for pain control. White willow bark was used for centuries by Egyptians and Greeks because it contained salicin, which was isolated by Johann Andreas Buchner in 1828 and later used to create aspirin.

Poppies are the source of opiate pain relievers, and anyone with a femur fracture, amputation, or open-heart surgery will attest to their necessity in some circumstances. And the Pacific yew (*Taxus brevifolia*) is the basis of the chemotherapy paclitaxel, which treats breast and ovarian cancer.

The world’s three hundred thousand species of plants likely hold cures for everything from diabetes to Alzheimer’s, but we may not have time to discover them. More than five hundred plant species have gone extinct in the wild since the 1750s, and as many as three plant species disappear every year.

The problem with plants is not that they are deadly but that they are dying. This loss of biodiversity due to climate change, pollution, nonnative species infestations, and loss of habitat may be the greatest threat to human life.

WATER

I hate to do this since drinking water seems to be the only safe space at this point, but it is not. In fact, water is so lethal that it made it into two separate *99 Ways to Die* sections, Poison and The Elements.

A human is mostly water, around 60 percent. Similarly, the Earth is mostly high-quality H₂O, with 71 percent of its surface being covered by water, 97 percent of which is oceans. Water is essential to life. Early human civilizations congregated around the longest rivers in the world, tied to their water sources. As civilization evolved, technologies such as aqueducts allowed previously tethered societies to explore and expand, but only by taking water with them. How could something so vital to life cause death? As the Greek-sounding Swiss physician Paracelsus once said, “All things are poisons and there is nothing that is harmless, the dose alone decides that something is not poison.” The dose makes the poison.

Water is clearly a requirement for human life. The National Academy of Medicine recommends that adults drink nine to thirteen eight-ounce cups of water daily, depending on body size and gender. It is never recommended to give a child under the age of six months water,^{*} for the same reason an adult should not drink water too rapidly or in excess: hyponatremia. Hyponatremia is a low concentration of sodium in the bloodstream, and it can be deadly. Hyponatremia has several different varieties—for instance, it can occur chronically or rapidly, due to medication or kidney dysfunction—but this section focuses on acute low sodium due to excessive water intake.

It is never recommended to give a child under the age of six months water, for the same reason an adult should not drink water too rapidly or in excess: hyponatremia.

Hyponatremia occurs when a person drinks more water than their kidneys can excrete. Adult kidneys can excrete about twenty liters of water daily but cannot exceed one liter of water per hour. Rapid or excessive drinking of water will cause a decrease in the concentration of salt in the blood, most importantly sodium. Fluid concentration can be a tricky concept. Think of it this way: You and nine friends are floating in the pool when the pool is drained of half of its water; you all move closer together in less water and become more concentrated. The pool is then filled completely with water, and you all spread, decreasing your concentration.

Fun, right? Until someone gets hurt. When the concentration of sodium in the blood decreases rapidly, it can be dangerous.

According to the biography *Bruce Lee: A Life*, the influential martial artist and actor was in Hong Kong in the summer of 1972, where he visited the home of his alleged mistress. He had acted out scenes from an upcoming film when he developed a headache after drinking water and was given a sleeping pill to rest. Two hours later the actor was found unconscious. A doctor was called, performed CPR, and then pronounced Bruce Lee dead. The autopsy showed brain swelling. It was ruled that this swelling was due to an allergic reaction, but this is not a common response to an allergy. Medical experts have hypothesized that the true cause of death was hyponatremia.

Hyponatremia is alarmingly common; in 2023, actress Brooke Shields had a seizure due to low sodium after drinking too much water. A study in the *New England Journal of Medicine* found that 13 percent of Boston Marathon runners had hyponatremia post-race. Hyponatremia has also been seen in rave attendees, military personnel undergoing high-stress physical pursuits, and other endurance athletes. When we lose even a small percentage of our body's water, we feel thirsty and naturally drink water. However, endurance athletes and rave dancers are at risk for hyponatremia not only due to rapid water intake but also the loss of sodium through sweating and urine. While not all hyponatremia is life-threatening, large changes in the body's sodium over a short period can be a big problem.

When the concentration of sodium decreases in the blood due to rapid water consumption and the sodium quickly drops to less than 130 mEq/liter, symptoms of headache, vomiting, confusion, and tremors can be seen. This is because the rapid change in sodium concentration has caused the brain to begin swelling. Symptoms can then progress to seizures, coma, and respiratory arrest, often once the sodium level is less than 120 mEq/liter.

In the emergency department, these patients must be rapidly given a high concentration of sodium to stop brain swelling or they will die. Unfortunately, rapidly replacing the body's sodium also comes with a substantial risk: osmotic demyelination syndrome. This syndrome strips the nerve cells of the brain of their protective coating, causing permanent brain damage, and locked-in syndrome, irreversible brainstem damage that causes the patient to lose control of all voluntary muscles, except the eyes. Osmotic demyelination syndrome is much more of a risk when correcting

the low sodium levels in patients with long-term hyponatremia, with months to years of low sodium due to medications, kidney problems, heart disease, or other disorders.

The great news is that there is a simple way to prevent all of this: electrolytes. When drinking large volumes of water or performing strenuous exercise, drink water balanced with electrolytes to help prevent drops in blood sodium, give your kidneys a rest, and help you rehydrate more efficiently.* That's it. That's all you have to do. It's a bit anticlimactic.

It is often surprising that too much water can kill you, but everyone knows a lack of water is deadly. A human can only survive a few days without water, a length of time that can be shortened based on age, hydration, and weather. Dehydration will eventually cause low blood volumes, shock, and organ failure. This is why freshwater scarcity is an immediate problem.

Some experts have stated that the world will run out of drinking water as early as 2040 unless major strides are made toward sustainability. The Pew Research Center reviewed fourteen years of satellite data on Earth's fresh water collected by NASA's Gravity Recovery and Climate Experiment, and it's not great news. The world is getting hotter, and climate is becoming more severe, resulting in critical water insecurity. For instance, over half of the world's groundwater is past its sustainability point, meaning the water is withdrawn before it can replenish. The fresh water we do have is often contaminated; already two billion people do not have safe drinking water in their homes, and over half of the world's population resides in water-stressed areas.

Available fresh water is often polluted. Aside from the run-of-the-mill toxins that make water undrinkable, it turns out humanity dumping six billion tons of plastic in the ocean and landfills over the past hundred years has created a problem: microplastics.

Without mentioning the ten-thousand-plus chemicals present in plastic, microplastics are microscopic pieces of plastic floating around in much of our fresh water. It is present in virtually all water bottled in plastic. Turns out the ladies had the right idea when they made a run on the stainless steel Stanley Quencher water bottles. If you know, you know. If you don't know, ask your wife or girlfriend. Microplastics are so small that when ingested they are absorbed into the body, making their way into the bloodstream, to the lungs, heart, and even breast milk.

A 2024 *New England Journal of Medicine* article with a fancy scientific name^{*} showed that microplastics were present in the plaques that caused blood vessel blockages leading to heart attacks. And the patients who had these microplastics present were more likely to die. Microplastics can be filtered out of water, but they require a microfilter to do so.

I bet those environmentalists' emphatically stickered metal water bottles are looking sexy right now, and water is looking more dangerous. I am a medical doctor, so I'm not the right kind of doctor to fix the water crisis, but I would recommend putting the brakes on commercial pollution, given that most of the world's pollution comes from less than a hundred companies.

In conclusion, everyone should drink more or less water, do so sustainably, and add electrolytes, but filter out microplastics.

HEALTH INFLUENCERS

The rapid rise of pseudoscience in the United States is largely due to three forces: the Dunning-Kruger effect, confusion between correlation vs. causation, and unqualified, often uneducated health influencers.

The Dunning-Kruger effect is the phenomenon of having just enough information to be dangerous. It's like knowing only where the gas pedal is, but not the brake. When learning something new, there is a point where the information starts to feel comfortable, and that is where most people stop learning. This is dangerous because it creates dogmatic beliefs based on foundational knowledge without understanding complexities and alternatives. If a belief has never failed, it may be because it has not been tested, and the testing of beliefs is essential to finding truth.

The Dunning-Kruger effect coupled with public confusion between causation and correlation has led to a maelstrom of *la connerie*, excuse my French, which ends with a celebrity convincing followers to place a jade egg in the vagina to strengthen the pelvic floor and balance hormones. But the egg only causes infections and unfortunate hunts, which brings us to the important difference between causation and correlation.

Correlation is an emotional manipulation tactic used in marketing. Causation is science: Causation is the science-backed result of "if X, then Y." It is "science-backed" in medicine because someone completed a randomized, double-blind, placebo-controlled trial^{*} with a sufficient number of people in a controlled environment to find a statistically significant trend.

If you flip a coin one million times, it will be tails close to 50 percent of the time. But you can't flip a coin twice and call it a day.

Correlation versus causation often gets the public in trouble. Any sentence that starts with

“When I had...”

“My neighbor told me that...”

“When Madison's cousin's brother...”

is about to state a correlation. For the cool kids who know Latin, this is a *post hoc, ergo propter hoc* fallacy.

What are things that correlate? New York violent crimes and ice cream sales. The age of Miss America and the number of murders using steam. Pool drownings and the number of films starring Nicolas Cage. While the desire to blame ice cream, vicenarian Misses America, and Mr. Cage for countless deaths is strong, I urge you to reflect, question the belief, and seek out more information. Lastly, 100 percent of people who mistake correlation for causation die, so understanding the difference could save lives, or not.

Here is another example of a correlation: Jimmy ate breakfast and then choked on his food. Therefore, breakfast is dangerous. Why not lunch? Or dinner? Because Jimmy choked at breakfast, and when something emotionally traumatic happens, it forms a strong evolutionarily driven association, especially for Jimmy's mom. Emotional memory is a strong associator. It's the reason you can't drink tequila anymore.

While standing on her virtual soapbox preaching the dangers of breakfast to her online followers, Jimmy's mom has inadvertently caused several children in her community to go hungry at school, have low blood sugar, and underperform on all-important standardized testing. She is hurting her community and there is nothing wrong with breakfast, but she is convinced that breakfast causes choking and will kill children, igniting her passionate vendetta against morning meals.

At the end of the day, or the beginning, in Jimmy's case, there is a correlation between breakfast and choking—the cause of choking is under-chewed food and there is food at breakfast. But *the most important meal of the day* is not the culprit.

The element that most strongly seduces a person into their firmly held beliefs of a correlation is recurrence. When Jimmy's mom met Chad, a

father whose child also choked at breakfast, you better believe they lit the cereal aisle on fire.

One group of people who often suffer from the Dunning-Kruger effect and love to employ correlations are influencers, especially health influencers. And when trying to go viral, lies have been proven to be far more seductive than the truth, which is often boring. A Massachusetts Institute of Technology study found that false stories are 70 percent more likely to be shared than true stories, resulting in the truth taking six times as long to reach fifteen hundred people.

More views, clicks, and likes are the ultimate goals, and the internet is chock-full of people trying to sell you something, including themselves. This is the most addictive marketing ploy to date, with the average American internet user spending 2.3 full days on social media each month.

While some social media information is relatively harmless, medical misinformation has proven deadly. Find a trusted medical advisor—for many this may be a primary care doctor. Use trusted advisors to make important health decisions and during medical emergencies. When looking for health information, limit yourself to reputable, established sources, and understand credentials and their limitations.

While some social media information is relatively harmless, medical misinformation has proven deadly.

The next time a health influencer pops up on your social media feed touting the dangers of breakfast with special guest Jimmy's mom, know that whatever they're selling is probably not science-backed. For now, just chew your food and avoid social media health advice.

FOOD

Dysentery & Food Poisoning

Anaphylaxis

Pufferfish Tetrodotoxin

Fish Poisonings

Mushrooms

DYSENTERY & FOOD POISONING

During the late 1900s, elementary students across the United States would file into computer labs to be met by rows of beige boxes with black screens alight with neon-pixelated fonts. The hottest ticket in town was a computer game that simulated the Manifest Destiny plight of settlers in the early 1900s as they moved west, a computer game called *The Oregon Trail*. The game was full of pitfalls. If it wasn't an ox wandering off or a wagon axle breaking, someone would inevitably get typhoid or cholera or die of dysentery. The elementary school players had no idea what any of this meant; they were just trying to get to Oregon before the bell rang.

Dysentery is a specific type of invasive diarrheal infection often transmitted through food and water, but other, similarly transmitted diarrheal infections can be just as deadly.

Cholera, caused by the bacterium *Vibrio cholerae*, spreads primarily through contaminated food and water, and is still prevalent worldwide, especially in areas without the privilege of sanitary drinking water. Cholera also occurs in brackish waters, where fresh and salt water meet, and can be contracted via raw seafood.

This bacterium, responsible for several pandemics, attacks the lining of the small intestine, causing massive fluid secretion and stools that look like rice water. Cholera incited one of the first major public health interventions using epidemiology, the study of the patterns and distribution of disease in a population.

In 1854, John Snow (the public health guru, not the King in the North) discovered that the use of the London water pump on Broad Street was a common denominator in a cluster of cholera cases, so he shut off the pump and ended the outbreak, stymieing the death toll at 124 people. This was impressive because at the time we did not understand what caused cholera, or its association with dirty drinking water. The prevailing theory of the time was that vapors from foul odors caused the disease, which is a great example of correlation, not causation. The smell of poo wafting from the river was a warning not to drink the water, but it wasn't making anyone sick.

According to the Centers for Disease Control, as many as 4 million people contract cholera worldwide annually, with up to 143,000 deaths. Many people who are infected with the bacteria will not have symptoms,

but one in ten will have severe symptoms, with possible mortality. Cholera treatment requires rehydration and antibiotics, which, in this specific case, may only require one dose. Other causes of food- and waterborne illness are not as easy to fix.

In 1883, Mary Mallon was only a teenager when she left Ireland alone for the United States to start a new life. She moved to New York, living with her aunt and uncle until she was eventually hired by a wealthy banker as a domestic, serving as a cook at his Long Island home. It was later that hot-girl summer when eleven people at the home became sick with typhoid fever.

The wealthy family hired a sanitary engineer to track down the source of the outbreak, which was linked to the first described “healthy carrier” of typhoid, Mary. That year some three thousand New Yorkers were infected with typhoid, and at the time there was no treatment or vaccine. Some believed Mary was the cause of the entire outbreak, although only three deaths could be directly linked to her.

“Typhoid Mary” became an overnight household name, as she was splashed across the papers, and so the New York Department of Health forced Mary into two years of quarantine at Riverside Hospital on North Brother Island. She sued and was eventually released, under the stipulation that she would not work in any kitchens. She broke the terms of her release, assuming an alias and taking a job at Sloane Maternity in Manhattan, possibly the worst place for her to work. In three months, she infected around twenty-five people, killing two, so she was placed back in mandated quarantine on North Brother Island, where she remained for twenty-three years until her death.

It is unlikely that Mary understood the science behind the disease, and although the terms of her forced isolation were unique, her carrier status for typhoid was not. For instance, Tony Labella was a noncompliant New York food worker and asymptomatic carrier of typhoid who caused more documented deaths than Mary, but he was released from quarantine after only two weeks and spared the nickname Typhoid Tony, which is much catchier. It is now known that a chronic carrier state is established in up to 5 percent of those infected with typhoid.

Typhoid, which I have had the pleasure of experiencing, is caused by the bacterium *Salmonella typhi*, which is related to the type of *Salmonella* that causes food poisoning due to undercooked meat, poultry, dairy, and

eggs. Symptoms of typhoid include nausea, vomiting, diarrhea, high fever, rash, and intestinal bleeding and perforation.

Typhoid, also known as typhoid fever due to the associated high fevers, infected more than seventy-five thousand Union soldiers during the Civil War, some years killing more than half the soldiers it infected. Today, thanks to antibiotics that treat typhoid, mortality is less than 1 percent, although drug-resistant strains of the bacteria are developing. Typhoid fever is also preventable through an injectable vaccine with only pieces of the virus, which cannot cause typhoid, and a live attenuated vaccine in pill form.

Rotavirus is the leading cause of diarrheal death in children under five worldwide. Twenty-five million children are infected with the virus annually, leading to more than two million pediatric hospitalizations, mostly from dehydration and electrolyte abnormalities, due to vomiting and profuse watery diarrhea associated with the infection. In low- and middle-income countries, most children will have their first infection before a year of age, while in high-income countries the first infection is often after the age of two years old. There is no curative treatment for the virus, but there is prevention in the form of a vaccine, which is recommended by the American Academy of Pediatrics as part of routine infant immunizations. Although neither a previous rotavirus infection nor the vaccine confers complete immunity, children are far less likely to get severe illness once vaccinated.

The United States is fortunate to have the infrastructure to ensure most residents have access to clean water. Many low- and middle-income countries do not have this advantage, so citizens and travelers must be cautious. In many countries, it is only recommended to drink bottled water, even for small tasks such as brushing teeth. Typhoid, cholera, and rotavirus are certainly not the only illnesses contractible through contaminated food and water.

In the US most cases of diarrhea are viral caused by norovirus. Viral infections cannot be treated with antibiotics and will pass on their own. Travelers' diarrhea is seen in up to 60 percent of travelers in locations with poor institutional sanitation, and most cases are self-limited and bothersome, but not dangerous. Rehydration is key, and it is recommended to carry rehydration salts when traveling in these areas, or adults can make their own electrolyte drink using the World Health Organization's oral

rehydration recipe of salt, baking soda, and sugar added to water. Fevers, bloody diarrhea, or symptoms beyond five days should prompt adults to seek medical care. For instance, bloody diarrhea as seen in amoebic dysentery is caused by a parasite and should be diagnosed through stool studies and treated with a specific medication. Stool cultures are important, because if you are given the wrong medication for the wrong cause of diarrhea, you could die.

Patients with bloody diarrhea (and some would argue any diarrhea caused by infection) should not be given an antibiotic without a stool culture, because one of the common causes, Shiga toxin–producing *Escherichia coli* (*E. coli*), is more likely to cause hemolytic-uremic syndrome (HUS) when an antibiotic is given, and HUS is deadly.

HUS causes the blood to go crazy, creating severe anemia and causing the kidneys to fail. It is a complicated syndrome that includes big medical words like *microangiopathic hemolytic anemia*. More than 90 percent of pediatric cases of HUS are associated with Shiga toxin–producing *Escherichia coli*, and antibiotics have been shown to increase the likelihood of HUS following the infection, which has a mortality of up to 5 percent and may cause chronic kidney disease in survivors.

Patients with bloody diarrhea (and some would argue any diarrhea caused by infection) should not be given an antibiotic without a stool culture.

In the US, common culprits of bacterial food poisoning include *Staphylococcus aureus*–contaminated mayonnaise left out at a picnic, which can cause rapid-onset, violent nausea, vomiting, and diarrhea that resolve just as quickly. The perp lineup includes *Salmonella*-contaminated poultry, campylobacter in meat, and deli meat containing listeria, which is one of the most common causes of death due to foodborne illness in the US.

In 2024, Boar's Head had a listeria outbreak at deli meat factories affecting eighteen states, with the United States Department of Agriculture (USDA) inspection of one plant reporting mold, insects, and lots of listeria. For anyone who did the required summer reading in high school, the USDA report was giving Upton Sinclair's *The Jungle*, a work of fiction that contained important truths about the poor sanitation in meatpacking plants in the early 1900s and led to the US Pure Food and Drug Act, but unfortunately some US plants are still not pure enough.

Listeria causes nausea, vomiting, and diarrhea, but in the young, old, immunocompromised, and pregnant, listeria can cause a blood infection and death, as seen in the 2024 Boar's Head outbreak, which was linked to the deaths of at least nine people. Most healthy people survive with a bad memory, but why roll the dice? Heating meat to an internal temperature of 165°F (74°C) does kill listeria but keep in mind that deli meats can be contaminated after cooking. To avoid listeria, food products that are not shelf-stable must be kept in the refrigerator at 40°F (4.4°C) or colder, dairy products should be pasteurized, and storing cut melon or deli meats for extended periods must be avoided. The melon listeria outbreak of 2011 was rough.

Many food poisoning deaths start with improper storage of food. It wasn't until the early 1900s that the home refrigerator was invented and mass-produced in the US, which preceded a rapid and drastic decline in foodborne illnesses. Unfortunately, refrigerators are not always used, and social media was horrified by the viral story of a young man who suffered food poisoning after eating pasta that had been left out on the counter for several days. He died that night. His tragic death was associated with *Bacillus cereus*, a bacteria infamous for growing in fried rice and pasta leftovers that can cause liver failure and blood infection, although a vast majority of people do not die from the infection. To prevent *Bacillus cereus* food poisoning, keep hot food over 140°F (60°C) and cold food under 40°F (4.4°C). Leftovers are always a risk, so refrigerate immediately and eat as soon as possible. Food sitting for hours or days under heat lamps or left out on the counter overnight is a bit too risky for my taste.

Lastly, some of your foods don't need any help poisoning you. According to the US Department of Agriculture, food manufacturers provide a "best by" date to indicate when the food is of the best quality, but, except for infant formula, these dates do not indicate product safety. Though the marketing ploy of the "best by" date may cause unnecessary food waste, some foods do expire with consequences beyond a funny taste.

For instance, potatoes, especially those stored for long periods, that turn green or begin sprouting can produce solanine, a neurotoxic poison. This becomes a larger concern with the necessity to store food. In 1952, there was a solanine poison outbreak reported in North Korea due to stored potatoes during wartime, which affected hundreds and killed dozens. Once your potatoes have eyes, they can see you coming and are trying to avoid

the masher, so sprouts and green color should serve as a flashing red light to avoid eating.

Now that this chapter has scared the crap out of readers, hunger has set in, so go get a snack.

ANAPHYLAXIS

I'm not sure if I have mentioned it yet, but I am not a kid person. I believe my child is intrinsically different from all others, as is hormonally mandated, because she is genetically predisposed for awesome. As for everyone else's kids, I don't mind them most days—I just don't want them in my emergency department, because nothing is worse than a sick kid.

On one particularly fun day in my single-coverage ED, I was taking care of fourteen critically ill patients and a full waiting room when the ambulance brought me a tiny patient. Sweet Peanut was six months old and had just tried peanut butter for the second time. After eating the peanut butter, she immediately developed hives, wheezing, and difficulty breathing, but Mom thought fast and called 911.

Tiny Sweet Peanut looked ridiculous wheeling into the department on her adult-size emergency services gurney, but no one could concentrate on the cuteness because she was struggling to breathe. Mom followed closely, explaining the story.

Sweet Peanut was transferred to our monitors, an IV was placed, and she received anaphylaxis medications. The most important medication that was given was not given through the IV, but intramuscularly: epinephrine, which is often prescribed as an EpiPen. Sweet Peanut ended up getting a dose of epinephrine every fifteen minutes, at which point she would improve momentarily, but then worsen again.

She was placed on a baby BiPAP breathing machine, which is similar to a CPAP machine used for sleep apnea. While this did help her oxygen level, she continued to wheeze and have hives. This is not a normal response. She should have responded to the treatment and improved, but she continued to relapse. I began racking my brain as to why Sweet Peanut was not getting better as I prepared to put her on a continuous drip of epinephrine.

Mom stayed close throughout the care, comforting Sweet Peanut, and then I saw it. She was holding Sweet Peanut's hand, and Mom had butter fingers. Mom had imperceptible peanut butter residue still present on her

hands, and every time she would touch Sweet Peanut, the allergy would reignite.

When a person has a severe allergy, after giving an EpiPen and calling 911, the patient must immediately be decontaminated. In Sweet Peanut's case, this meant washing her face and hands, washing the parents' hands, and taking away and cleaning pacifiers and anything else that could have touched the peanut butter. Re-exposure will make the allergy worse.

When a person has a severe allergy, after giving an EpiPen and calling 911, the patient must immediately be decontaminated.

Mom washed her hands, and Sweet Peanut made a full recovery. Fortunately, allergies seen before the age of one are rare and will often be transitory, but it is crucial to avoid the allergen and follow up with a pediatrician or allergist for further testing. Most importantly, always carry an EpiPen, or in Sweet Peanut's case, an EpiPen Jr or an Auvi-Q; it could save a tiny life.

The nine major food allergens identified by the US Food and Drug Administration are milk, eggs, fish, shellfish, tree nuts, peanuts, wheat, soybeans, and sesame. While any food can cause an allergy, these are the most common. Food manufacturers must list these ingredients on the packaging as allergens.

Food allergies are a Type I allergic response by the body. There are four types of allergic responses, also known as hypersensitivity responses, the body can have, based on what white blood cells and antibodies the body uses to attack the allergen, and none of them are good. Type II and III allergic responses are complicated pathways that result in transfusion reactions and diseases like lupus, respectively. A Type IV allergic response is what creates contact dermatitis, such as poison ivy or poison oak.

A Type I allergic response is what most people think of when they hear "allergy." It is the type of allergic response the body has to food, bee stings, and seasonal allergens. This allergic response requires sensitization, which means the body must have been exposed to the allergen previously.

For example, Sweet Peanut had tried peanut butter once before. Upon exposure, the body believed peanut butter was a dangerous invader, so it created an antibody to the allergen like it would for an invading bacteria or virus. This antibody is known as the IgE antibody and circulates in the

blood. The next time that Sweet Peanut was exposed to peanut butter, the IgE antibody that had been made on previous exposure immediately recognized the peanut butter as foreign and dangerous. The IgE caused white blood cells, called mast cells, to release massive amounts of histamine and other inflammatory chemicals to fight the peanut butter, causing anaphylaxis, a sudden, severe, and life-threatening allergic response involving the entire body.

Peanut butter is delicious and certainly not a dangerous virus or bacteria, so why did Sweet Peanut's body recognize it as a foreign pathogen and mount a kamikaze-type anaphylactic response? If we knew that, no one would have allergies.

There is hope for those with allergies. An allergist can perform allergy testing and desensitization. Desensitization is a process of repeat micro-exposures to an allergen that helps build tolerance and reduce symptoms while in a medically controlled and supported setting. You may never become a beekeeper or eat peanut butter recreationally, but after desensitization you won't have to be scared for your life at every picnic.

For mild seasonal allergies, second-generation antihistamines like fexofenadine (Allegra), loratadine (Claritin), and cetirizine (Zyrtec) are recommended. First-generation antihistamines, like diphenhydramine (Benadryl), cross the blood-brain barrier and cause sleepiness, so they are generally not recommended for daily use. Diphenhydramine has gotten some bad press, as a *Journal of the American Medical Association* article showed that years of cumulative use of diphenhydramine was associated with increasing risk of dementia. Use of diphenhydramine in the emergency department for life-threatening anaphylaxis is still the standard of care, but consider short-term use of second-generation antihistamines for seasonal allergies, given the decreased side effects. There are also other medications used for allergies like steroids and the all-important EpiPen.

EpiPens are foolproof auto-injectors filled with a single dose of epinephrine, which shuts down the anaphylactic response. There is a half dose of epinephrine present in the EpiPen Jr, which is made for patients who weigh between fifteen and thirty kilograms (thirty-three to sixty-six pounds).

The Federal Aviation Administration has required epinephrine to be present on airplanes since 2003, but there are exemptions, and planes do not stock the infallible EpiPen auto-injector but cheaper vials of epinephrine,

which should come with a nurse because no one else is going to be able to figure out that dosing while someone is actively dying.

Surprisingly, EpiPens are not required to be present in most schools, where as many as 25 percent of children will have their first allergic reaction. As of 2022, only fourteen states require EpiPens to be present in schools, so parents should know whether their school has an EpiPen. If not, stock your own EpiPen in the nurse's office. States also have entity stocking laws, which allow, but do not require, public venues to stock EpiPens in case of life-threatening anaphylaxis. Such venues include day camps, after-school programs, daycare centers, university campuses, restaurants, and sports arenas.

To summarize the takeaway points:

- Always carry an EpiPen for any severe allergies.
- After using an EpiPen and calling 911, always decontaminate the patient, inanimate objects, and yourself. No butter fingers.
- If you or your loved one has a severe allergy, consider seeing an allergist for desensitization.
- Check that your child's school stocks an EpiPen.
- Airlines choosing to stock a cheap vial of epinephrine instead of an easily used EpiPen auto-injector should also stock a nurse, who charges hourly.

PUFFERFISH TETRODOTOXIN

Sushi is my second favorite food, but unfortunately, there are a lot of ways to die from fish.

On a trip to Japan, a country known for its fish, I was fortunate to visit the famed Tsukiji fish market in Tokyo and eat at Ginza Kojyu sushi restaurant for my husband's birthday. Before taking my first bite, I was promptly reprimanded by the chef for sloshing my sushi around in soy sauce. It turns out the sushi is prepared in the way it is meant to be eaten, so my soy sauce was taken away. The chef was right; it was the best sushi ever.

One fish I have not eaten is pufferfish. Also called blowfish and swellfish, there are more than ninety species of pufferfish found all over the world, primarily in tropical ocean waters like Hawaii. These fish inflate like

spike-covered naval mines when threatened. As if this isn't enough of a deterrent, many pufferfish carry tetrodotoxin.

Tetrodotoxin is found in the tissue of pufferfish, as well as that of the blue-ringed octopus, starfish, and horseshoe crabs. It is found in the highest concentration in the pufferfish ovaries and liver, two organs the fish prefer not to have eaten. Because the toxin concentrates in the organs, Japan has outlawed the consumption of these particular parts of the fish. Even if you avoid the fish in raw sushi form, tetrodotoxin is not destroyed with cooking.

In Japan, pufferfish are referred to as *fugu*. Fugu will kill you if it isn't cut and served correctly. This is one time you may want to pay compliments to the chef *before* they serve you dinner. As of 2023, fugu chefs in Tokyo are legally required to pass an exam and be licensed by the government.

Just a little tetrodotoxin in fugu causes a light tingling around the lips; a little more and you die. It's a sushi knife-thin line. The minimum lethal dose in humans is only 2 mg of toxin.

Why do people eat fugu? Fugu is an expensive delicacy, thought to bring good luck if it doesn't kill you. Before anyone gets too self-righteous, fast food and soda will also kill you, yet the highest-grossing restaurant in the US is McDonald's. Everyone picks their poison. That being said, please consider the potential benefits of avoiding pufferfish and soda.

Most deaths from tetrodotoxin poisoning occur in the Indo-Pacific region and Japan. Many of these are poisonings from home-prepared pufferfish. Data often focuses on Japan, because many Indo-Pacific societies do not regulate pufferfish consumption, thus mortality data is not readily available.

How does it kill? Tetrodotoxin is a nerve blocker.

All the nerves in your body constantly play a game of telephone to get messages to and from the brain. Sometimes the brain is busy, so the calls stay local in muscles, but the point is that everybody is talking. It is how you move. It is how you think. It is how you decide to eat pufferfish. Tetrodotoxin comes in like a pair of scissors and cuts the phone line. When you pick up that phone and there's no dial tone, you know who is in the house.

Your nerve phone lines are made of neurons. Neurons use sodium to know when to place a call. When sodium builds up to a certain concentration inside a neuron, the nerve will fire off a message. Who knew salt was so important?

Sodium entering the first neuron begins the game of telephone, releasing the message down the chain. For instance, if the brain wants you to chew your pufferfish, the message is sent from the brain to the muscles of the mouth. This requires each neuron to be set off along the line. The pufferfish tetrodotoxin binds and blocks the sodium channels, so sodium can't get into the neuron. Bada-bing, bada-boom, snip the line, no dial tone, no message delivered.

If nerves can't fire, paralysis ensues. There are a few muscles in the body you never want to paralyze at dinner. One is the diaphragm, which controls breathing. What starts as numbness and tingling in the mouth and lips quickly progresses to headache, nausea, vomiting, diarrhea, and progressive paralysis.

There is currently no known antidote for pufferfish poisoning. So, if you eat the fish and the tetrodotoxin content is too high, you're going down. The current treatment is supportive care, including breathing for the patient using a ventilator until the body can metabolize the poison. Diaphragm paralysis usually occurs within four to six hours, so get to a ventilator quickly or bring one to the restaurant. Unfortunately, even with ventilator support, some patients still die from tetrodotoxin poisoning due to the toxin's effects on other organs like the heart, where it causes life-threatening arrhythmias.

Needless to say, I stuck to nonpufferfish sushi on my trip to Japan, but unfortunately, there are plenty of other fish in the sea that can kill you.

FISH POISONINGS

While most food poisoning is caused by sunny picnic potato salad or street meat contaminated with bacteria such as *Staphylococcus aureus*, *Salmonella*, or *E. coli*, fish are associated with a unique deadly set of poisonings. Unfortunately, pufferfish is not the only fish that can take you out at dinner.

SCOMBROID POISONING

Scombroid is one of the most common types of fish poisoning and is often confused with an allergic reaction since scombroid is caused by an excess of histamine in ingested fish.

Histamine is the chemical that makes you itch, sneeze, flush, and break out in hives, and it can also cause breathing problems, such as wheezing

and airway closure. Anyone devoted to taking springtime antihistamines, like cetirizine (Zyrtec) or loratadine (Claritin), has experienced some of the negative effects of histamine.

Both fish and shellfish are among the nine foods recognized as major food allergens by the FDA. Fish and shellfish are listed ahead of peanuts, which is never good. Up to 60 percent of first-time allergic reactions to these fish occur in adults. Patients are often surprised by this since they have eaten fish since childhood, but that is how Type I hypersensitivity allergies work.

Food allergies are rapid allergic responses, due to the release of histamine and other chemicals, upon re-exposure to an allergen. This means one day, for no apparent reason, your body decides it's a "no" on fish and tries to kill you for consuming it. Even though you have been hitting the Happy Crab since you were a kid, today is the day you are allergic to shellfish for the rest of your life. Some people will get bothersome hives while others will experience anaphylaxis and breathing difficulty. Anyone with a food allergy should always carry an EpiPen, as you never know when your previous bothersome hives could progress to an anaphylactic reaction.

Scombroid will have symptoms similar to a fish allergy, and can be caused by certain types of fish including tuna, mackerel, bonito, skipjack, mahi-mahi (dolphin fish), amberjack, bluefish, marlin, swordfish, herring, anchovies, sardines, salmon, trout, and tilapia. Scombroid is more common in recreationally caught fish than commercial fish.

This seafood poisoning is caused when fish are stored at too high a temperature (above 40°F [4.4°C]), which allows bacteria to grow. These bacteria can convert chemicals inside the fish into toxic levels of histamine in several hours. Once the histamine is present within the fish, cooking or freezing will not decrease these levels. The histamine makes the fish taste peppery or spicy, and if you keep eating, you'll find out why. Within an hour of eating the contaminated fish, burning around the mouth, flushing, diarrhea, headache, and hives may ensue, followed by possible palpitations, low blood pressure, and breathing problems.

Scombroid is seldom deadly and treated with antihistamines for low-risk reactions. Those reactions with severe features, such as breathing problems, are brought into the hospital for IV medications and supportive

care. Symptoms usually resolve within two days and have no long-term effects.

CIGUATERA POISONING

Ciguatera is a peculiar disease caused by the ingestion of tropical reef fish, such as barracuda, amberjack, moray eel, and certain types of grouper, snapper, and parrotfish. Many of these fish aren't commonly eaten, but if they are being considered for consumption, ciguatera may be a reason to catch and release.

While grazing on seaweed, these fish consume the plankton *Gambierdiscus toxicus* that produces ciguatoxins. Ciguatoxins are metabolized and concentrated within the fish. Cooking or freezing the fish will not destroy the ciguatoxins, and the toxins do not change the taste, smell, or appearance of the fish. There are tests for ciguatoxins, but they are not effective due to poor accuracy and lack of rapid testing.

Three to thirty hours after someone consumes ciguatoxin-containing fish, the barracuda exacts its revenge. Thirty hours may seem prolonged, but every barracuda knows revenge is a dish best served cold. The initial ciguatera poisoning symptoms of nausea, vomiting, and diarrhea are unimaginative, but then symptoms take a turn for the surreal: Tingling occurs around the mouth as a metallic taste fills the tongue, followed by a sensation that the teeth are falling out. Freezing ice feels burning hot, vision blurs, and dizziness ensues. Finally, the poison can block the heartbeat and cause death, but that is rare. Ciguatoxin accomplishes these symptoms by opening sodium channels attached to cells, the opposite mechanism of pufferfish poisoning, which blocks sodium channels.

Fortunately, of the approximately sixteen thousand causes of ciguatera poisoning annually in the US, fewer than five are fatal. Regardless of the death toll, it is best to never mess with sodium channels and avoid tropical fish at dinner.

Avoiding these types of fish may become more necessary as ocean temperatures rise and the risk of fish poisoning increases, since the toxic ciguatoxin-causing plankton flourish in warmer seas. Rising ocean temperatures will also contribute to an increase in other toxic phenomena, such as algae blooms, creating red tides, and an increasing probability of shellfish poisoning.

SHELLFISH POISONING

The Happy Crab strikes again in these next poisonings, all caused by shellfish and mollusks, namely: shrimp, lobster, crab, mussels, clams, oysters, scallops, abalone, and others. After ingesting toxin-forming plankton and algae, these fish concentrate the toxins, creating three unique types of poison.

AMNESIC SHELLFISH POISONING

This is a bizarre type of poisoning, first discovered in 1987, when a hundred people became ill and three died from eating cooked mussels on Prince Edward Island. Amnesic shellfish poisoning is due to the algae-generated toxin domoic acid. Usually within hours of consumption, patients will have nausea, vomiting, and diarrhea, followed by memory loss. Domoic acid binds receptors in the hippocampus, a part of the brain that controls memory, and destroys the brain cells, sometimes causing permanent loss of short-term memory. Severe symptoms such as seizures, coma, and abnormal heartbeat have resulted in death, but this is rare.

NEUROTOXIC SHELLFISH POISONING

Karenia brevis, the algae responsible for red tides, produces potent neurotoxic brevetoxins, which concentrate in shellfish. Red tides frequently occur along the Gulf of Mexico, which some maps now label as the Gulf of America, the ocean under the United States and above Mexico on the right side. Regardless of whose name you put on it, it's full of red algae.

These tides are common in coastal Florida, where a 1996 bloom killed 149 manatees, and a bloom the following year killed 740 bottlenose dolphins. In humans, this tasteless, odorless toxin causes nausea, vomiting, and diarrhea, like most food poisoning. The patient can then develop tingling in the mouth, inability to walk, slurred speech, and dizziness. While no human deaths have been reported due to the toxin, the red tide is not worth testing.

PARALYTIC SHELLFISH POISONING

The most common shellfish poisoning, paralytic shellfish poisoning, often occurs after consumption of clams and mussels during algae blooms of saxitoxin-producing *Alexandrium*. Paralytic shellfish poisoning is present worldwide, but outbreaks are frequently seen from the temperate waters of North America. Symptoms can begin within thirty minutes of consumption,

starting with GI upset and tingling of the body, followed by flaccid paralysis and paralysis of the muscles used for breathing. While saxitoxins have similar symptoms and mechanism to the pufferfish's paralyzing tetrodotoxin, saxitoxins are unrelated chemicals. The clams came up with it on their own. Like pufferfish paralysis, paralytic shellfish poisoning is swift and lethal, so get to an emergency department, and bring a doggie bag so we can check out your mussels.

MUSHROOMS

Mushrooms can be magical; *go ask Alice*. Aside from causing psilocybin-induced hallucinations, mushrooms are capable of many wild and wondrous things. For instance, the world's largest living organism is a two-thousand-year-old mushroom, an *Armillaria solidipes*, which occupies 2,384 acres of Oregon's Blue Mountains. Some mushrooms glow in the dark, some help fight cancer, and others can kill you in a single bite. But of the thousands of mushroom species, only around a hundred cause poisoning, and fewer than twenty are lethal.

Evolutionary biologists have shown that fungi are more closely related to humans than to plants, so our family tree has some funky branches. Oddly, truffles are not technically mushrooms, but another species of fungi that grow underground. Truffles, inaccurately known as the crown of mushrooms, can be worth more than their weight in gold. For instance, at an Italian auction a 3.3-pound white truffle sold for \$330,000. This is why truffle pigs, which can detect nuggets three feet underground, are employed to hunt the fungi. I assume the pigs are well compensated.

Humans were not always paying for fancy fungi. Mushrooms have been part of the human diet since the Upper Paleolithic period, around the time humans became effusively passionate about cave painting; we excelled at handprints and ponies. Mushroom foraging has been consistent through the ages in cultures on every continent (aside from Antarctica, where mushrooms grow free from human predators). Fungi are present everywhere, many times requiring no foraging or porcine employment to be found. Mushrooms often come to you, garnishing your front lawn with species that are probably harmless, although not particularly edible. But beware, other times mushrooms are plentiful and may be poisonous, even deadly.

The death cap mushroom is self-explanatory. Also known as *Amanita phalloides*, the death cap is a stereotypical-looking mushroom. If this mushroom were a groomsman at your best friend's New England wedding, he would be named Chad, wearing a popped-collar polo and boat shoes. Don't do it. He is poisonous. The point is that if you drew a picture of a mushroom, it would be *Amanita phalloides*: a small gray-and-white mushroom.

Death cap mushroom poisonings are most common in Europe and Asia, where mushroom foraging is more popular. These mushrooms, along with several related species, contain amatoxin. Although amatoxin only kills a few people in the US annually, it is a highly potent toxin, lethal with the consumption of only one or two mushroom caps. Initially, patients will have symptoms of food poisoning, sometimes with blood in the stool, then the patient will feel better, lulled into a false assurance that the worst has passed, only to go into liver failure two to four days after initial mushroom consumption.

Death occurs in up to three in ten patients within two weeks. If the mushroom ingestion is identified quickly, activated charcoal can be given to block the toxin uptake. Once the toxin is absorbed, intravenous medications can be given, including silibinin, a milk thistle extract, but none have proven beneficial. Patient care is supportive, and if stable the patient may be a candidate for a lifesaving liver transplant. The good news is that if you can avoid this one fungi, it is unlikely that you will be murdered by a mushroom, since 90 percent of mushroom-related deaths are due to death cap mushrooms.

Amanita muscaria is a fairy tale gone wrong. This red-orange-capped mushroom with white spots may look familiar if you have ever earned an extra life playing Mario Brothers-branded Nintendo games. The fairytale-flavored mushroom also served as an inspiration for Lewis Carroll in *Alice's Adventures in Wonderland*, where a hookah-smoking caterpillar claimed the mushroom to be size-altering, but in real life it is deadly.

The mushroom contains muscarine, ibotenic acid, and muscimol, which go to the brain and cause agitation, inability to walk, hallucinations, heart rate change, and space and time disorientation. Rarely the mushroom will decrease breathing and cause death.

There are several other poisonous mushrooms, including webcaps (some *Cortinarius* species), autumn skullcaps (*Galerina marginata*),

destroying angels (three *Amanita* species), common conecaps (*Pholiotina rugosa*), and false morels (e.g., *Gyromitra esculenta*), so avoid all those as well. Many hallucinogenic mushrooms taken recreationally resemble species of poisonous mushrooms, so species confirmation by someone more qualified than a stoned caterpillar is crucial in escaping death.

According to online foraging resources, there are several indicators that a mushroom may be poisonous. Signs that a mushroom may be poisonous include white gills underneath the cap of the mushroom, a ring around the stem of the mushroom, red coloring, an unpleasant smell, or a bulbous structure at the base of the stem. Most sources indicate that it is incredibly difficult to tell if a mushroom is poisonous without significant training, because many mushrooms evolved using Batesian mimicry, where nontoxic mushrooms mimic the appearance of toxic mushrooms to avoid being eaten.

I prefer to forage for fungi on aisle two of my local grocery store, where deadly mushrooms have been preselected out, but even these mushrooms should come with warnings. Although not deadly, shiitake dermatitis is a rare side effect of eating undercooked or raw shiitake mushrooms. Caused by a reaction to the chemical lentinan in the mushrooms, the rash appears as long lines all over the body that look like lashings or scratch marks. It is a bizarre rash that will certainly cause panic, but don't worry, you won't die.

Mushrooms are diverse, delicious, and sometimes magical, but you need to know which ones are safe to consume, or you could end up in the emergency department or trying to fit yourself into a rabbit hole. Mushrooms have learned to avoid consumption through poison accumulation and mimicry. If you do decide to forage for fungi, be sure to do so with a certified mushroom expert and taste-tester to consume the mushrooms first, and then maybe give it twenty-four hours before you dig in.

LOCOMOTION

Cars

Motorcycles

All-Terrain Vehicles (ATVs)

Helicopters

Planes

CARS

Every year 1.19 million people die in road traffic accidents worldwide, with up to 50 million suffering nonfatal injuries. It is safe to say we are terrible drivers.

It depends on the year, but the US Department of Transportation (DOT) data generally shows traffic accidents to be around the thirteenth leading cause of death in the US. Unfortunately, this ranking sharply increases in younger populations. Motor vehicle accidents are a leading cause of death among US teens, causing one-third of deaths, and losing eight young lives daily. According to the CDC, in fatal teen crashes 56 percent of teens were not wearing seat belts and 29 percent of sixteen- to twenty-year-olds had been drinking alcohol.

Young males are three times more likely than similarly aged females to die in motor vehicle accidents due to risky driving practices, according to the Insurance Institute for Highway Safety, but women are more likely to die in accidents of similar severity, in part due to historical crash testing exclusively considering male anatomy, which is an example of why we need research on both sexes.

Women are more likely to die in accidents of similar severity, in part due to historical crash testing exclusively considering male anatomy, which is an example of why we need research on both sexes.

The DOT states that 95 percent of the people who die using transportation networks in the US die in motor vehicle accidents, making most other modes of transport, such as trains, planes, and boats, far less deadly. Freeway crashes are statistically higher mortality, given the speeds, and there are specific stretches of freeway that are more deadly than average, likely due to the design and the density of vehicles. Although it might be assumed that almost all fatal car accidents happen in urban centers, 40 percent of deadly accidents are rural.

Claims are often made that certain states are more dangerous to drive in, and while forty-eight can attest that its neighboring states' drivers are the worst, DOT data showed South Carolina has had the highest rate of fatal crashes per mile driven, so only North Carolina and Georgia would be correct in their assertions. Traffic laws also differ by state, but all require

seat belts to be worn, except New Hampshire, where there is no seat belt law and the license plate displays the state motto, “Live Free or Die.”

While some countries will allow the use of a US driver’s license abroad, many require an international driver’s license or permit, which can be obtained from the American Automobile Association (AAA). There is no test for this license; it is simply a translation of your US driver’s license into another language, guaranteeing that tourists will make terrible drivers. Unsurprisingly, the number one nonnatural cause of death in Americans living, working, and traveling abroad is motor vehicle accidents.

Even for local drivers, some countries are far more dangerous. Ninety percent of traffic accident fatalities occur in low- to middle-income countries, greatly due to the lack of infrastructure, including poor road maintenance. The 2023 World Health Organization (WHO) Global Status Report on Road Safety found Southeast Asia was the deadliest place to drive. Aside from infrastructure and vehicle safety standards, the WHO identified five contributors to motor vehicle deaths: speeding, drinking while driving, and lack of motorcycle helmets, seat belts, and child restraint systems. Country-specific legislation varies wildly on each of these contributors. For instance, much of the German Autobahn has no speed limit, the US has no universal helmet law for motorcycles, and some countries have no blood alcohol content limit for driving; meanwhile, in other countries drinking and driving is punishable by death.

Most people in car accidents die of blunt force trauma that causes lethal brain injury. If the brain survives, other causes of death include internal organ injury, spinal cord injury, and major blood vessel injury.

My first thoracotomy, a procedure colloquially known as “cracking the chest,” was a car accident victim. It was a male in his twenties, and we immediately sensed it was not going to go well, so we moved directly to the operating room. When he arrived, he was unconscious and had a breathing tube placed by the paramedics. The portable chest X-ray showed multiple rib fractures and a punctured lung that had collapsed, known as a pneumothorax. Shortly after arrival the patient lost pulses, and I began a clamshell thoracotomy. The procedure requires cutting along the ribs on both sides of the chest, then quickly cutting up the center of the chest—giving the chest a clamshell appearance—to reveal the heart, lungs, and aorta. This allows the doctors to quickly identify and repair bleeding from the heart or the body’s largest blood vessel, the aorta. The goal is to open

the chest as quickly as possible, preferably in under a minute. Survival rates for this procedure are low, quoted at 9–12 percent for penetrating trauma and less than 2 percent for blunt trauma, which is why an emergency thoracotomy is often only done in an attempt to bring a patient back from death.

The global motor vehicle fleet exceeds one billion and is projected to double by 2030, but many of these cars will not meet safety standards. In the US, crash tests conducted by the National Highway Traffic Safety Administration assess car safety by make, model, and year, which can be checked on their website. The Insurance Institute for Highway Safety also supplies data on car safety with the list of top safety picks for 2024 including the Volvo XC90, the four-door Honda Accord, and the Mazda CX-30. Alternatively, Consumer Affairs looked at data from 2018 to 2021 and reported the highest death rates in drivers of the Mitsubishi Mirage sedan, the Mitsubishi Mirage hatchback, and the Dodge Challenger.

Further removing the driver from the crash equation, self-driving cars pose new challenges but may be able to improve vehicle safety, especially because machines are historically better rule followers than humans. But while the rules of the road are black and white, the ethics are not. When a person is driving, they may have a split second to make a life-altering decision. For instance, if a car is speeding down a road and suddenly an object falls in front of it, the driver may choose to swerve. In this case, on the left is a parked car, and on the right is a school bus full of children. Since swerving right could kill children, the driver may make the split-second decision to swerve left. How does the decision change when swerving to the left kills an elderly person or a biker? Many would consider these ethical decisions, but how do you teach a car ethics? Innovators seem to be hitting the gas without answering some of these critical questions.

Driving is one of the most deadly things we do. The WHO encourages the legal mandates of speed limits, motorcycle helmets, seat belts (even in New Hampshire), child restraint systems, and restricting drinking under the influence. While autonomous cars may improve vehicle safety because machines follow rules, determining the ethics of the road is more difficult than teaching a car Red Light, Green Light. For the time being, most forms of transportation are safer than cars, except motorcycles. Motorcycles are worse.

MOTORCYCLES

There are many benefits to owning a motorcycle. Motorcycles are cheaper than cars, have lower emissions, and one study found riders have a 25 percent decrease in cortisol, the hormonal biomarker for stress. Riding is a physical workout, and it looks cool.

Motorcycles are easy to fix, retain their value, and tend to be long-lasting vehicles. They are perfect for road trips and make great diary fodder. In some states motorcycles are allowed to go through red lights, once they stop, since the vehicle presence system will not recognize low-weight vehicles. California also allows motorcycles to bypass traffic via *lane-splitting*.

Motorcycles also make you friends. Buying this vehicle is kind of like buying a Subaru; people may invite you to join their club. You don't have to join, but it's always nice to be invited. "One-percenter" motorcycle clubs may not be for you, since these are clubs that got their name due to involvement in illegal activities. The term came about after the American Motorcyclist Association president stated 99 percent of motorcyclists are law-abiding citizens, not engaging in the one-percenter, Sons of Anarchy-type activities.

Despite the many benefits, the rap sheet for motorcycles is a long one, and the numbers are rather incriminating.

While only 3 percent of US registered vehicles are motorcycles, they account for 14 percent of motor vehicle deaths. Each year, approximately six thousand motorcyclists die in accidents in the US, and more than eighty thousand are injured. For every mile driven you are thirty-five times more likely to die on a motorcycle than in a car.

What contributes to motorcycle fatalities? Well, alcohol, speeding, not wearing a helmet, and driving unlicensed. These seem obvious, but you would be surprised. In 2021, one in four US motorcycle fatalities involved intoxicated riders.

Abroad, motorcycles are a far more common mode of transport. For example, over 80 percent of households in Thailand own a motorbike. A study of motorcycles in Asia showed that 78 percent of fatalities worldwide occurred in just five Asian countries—Thailand, Laos, Vietnam, Malaysia, and Cambodia. These countries have more motorbikes and thus more crashes, but also have heavy traffic patterns, as well as road safety and design challenges. I know Lizzie McGuire and *Roman Holiday* made

Vespas look fun, but motorcycles are not for tourists. You don't even know where you are going. Get a car, with seat belts.

Another place you probably do not belong on a motorcycle is a racetrack. Professional motorcycle races take place in such exotic locations as Macau and Daytona. They include unfathomable feats and motorcycles moving at well over two hundred miles per hour. Unsurprisingly, these races are deadly, with the world's deadliest course being the Snaefell Mountain Circuit on Britain's Isle of Man, leading to around 270 deaths in the last century. This number includes some spectators, so maybe watch from home.

For those requiring enhanced elements of danger, the world of underground motorcycle street racing takes place aboveground, on city streets. Bikers clear streets in the depths of night to race, sometimes using nitrous oxide to increase fuel-burning efficiency, rocketing the bikes forward. The use of nitrous oxide, NOS, or spray is generally outlawed in the street-racing community, but many riders are not big rule followers.

A lifesaving rule all bikers should follow is to wear motorcycle gear that covers all extremities. Road rash from a crash can be equivalent to severe burns, requiring skin grafts, so cover that skin! One of my patients, who was not wearing motorcycle gear, went home after his crash instead of to the emergency department. The deep road rash, with a depth equivalent to that of a third-degree burn, then stuck to his clothing like glue. Waiting to seek treatment for road rash can cause infection, complications for possible skin grafts, and sepsis.

The one thing most proven to save lives in motorcycle accidents is a helmet. DOT-compliant helmets have been tested to meet federal safety standards and have adequate chin straps, lining, helmet weight, safety design, and thickness. These will be marked with a DOT sticker and a label on the inside of the helmet. Snell is a nonprofit organization that further tests and labels helmets to ensure proper safety.

Only 65 percent of US motorcyclists wear DOT-compliant helmets, and only eighteen states require riders to wear helmets at all. Twenty-nine states decided that children on motorcycles should wear helmets, which means the other twenty-one states are cool with un-helmeted babies on motorcycles. In the US, motorcycle helmet use has declined in the past five years, while fatal accidents have been increasing. With the exception of New

Hampshire, every state has seat belt laws, so why the paucity of motorcycle helmet laws?

Helmets are very effective in protecting riders in motorcycle crashes. For every hundred motorcycle related deaths, thirty-seven riders would have been saved by wearing a helmet. More than 70 percent of un-helmeted riders die at the scene of the crash. Unsurprisingly, states without helmet laws have much higher head trauma-related motorcycle fatality rates.

I don't have many happy hospital motorcycle tales. Too many of these stories end with paralysis or death, although some have escaped with only terrible road rash.

If you happen upon a motorcycle accident, if the rider is not in immediate danger in the current surroundings, it is best not to move the victim, especially the neck. In most cases, if the rider can breathe, you should not remove the helmet; emergency services will do this. Call 911. As always, if the rider does not have a pulse, start CPR.

If you choose to ride a motorcycle, take a Motorcycle Safety Foundation rider education course, and wear a DOT-approved helmet and rider-specific gear. I can't promise that you won't die, but I can promise you'll fare better in a crash than the guy wearing hot pants and no helmet.

[ALL-TERRAIN VEHICLES \(ATVS\)](#)

ATVs, also known as four-wheelers or quads, do not receive the same respect as motorcycles or cars. This makes no sense since these vehicles go up to ninety miles per hour, depending on the engine modifications, over rough, unstable terrain. ATVs are not made to be driven on paved roads and can be difficult to control with the risk of being overturned. Seems like a great idea so far.

While street legal in some countries, ATVs are often driven on private property and are not subject to the same laws as cars and motorcycles. They are often ridden without helmets or safety gear, and sometimes under the influence of drugs and alcohol. Children also drive these vehicles, with the ATV industry even designing models for smaller hands and feet. Four-wheelers are also popular with tourists looking for a painful way to die in a foreign country.

The US Consumer Product Safety Commission (CPSC) reports more than eight hundred deaths with over one hundred thousand emergency

department injuries annually due to off-highway vehicles. This is high considering only a small percentage of people in the US own and operate ATVs. Approximately half of ATV-related injuries and 35 percent of ATV-related deaths are in children, despite the American Academy of Pediatrics and the CPSC releasing statements against the use of ATVs by those under sixteen years old.

This is one of my least favorite emergency department memories, branding me from the inside, and scarring straight through.

I was working a late shift when I was told we would be getting a border transfer from Mexico. *Border drops* are usually US citizens who have had some form of medical treatment in Mexico and then are dropped at the Mexico-US border for US emergency medical services to pick up and bring to a hospital. They are called “border drops,” but the transfer has usually been requested by the family or patient.

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Our hospital would often get very little information about these patients, and in my experience, it was fifty-fifty that they were still alive by medical standards. I remember one patient having an IV fluid bag that looked like an empty liter soda bottle attached to his IV. Many of the patients I saw from these transfers were already brain dead or had injuries that were not survivable. Some patients had been injured on vacation, others had elective surgeries that had gone wrong (often gastric bypass), while others were expats, often with chronic illnesses.

When traveling in a foreign country, it is important to know your resources. Not only is the number for “911” different in many countries, but in some countries, no one will be picking up. The United States uses the Franco-German model for emergency services, with a fairly robust system that includes a rapid response time in many areas with treatment on scene. Many countries do not have this infrastructure, and some areas lack access to emergency services completely, meaning if you are injured you need to find a ride to the hospital.

For those on vacation, especially those who decide they are going to do more than sit on a beach, travelers should always consider purchasing

medical evacuation insurance. Some travel credit cards include insurance, but it is heavily restricted, and evacuations often need to be pre-approved and coordinated through the credit card company.

Medical evacuation insurance was probably the last thing on the mind of the Peters family when they allowed their children to go on a trip with friends. The Peterses were a picture-perfect family of four, the American Dream type who always look perfect on Christmas cards. While on vacation in Mexico, the kids decided to try an ATV excursion, which is exceedingly common in Baja California. It was a guided tour through terrain that had been driven countless times before. Nothing seemed dangerous about this adventure.

When we received the EMS call from the border, I was told a child was being brought to our emergency department. The details were limited, but the patient was a trauma activation in critical condition.

As the group of kids rounded a bend on the guided ATV excursion, the youngest child had been in the lead. There was unsteady ground, or maybe the cliff had eroded slightly, but she plummeted off the seemingly stable cliff when the ATV wheels hit a patch of ground that couldn't hold the vehicle's weight. Another child fell immediately after her. Finally, the last child fell but was caught by a shelf on the cliff's rockface. The ATV guide team was able to recover the last child, who came into my ED as a trauma in critical condition.

Life is full of choices made based on perceived odds and probabilities, but the upside of ATV adventures may not be worth the risk, especially when traveling in a foreign country. No matter where they are ridden, ATVs are not an uncommon cause of injury or death. Ride at your own risk.

[HELICOPTERS](#)

The safest way to travel, according to data from the US Department of Transportation, is to fly, but the most dangerous way to fly is a helicopter. The National Transportation Safety Board found that helicopters have a higher crash rate than any type of airplane, with an average rate of 35 percent higher.

There are reasons for this. If you have ever been in a helicopter, it is complicated. I have been told by a helicopter pilot that "Any ding-dong with a driver's license can figure out how to fly a fixed-wing airplane," and

maybe even land it if there is an engine failure. I don't think this is true, seeing that I am a ding-dong with a driver's license and a doctorate, and I am very much incapable of flying a plane. Regardless, helicopters are very complicated to fly and even more complicated to land. Unlike most fixed-wing planes, helicopters usually have only one engine, and if it goes out, the options are not good.

Airplanes have the possibility of gliding on wings to safety if there is engine failure, and most planes have more than one engine. Helicopters have one option—autorotation. The idea is that if the pilot can make the helicopter dive straight for the ground and pull up at the last moment, he or she can create lift and rotate the rotor blades enough to soften the landing. It's physics, but it's not very fruitful.

For this reason, helicopters have special rules about the type of weather and altitude they are allowed to fly in. While some helicopters can fly under instrument meteorological conditions (IMC), meaning using instruments such as a gyroscopic attitude indicator to fly, most are going to operate in visual flight rules, where weather conditions permit the pilot to see the flight path. The Coast Guard's H-65 helicopter can operate in all weather and nighttime conditions, aside from icing, which sounds horrifying.

Pilots flying using visual flight rules (VFR) who encounter unexpected weather may have to switch to instrument flight rules (IFR), but this transition can be disorienting and is the most common cause of weather-related helicopter accidents. The National Transportation Safety Board investigation into the tragic 2020 crash of Kobe Bryant's helicopter concluded just that. The pilot, who had been flying VFR, moved into an area that required instrument use due to fog and suffered from spatial disorientation, causing the crash.

I hate helicopters even more than I hate planes, but during my medical residency, I was granted the terrifying honor of flying with a helicopter air ambulance. The crew was amazing, but I was less than enthused every time we had to do our job. It was kind of like going hunting and hoping to not have to shoot anything.

Our crew flew an Agusta A109 helicopter to transport critically ill patients with one highly trained nurse and an emergency medicine physician resident, me. The crew wore flight suits and occasionally aviator sunglasses; it was like a medical version of *Top Gun*. It was all very sexy until I had to get on a helicopter.

Stories from flight medicine include scene calls, landing on freeways to collect patients fighting for their lives, and trips to nearby islands to transport heart attack victims that need immediate intervention.

Many of my coresidents had extreme cases of chest tube placements midair, and CPR while the helicopter hit turbulence. I, however, transported mostly people who were not imminently dying. Most of my patients were more likely to ask for a bag of pretzels during the flight than die. Honestly, I would have preferred a sick patient, because when I was focused on the patient, nothing else mattered.

During this rotation, I was what the healthcare world would call a “white cloud.” When I came on shift, critically ill patients stayed home and people who wanted refills of their blood pressure medications lined up. This phenomenon fluctuates with time—I did my fair share of chest tubes and floating pacemaker wires during my four-year residency in emergency medicine—but my flight shifts tended to be blessedly quiet.

Until one night, around 1 a.m., when I was snuggling into my sleeping bag at our airbase, and a call came in.

The pilot busted my bedroom door open. “Ashely, we are on standby for a scene call. It’s a multiple-vehicle accident.” The pilot ran outside to get the chopper hot. I wrestled my sleeping bag into submission, sprang out of bed, and yelled my obligatory last words, “Get to da choppa.”

I jumped into my flight suit and boots, like a firewoman ready to fight something, and grabbed my helmet. It was happening. I had my first scene call with multiple victims in what sounded like a potentially devastating car wreck. It was time to save lives.

We flew to a poorly lit area of the desert, where the only landmark was a two-lane highway where the car accident was located. Coming onto the scene we scanned the area for lines and wire, which could potentially take the chopper down. On our descent into the desert, copious amounts of dust clouded the air, so the pilot steadied the helicopter moving forward to avoid the “brown-out,” enhancing our ability to see the makeshift landing zone the paramedics had created near the highway. We landed safely and jumped out of the chopper with our medical bags, keeping our heads low.

The scene was dramatic. Cars flipped in every direction, crushed beyond recognition. The driver of a truck had fallen asleep and collided head-on with an oncoming car occupied by a family of five. And a ten-month-old child had not been properly restrained in a car seat.

The parents had been taken by chopper to the nearest hospital. The older children were not critically injured and therefore had been driven by ambulance. We were slated to take the ten-month-old child who had been unbelted and in the front seat, so I prepared for the worst. We climbed into the ambulance where he sat, a tiny person on an adult-size stretcher. Upon examination, there were no signs of trauma, and his vitals were normal. He appeared completely unscathed. We placed him back in his car seat for transport to the helicopter.

Once we loaded into the helicopter, the tiny bird of a child sat in his car seat facing me. His big blue eyes blinked, in the battle between exhaustion and intrigue. He never cried, he just stared. Given my lack of familiarity with children, I had no insight into this ten-month-old miracle's psyche.

Maybe he was hungry? Maybe he was scared? Maybe he was trying to tell me something? After trying to decipher his blinks with Morse code, I gave up and resigned myself to putting my left hand out. Maybe he wanted to hold hands?

His hand was only a fraction the size of mine, so when he grabbed my index finger, his tiny fingers wrapped around its entirety. I'm more of an animal person than a baby person. I had a lot of pets growing up, a hamster, an iguana, dogs, cats, and a parakeet, which is where I got my next move.

I stuck my right index finger out and he hopped his fingers forward. He seemed amused so I continued perching my fingers in front of him, while he marched his little hand forward. Left, right, left, like a baby parakeet.

We landed and he was delivered to the safety of a hospital emergency department for a thorough trauma exam.

It was a complete miracle he was uninjured, but that isn't to say flying him wasn't prudent. As previously mentioned, kids often do not decompensate until they are seconds from dying. But the little bird landed just fine and managed to do so without any injury.

In conclusion, as much as I hate to admit it, cars and motorcycles are far more deadly than helicopters and planes. It is safer to fly.

PLANES

I am terrified of airplanes. This fear emerged during my last year of medical school during a short flight from Boston to Washington, DC. We hit a bump, so I texted my husband to tell him we were probably going down. During

residency, my in-air panic greatly subsided, since if the plane went down I would not have to return to endless work. It seemed like a fair trade.

Unfortunately, postresidency, I regained my will to live. Now, every time we hit rough air I am again the woman on the plane gripping the armrests and making prolonged eye contact with strangers, looking for confirmation: “This is it, right?” Just in time for the pilot to come on to ask us to remain seated for impending death. These moments of panic are a great opportunity for CBT, not to be confused with CBD.

Haven’t heard of CBT? If you have anxiety, depression, alcohol dependence, insomnia, an eating disorder, stress, or are simply alive, CBT is a powerful tool. CBT is cognitive behavioral therapy, and it is a first-line treatment for anxiety. For panic disorders, CBT is even more effective than medications, but it’s free so no one has bothered to sell it to you.

CBT is based on the idea that some stress is created via preconceived notions that have been developed through individual experiences. For instance, if you were bitten by a dog you may feel scared when you see a dog, as your first thought is “Dogs bite.” Then you run away from Freckles in a panic.

CBT is a process in which you confront unproductive automatic thoughts in specific situations and create replacement thoughts. Maybe Freckles is a lover, not a biter. The crazy thing is how well this therapy works, as it can completely rewire your brain and in no time, you’ll run a doggie daycare, just because you can.

CBT accompanied by the use of biofeedback will calm panic. When our ancestors were being chased by giant armadillos (see glyptodon), their bodies adopted the fight-or-flight response, whereby fear causes the body to release a hormone called epinephrine—or adrenalin, if you’re British. Epinephrine causes the pupils to dilate (better to see with), hearing to become acute (better to hear with), and the gut to slow digestion (because who can eat at a time like this?). The hormone also causes the heart to race and breathing to increase, bringing oxygen to muscles preparing to run. But slow breathing during this automated fear response will cause the heart rate to fall and will shut off the fight-or-flight system.

Another coping mechanism for anxiety is education. So I have become a bit of a plane aficionado.

What is the most dangerous airport?

Tenzing-Hillary Airport in Nepal, where thrill-seekers land to hike Everest. It's windy and the runway is short and leads off a cliff, plus if the pilot misses the landing approach there is no safe go-around procedure.

What is the safest airline?

The third oldest existing airline, Qantas. "Qantas never crashed"—just ask Rain Man. In reality, they have had some crashes, but they haven't had a fatal crash since the 1950s. The airline with the most crashes does not surprise me. I do not fly on this carrier, because if they don't crash your flight, they'll likely cancel it. You can Google it.

What is the safest seat on a plane?

Back third of the plane, aisle seat.

Can turbulence kill you?

Sure, but not because a commercial aircraft falls out of the sky. In 2024 a Singapore Airlines flight hit severe turbulence flying from London to Singapore, killing one passenger. This is an extremely rare occurrence, made even more so by wearing recommended seat belts, but turbulence, especially dangerous clear-air turbulence, has been increasing with climate change, as Matthew McConaughey can attest. His Lufthansa flight plummeted a reported four thousand feet after hitting clear-air turbulence on its way from Texas to Germany, forcing a landing at Dulles International Airport. That is correct, McConaughey flies commercial—a man of the people.

Components of air safety that are deadly in deficit include air traffic control and airplane manufacturing.

Air traffic controllers have round-the-clock schedules, seven days a week, with up to ten-hour shifts in a high-stakes environment. In 2024, a nationwide shortage resulted in further strain and many close calls. The last line of defense against in-air collisions was stretched to the breaking point, causing further shortages, reported substance abuse, and suicide increase among workers. Understaffing at the Reagan National Airport tower was questioned as a cause of the 2025 midair collision between American Eagle Flight 5342 and a military Black Hawk helicopter. Similar to healthcare, it is critical to maintain and support the workforce, since without them the entire system will crumble.

In January 2024, the Boeing 737-9 MAX aircraft became a problem after a door plug flew off the plane of Alaska Airlines Flight 1282. The FAA

immediately grounded 171 Boeing 737-9 MAX aircraft and halted production expansion of the plane. The previous model, the Boeing 737-8 MAX, was involved in two fatal crashes internationally, one of which Boeing accepted liability for, due to the malfunctioning of an automated system that stabilizes the pitch of the plane. Several other 2024 Boeing incidents, including an engine cover falling off a Southwest plane taking off from Denver International Airport, provoked whistleblowers to come forward and testify in the investigation by a US Senate subcommittee on Boeing's "mishandling of nonconforming parts" and elimination of safety inspections, as well as "a culture that continues to prioritize profits, push limits, and disregard its workers. A culture where those who speak up are silenced and sidelined while blame is pushed down to the factory floor."

Boeing has been operating for over a hundred years, unveiling its first commercial airliner in 1919, so hopefully, with the FAA and US Senate oversight, the company can improve its product because everyone wants to fly safely.

If you don't trust the plane and choose to use the emergency exit mid-flight, the odds of survival are not good, but it is possible.

In 1971, seventeen-year-old Juliane Koepcke was flying over the Amazon on a flight to Peru when the L-188A Electra turboprop plane she was in was hit by lightning and came apart, throwing her into the sky at ten thousand feet, still strapped to her seat. A miracle and immensely bushy Amazonian treetops allowed her to land safely, waking up on the forest floor sometime later with relatively minor injuries. She then had to survive eleven days alone in the rainforest. She was eventually rescued, and her story is miraculous, but this was not the highest fall survived without a parachute.

In 1972, Vesna Vulović was a flight attendant who boarded the wrong plane in Stockholm, JAT Flight 367. Mid-flight there was an explosion, causing the plane to crash-land in snow from 33,333 feet, which is an odd number, and reported by the *Guinness Book of World Records* as the highest fall survived without a parachute. It was another miracle, but unfortunately Vesna was the only passenger to survive.

As dangerous as planes can feel, they are still the safest way to travel. For those who fly in fear, a key component of CBT is confronting fears and never avoiding them; thus, I have flown in an aisle seat in the back third of planes all over the world, except Tenzing-Hillary Airport in Nepal.

CRIME

Murder

Serial Killers

Gun Violence

MURDER

Homicide, the fancy word for murder, is the intentional, illegal killing of another human being. In the United States, more than three-quarters of homicides are committed with guns. Other, rarer forms of homicide include stabbing, assault with blunt objects, and asphyxiation.

Pro tip: If you find yourself in a situation where you are stabbed, don't pull out the weapon. In penetrating trauma, such as a stabbing, you don't want to remove the weapon if you can help it. Think of it like unplugging a hole in a boat—you're going to sink faster. Removing the object can also cause more damage on the way out, so it is best to get to a hospital stat.

Pro tip: If you find yourself in a situation where you are stabbed, don't pull out the weapon.

One place where homicidal maniacs may end up is in the emergency department. Consequently, more than half of ED workers will be victims of workplace violence by patients or patient relatives, and tragically, I have had colleagues killed at work by patients.

A colleague who trained in one of the most dangerous cities in the United States had several stories concerning the perils of the emergency department, including a person who threatened the waiting room with a bomb.

In that same city in 2006, a man was arrested and brought to an emergency department, presumably for medical clearance for jail. According to newspapers, the man overtook an officer, stealing a gun and taking the ED desk clerk hostage. This man then proceeded to steal an ambulance as an escape vehicle, which unfortunately had a patient in it. This is not a unique occurrence, because ambulance drivers often leave their rigs running. In another instance, a parked ambulance was stolen by a psychiatric patient. In the back, serendipitously, was a police officer, so the ambulance did not go far.

In 2023, according to FBI crime data, the most dangerous US cities were St. Louis, Missouri; Birmingham, Alabama; Baltimore, Maryland; Memphis, Tennessee; and Detroit, Michigan. In the US, males are three times more likely to die of homicide than females, and they also account for

90 percent of perpetrators. Black males make up more than half of domestic deaths from homicide.

One city that did not make the list of the FBI's most dangerous is New York City. In the 1990s US homicide was wildly out of control, and at the time the Big Apple had a big murder problem. Violence peaked in the US around the time *Home Alone 2: Lost in New York* saw its box office debut, then murder rates saw a cliff-like drop-off, but why?

In May 2001, John J. Donohue III and Steven D. Levitt published an article in the *Quarterly Journal of Economics*, aka the world's sexiest math journal. The two economists offered evidence that the legalization of abortion "contributed significantly" to the plummeting in crime rates, including homicide. While New York City had specific measures that may have contributed to crime reduction, the authors found a widespread reduction in crime across the entirety of the United States that did not correlate with other factors. Economics looks at correlation, not causation, but a national drop in crime required a national change, and it is plausible that change had been made seventeen years earlier when abortion was made legal in the United States.

The countries with the highest per capita homicide rates are Mexico, Brazil, the United States, Colombia, and South Africa. Keep in mind these are non-war-related homicides, so war-torn countries such as Afghanistan are excluded from the statistics.

As a native San Diegan, I love Mexican food and culture, y hablo español, but Mexico has its challenges. A major source of violent crimes in Mexico are the drug cartels, and if the work life wasn't dangerous enough, many kingpins have developed a wild hobby. The exotic pet trade began increasing in popularity among narcos in the 1980s, and although owning wild animals is legal in Mexico, exotic pet trades are often done through illicit channels. The animals, kept as pets, are often sedated but still dangerous. While I was working at a border children's hospital, a Mexican child was flown to our hospital after being brutally attacked by a lion house pet.

The safest countries in the world based on the Global Peace Index, which takes into account the level of violent crime along with twenty-three other criteria, are Iceland, Denmark, Ireland, New Zealand, and Austria. The US can't manage to crack the top hundred, and Afghanistan is last, probably due to constant human rights violations.

Anecdotally, I can confirm that the safest state to be in any country is the state of awareness. Most post-altercation patients have the same story when coming into the emergency department: “I was just minding my own business when...” It is best to know everyone’s business, then you’ll know when to get out of the way.

SERIAL KILLERS

The United States holds just over 4 percent of the world’s population, but is home to an estimated 66 percent of the world’s serial killers. Keep in mind, these are only the serial killers that we know about, so there are a few possibilities. One, the United States is chock-full of serial killers. Two, US law enforcement is top-notch, catching all the serial killers. Three, US serial killers are like toddlers baking brownies and they leave their sticky fingerprints all over every crime scene. Regardless, the US has been home to thousands of serial killers while the next highest country has fewer than two hundred. It’s Russia, always trying to compete.

Given that most of the world’s serial killers live next door, imagine my surprise when I moved to an island on the other side of the world, only to encounter its one and only serial killer.

During graduate school, I studied on the island of Cyprus, a country of extreme historical significance and once home to adorable miniature hippos and elephants, now extinct. I lived in the capital city of Lefkosia (Nicosia), the only remaining United Nations (UN) Green Zone divided capital city since the fall of the Berlin Wall. The UN Green Zone divides the Turkish-occupied north from the independent nation of Cyprus to the south.*

At twenty-two years old, I was the youngest in a small group of international professionals in my public health program, which included politicians, dentists, and doctors from countries all over the world. As a foreigner in a nation that had been occupied throughout most of human history, I found it understandable that locals were suspicious of my presence. I went to Greek school, and I am the poster child for persistence, so I eventually wore the locals down and made a Cypriot best friend in a classmate whom we will call Bob. Bob is not a serial killer; she is a Harvard PhD who loves mountain picnics, statistics, and Popeyes fried chicken. Many years later, Bob was a bridesmaid at my California wedding and still remains one of my close friends.

Today, Cyprus continues to be occupied in the north, but is also home to other suspect foreign inhabitants who have historically used the geographic location of Cyprus for trafficking purposes between the Middle East, Europe, and Russia. The Cypriot people have nothing to do with this—they are just trying to eat their halloumi* in peace. Even with foreign corruption littering their shores, there was one thing Cyprus had never had: a serial killer ... until I arrived.

Calm down, it's not me.

After wowing locals with my charm, I was finally invited by Bob to a bouzoukia, a Greek-style nightclub with requisite table dancing, where I was introduced to another classmate's fiancé. Recently, Bob showed me a photo of our group from that night, and I have no recollection of the fiancé in the picture, which I suppose is a mark of a decent serial killer. It was later discovered that this serial killer targeted foreign women living in Cyprus, cutting victims into pieces, placing bodies into suitcases, then dumping them into lakes. Although I met his victim profile, given his modus operandi, there was one problem.

As previously mentioned, I come from a family of athletes. I played Division I college water polo. Statistically, I am taller than most of the world's men. While I would like to think it was my street smarts that kept me safe in my younger years, I don't even remember the serial killer I met, so I think it may have been the fact that, for most aggressors, I would be an imposing physical undertaking.

The US Department of Justice defines a serial killer as someone who commits two or more murders separated in time, noting these crimes are often in different geographic locations and involve victims who are strangers. Serial killers are typically white males from twenty-five to thirty-four years old, a group that doesn't need any more bad press. It is common for initial killings to be planned and then devolve into unorganized frenzies, with motives varying from sado-sexual to psychological.

There is a common misconception that serial killers are reclusive and socially inept. The FBI found this is often not the case, as many serial killers are gainfully employed, with families, and socially engaged. I met one at a club, so clearly, he wasn't an agoraphobe. While most homicides are committed by an assailant who knows their victims, the majority of victims in serial murders are not acquainted with their killer. Hollywood often casts the serial killer as a diabolical genius, but the FBI has found no

association with intelligence level; rather, killers often have associated personality disorders, though not criminally insane, that is to say not having a mental illness that makes it impossible for a defendant to know they are committing a crime.

A personality disorder is defined by the American Psychiatry Association as “long-term patterns of behavior and inner experiences that differ significantly from what is expected,” making patients completely out of touch with certain realities. There are ten personality disorders, but antisocial, narcissistic, and borderline personality disorders are often associated with serial killers. Psychiatrists have stated that Jeffrey Dahmer, an American sex offender, cannibal, and serial killer, had borderline personality disorder, marked by emotional lability and instability of interpersonal relationships and self-image. Both Ted Bundy and the fictional *Silence of the Lambs* killer Hannibal Lecter have been said to have narcissistic personality disorder, marked by a grandiose sense of self-importance with a lack of empathy for others. Possibly the most typical personality disorder for a serial killer is antisocial personality disorder, sociopathy in lay terms, which is a disregard for and violation of the rights of others occurring since fifteen years old.

Sociopathy and psychopathy are not medical diagnoses, but colloquial terms. Sociopathy is a learned lack of empathy and disregard for others as a result of the environment or society. Psychopathy is an innate lack of the human soul or psyche, an incapacity to feel from birth, an absence of emotions, and an inability to form attachments. The revised Psychopathy Checklist is used to detect psychopaths in the legal system, using a twenty-item checklist with each item scored out of three points. A score of thirty or more in the US or twenty-five or more in the UK means you probably found a psychopath. Given the Brits are far less emotional than Americans, the threshold for deeming a person a psychopath is lower for the British. I scored a four, so I’m good for now.

The US serial killer population has been dwindling since the 1970s, and unlike the pygmy hippos of Cyprus, this is an extinction we can all look forward to. Although this decline is thought to be due to innovations in investigative technologies, it is still recommended to avoid sociopaths, psychopaths, and anyone harboring homicidal tendencies, but they are tough to spot.

It's clear that I am a terrible serial-killer spotter, seeing as how one crossed right in front of me and I was like a bird dog watching Nintendo Duck Hunt—zero recognition. How did I avoid being taken by a serial killer? As *Love Actually* star Liam Neeson would say, “What I have is a very particular set of skills.” Genetically provided physical attributes and skills I have acquired over a very long career as an athlete. Skills that make me a nightmare for serial killers—huge femurs. If your femurs are done growing and on the smaller size, consider learning Krav Maga and carrying a Taser. Stay safe out there.

GUN VIOLENCE

Guns are a hair-trigger issue in the United States, so let's start somewhere neutral, like Switzerland.

Until recently, Switzerland, the epitome of armed neutrality, required all able-bodied males to keep a gun in the home or local armory for purposes of national defense. Switzerland continues to have high rates of gun ownership, yet low rates of gun-related deaths.

But as Uncle Ben would say, *With great power comes great responsibility*. Voltaire may have said it first, but Stan Lee made it stick with Spider-Man.

In Switzerland, gun ownership requires a high degree of responsibility and regulation; for instance, if a gun is not safely stored and is stolen for illegal use, the owner can face up to three years in prison. It is illegal for civilians to own silencers or automatic weapons, and handgun licenses last only nine months, requiring a permit, a crime-free background check, and a psychiatric evaluation if deemed necessary. Citizens even have to declare airsoft and paintball guns.

In the US, gun ownership is less regulated. A US citizen who passes a National Instant Criminal Background check can buy a gun. In many states, there is no minimum age to purchase or possess a long gun, and the only state that requires registration of all firearms is Hawaii. To carry a gun on public property you must have a permit that some states are required to issue US citizens, while other states have additional qualifications. The lack of restrictions on guns is in part due to the extensive lobbying efforts of the National Rifle Association (NRA).

This is where it gets political. But it includes a crazy Twitter (X) fight, so it's worth it.

The NRA lobbies against limiting the Second Amendment right to gun ownership, which unfortunately has consequences for gun safety measures. For example, in 2003 the NRA helped draft the Tiahrt Amendment, prohibiting the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) from releasing firearm trace data. This blocked research organizations from using the data, prohibited gun dealer inventory reporting, and protected firearm purchaser information. Following the passage of the amendment there was a 203 percent increase within a year in the number of guns diverted to criminals. In 2010, Congress loosened some restrictions on data sharing between law enforcement, but continues to limit research.

After a research study published in the *New England Journal of Medicine* showed that individuals who owned a gun were more likely to be murdered at home, the NRA lobbied very effectively and barred the Centers for Disease Control from funding research on gun violence that could lead to gun control.

Research continued to be funded by other organizations, and in 2018 the *Annals of Internal Medicine* published several articles on US gun violence. These articles angered the NRA to the point of seeking retribution against the medical community, but in the events that followed they inadvertently became a leading recruiter for physicians against gun violence.

On November 7, 2018, the NRA woke up and chose violence, tweeting, "Someone should tell self-important anti-gun doctors to stay in their lane."

The NRA post made some doctors angry. Physicians aren't inherently antigun. One study of emergency physicians found 42.9 percent have a gun at home, but telling doctors that bullets aren't their business is obtuse.

Regardless of a person's position on guns, it would be astute to include those who treat all gun-related injuries in the conversation. For instance, bullets are the number one cause of death in children in the United States. Pediatric doctors should be involved in researching and preventing the number one cause of death in children. Imagine telling dentists that the number one cause of cavities is none of their business. Four out of five dentists would disagree. I imagine the fifth dentist always forgets to vote.

Bullets are the number one cause of death in children in the United States.

As an emergency medicine doctor, I diagnose and stabilize emergencies, but many emergencies require collaboration with other specialists. If you get shot in the eye, I need the eye team: ophthalmology. If you get shot in the bone, I talk to the bone crew: orthopedic surgery. I work with every type of doctor. I even called a dermatologist once; she was surprised by my call.

When a person is shot, there is one other doctor who is almost always in the room with the emergency medicine doctor—the trauma surgeon. Many doctors were angered by the NRA's tweet, as their disregard was felt deeply by many emergency medicine doctors and trauma surgeons who work with gun violence victims daily.

I don't know if you have ever made a trauma surgeon angry, but I do not recommend provoking them. If Einstein and a grizzly bear raised a child together, I imagine the child might have the temperament of a stereotypical trauma surgeon, as well as the innate right to bear arms. Every day is arm day when you do ten hours of surgery, and you've got to be fierce to save lives.

The medical community's response to the NRA tweet heard 'round the world was in fact fierce. The tweet was basically a Bat-Signal for physicians to engage in antigun violence activism. Physicians shared pictures of their empty, bloodied trauma rooms and stories of the children with gunshot wounds they lost that day. Some emergency departments treat multiple gunshot victims every day. Other countries send their physicians to the United States to train in penetrating trauma, since there is such a high incidence of gun violence.

In the United States, we have an epidemic of gun violence, with a mass-shooting event every day. There were more than six hundred mass shootings in the US in 2022, and our gun violence rates are increasing over time. More people have died from gun violence in the United States than US soldiers lost in every war combined.

The rate of death from gun violence in the United States is too high, but the solution requires information. How do other countries prevent gun violence? What are the risk factors associated with gun violence? What states have the least violence, and what do they do differently? These are all questions that can be answered, but someone must do the research, and doctors are up for the challenge. Physicians research all types of things that kill people, like cigarettes, the sun, and motor vehicle accidents. Why wouldn't physicians research gun deaths?

The mission of public health research is not antigun but rather anti-gun violence. For instance, a fellow emergency medicine physician founded the American Foundation for Firearm Injury Reduction in Medicine (AFFIRM), a research organization to fund evidence-based solutions to reduce firearm deaths.

The irony is that the NRA needs gun research. One of the biggest threats to gun rights in the United States is bad gun owners. Gun safety research and legislation should be a major goal of the NRA because not everyone should have a right to a gun. For instance, there is a consensus that those who have a history of murder should not own a gun. A card-carrying NRA member might argue that the NRA should fund research that promotes gun safety and education that decreases gun violence to protect the gun rights of responsible gun owners.

At the very least, the NRA should research its slogans. For instance, there's the famous saying, "The only thing that stops a bad guy with a gun is a good guy with a gun." FBI records show over 50 percent of active shooters commit suicide—meaning the person that most commonly stops a bad guy with a gun is a bad guy with a gun. Additional publicly available FBI research shows armed citizens thwarted only 4.4 percent of active shooter incidents.

Why does any of this political crap matter in medicine? In some cases, the most effective treatment is prevention, in this case preventing bullet holes, which may require policy intervention. Preventative medicine is not a new concept. Many of the most successful programs for reducing cancer deaths have preventative programs: Mammograms starting at age forty reduce breast cancer deaths by 41 percent, and colonoscopies in the general population, previously starting at fifty years old and now recommended at forty-five years old, reduced colon cancer deaths by 88 percent. And prevention doesn't necessarily mean taking guns away, although that did seem to work in Australia.

In response to a mass shooting in Tasmania that killed thirty-five people in 1996, the Australian National Firearms Agreement (NFA) banned the possession of guns without a genuine reason, such as hunting, skeet shooting, or Olympic shooting. The government bought back guns, estimating a national gun ownership reduction of 20 percent. Since NFA implementation, the annual rate of gun-related deaths fell from 2.9 per 100,000 in 1996 to just 0.88 per 100,000 in 2018. This may not be the

solution the US is looking for, but it improved Australia's gun-related death rates.

The countries with the strictest gun laws, namely South Korea, Japan, China, and Singapore, have the lowest firearm-related death rates in the world. The three countries with constitutional rights to gun ownership, Guatemala, the United States, and Mexico, are number three, five, and twelve in world firearm death rates respectively. In these three countries, clearly some of the wrong people own guns.

When comparing the rate at which people are killed by guns around the world, the United States is ranked 32 out of 194 countries in gun death rates. We trail closely behind Iraq. Afghanistan has a considerably lower gun death rate than the United States, ranking seventy-third in the world. In deaths by number of people, the US ranks number three worldwide, but we also have a large population, so death rates are more helpful in comparisons. In 2021, about half of US gun-related deaths were suicides, while 43 percent were homicides.

If you are ever shot, call 911, and hold pressure on the wound directly. Do not apply broad pressure, but rather pressure directly over the injury. Think about it like plugging a hole in a sinking boat—you want to put a cork directly in the hole, not hold a sponge over the entire area surrounding the hole.

Here's a fun fact—doctors don't search for bullets. I consult in TV and film industry medical writing, and this is something I often must correct. We leave lost bullets inside the body because the search can cause more damage. If doctors happen to see the bullet during surgery, we'll take it out, but otherwise you get to keep it.

If bleeding is not controlled with direct pressure, tourniquet any bleeding limbs. You can use a belt for this, wrapping it around the limb, then tightening the belt until the bleeding stops. Record the time the tourniquet is applied, as the hospital will need to know how long the tourniquet is left on to avoid losing the limb. Doctors keep tourniquet time to less than two hours.

It is unfortunate that many Americans will need this information. A 2023 poll by the Kaiser Family Foundation found one in five Americans have had a family member fatally shot, and one in six have personally witnessed a shooting.

What we are currently doing in the United States is not working, and while doctors might be able to provide the research and attempt to plug the holes, the power to stop the bleeding in our country belongs to the people.

THE ELEMENTS

Lightning

Time

Tornadoes

Earthquakes & Fires

Volcanoes

Altitude Sickness

Diving: Scuba & Free Diving

Exposure: Hypothermia & Hyperthermia

Drowning

LIGHTNING

Lightning is a mystical and beautiful force of nature that can kill you. According to the CDC, there are six thousand lightning strikes every minute, which is more than eight million strikes every day. That is a lot of opportunities to get hit, so this seems like an important chapter.

Lightning has been of human interest throughout history because of its awe-inspiring form and deadly properties. This might be why the most powerful god on Olympus, Zeus, wielded lightning, and why it is the power of the second-best X-Men character.

Because of its mystical roots, a lot of lightning folklore is untrue, but once in a while, stories hit the mark.

The 2002 romantic comedy *Sweet Home Alabama* used “fossilized lightning” as a key story element. When lightning hits sand, it forms glass called fulgurite, which looks like brown sea coral. It’s not as pretty as in the movie.

In the Harry Potter books, the main character has a scar on his forehead that resembles a bolt of lightning after being struck by the curse of death as a child. *The boy who lived* did in fact resemble a person who survived a lightning strike. Lichtenberg figures are fern-like branches that appear on the skin of lightning-strike victims, the markings themselves resembling lightning. They are due to small burst blood vessels in the skin along the lightning’s path, but usually disappear within twenty-four hours.

There is a saying that lightning never strikes the same place twice, and that might be because it has terrible aim. Of the three billion lightning strikes a year, only forty million hit the ground in the US. The odds of being hit by lightning are less than one in a million, and 90 percent of people who are hit live, but unfortunately, there are still twenty-eight lightning-related deaths a year in the United States.

Of note, lightning does strike twice, especially tall objects. According to the National Weather Service, the Empire State Building gets hit twenty-three times a year. This is one of the times I would trust the weather forecaster.

Cars are protected against lightning by the conductive metal roofs that move electricity quickly to the ground, not by the rubber tires, so don’t lean on the car doors in a storm.

To state the obvious: Most lightning strikes happen during storms, and lightning is attracted to tall objects. Do not stand near trees or any other tall structures. Metal and water do not attract lightning but are good conductors of electricity, so when lightning hits, it travels efficiently. Cars are protected against lightning by the conductive metal roofs that move electricity quickly to the ground, not by the rubber tires, so don't lean on the car doors in a storm.

Lightning strikes are more likely in the summer, most commonly in Florida and Texas. Lightning is also more likely to strike men, possibly because they're taller or outdoors ignoring the National Weather Service recommendations. Alternatively, lightning may be targeting men in Florida and Texas.

The primary way people die from a lightning strike is through cardiac arrest. The lightning disrupts the electricity of the heartbeat, causing a fatal arrhythmia and the heart to stop beating. If you survive the initial strike, there are burns and other health challenges to face, but mortality is generally caused by initial cardiac arrest.

A friend and fellow emergency medicine doctor was working at the White House when three people were struck by lightning. Because of his knowledge, he was able to spring into action and begin CPR immediately on one of the lightning-struck patients, who became the only survivor.

If someone is hit by lightning, they are not electrified, meaning you can touch them. The CDC recommends immediately starting CPR if the patient does not have a pulse and calling 911. If you don't know CPR, put this book down and go take a class, especially if you have kids.

If there is an AED nearby, have someone else get it. An AED is an automated external defibrillator that can be found in many public places including schools, swimming pools, shopping malls, grocery stores, airports, offices, and the White House. Take the AED to the patient and stick the pads on as pictured and push the shock button if indicated. The machine does the rest. The faster a shock is delivered to a fatal arrhythmia, the more likely the heart will start beating normally again. Keep in mind someone needs to be doing continuous CPR during the search for an AED, so you'll need a buddy.

Before you start CPR, always note if the patient is in a location that puts you in danger, such as below the needle of the Empire State Building or under a lone tree during a lightning storm. If it is safe to do so, you may

consider moving the patient to a less lightning-prone location to start CPR. If you get hit, you're not going to be much help. Now get out there and save lives, unless there is a lightning storm, then stay inside.

TIME

In 1900, world life expectancy was thirty-two years; today, in most countries, life expectancy exceeds seventy. This increase was greatly due to advancements in science, technology, and medicine. Access to clean drinking water, refrigerators, healthcare, antibiotics, vaccines, and public health efforts increasing education and sanitation have allowed the human lifespan to double, which is great because most people aren't ready to die at thirty-two.

The United States met a longevity roadblock as of late. For the first time since the 1920s, life expectancy in the US decreased in 2020, falling from seventy-nine to seventy-seven years. Two-thirds of this decline was attributed to the COVID-19 pandemic, but other concerns include the American lifestyle, poor nutrition, drugs, drinking, and lack of exercise. In his book *Outlive: The Science and Art of Longevity*, Dr. Peter Attia discusses the Four Horsemen of Aging: cancer, type 2 diabetes, heart disease, and neurodegenerative diseases. These are the diseases that will kill most Americans. For instance, the American Cancer Society states almost half of the US population will have cancer in their lifetime, and one in six will die from cancer.

The American Cancer Society states almost half of the US population will have cancer in their lifetime, and one in six will die from cancer.

Some populations have been able to maintain their longevity despite the obstacles, living in so-called Blue Zones, a term coined by Dan Buettner to describe the places with the longest-living people and high percentages of nonagenarians and centenarians. The Blue Zones include Okinawa, Japan; Sardinia, Italy; Nicoya Peninsula, Costa Rica; and Ikaria, Greece.

The longevity in these communities has been linked to plant-based diets, daily activity, and social support, with only 20 percent estimated to be due to genetics. It is important to note that in many of these locations, age is just a number, and it is not a number that is well documented. Some have pointed out that many of the world's "oldest people" live in regions that

lack accurate birth registries with low income, literacy, and a general population life expectancy that is lower than the national average, making the existence of supercentenarians, over 110 years old, unlikely.

No matter how long a life is, just being alive is not enough; the quality of the time spent alive is critical. In public health, we call this measurement quality-adjusted life years (QALYs), which combines the quality of a person's time alive with the life expectancy. My first introduction to this concept was not in a classroom but with my own family. My mother was diagnosed with cancer shortly after I was born, and though her treatment was successful, it left her riddled with a lifetime of health issues, requiring brain surgery and two open-heart operations, the second of which she did not survive. My mother had the insight to make her wishes clear with an advance medical directive. She did not want to suffer living connected to wires and tubes when efforts were likely futile, and quality of life was low.

Humanity has likely always been preoccupied with fear of death and thus sought to reverse aging. The mythical waters of the Fountain of Youth are present throughout history, written about by Greek historians, during the Crusades and the Age of Exploration, when Juan Ponce de León was searching for the Fountain and ironically found Florida, an eventual hotspot for the sixty-five-plus crowd.

Aging is a time-related dysfunction and deterioration of the physiological processes within the body caused by cellular dysfunction, epigenetic alterations (changes in DNA), and loss of telomeres. Telomeres are end-cap pieces of DNA that protect the DNA from being damaged, and over time they shorten, exposing the ends of the DNA. When the telomeres become too short, they cause cellular senescence, which means cells no longer divide but continue to release chemicals that can trigger inflammation. The old cell sits around like a grandpa on a front porch rocker yelling at kids to stay off his lawn, secretly plotting to attach thousands of colorful balloons to his home and float off to South America, which may be the logline for the Pixar movie *Up*.

If the grandpa had gone just a bit farther into outer space, he might have been able to slow his aging. The National Aeronautics and Space Administration Twins Study in 2021 showed that when one twin was shot into outer space, telomeres remained longer than in the earthbound twin. However, when the space twin returned to Earth, the telomeres quickly shortened to a length similar to the earthbound twin.

There could be multiple reasons behind the temporary twin telomere discrepancy, but it could be a biological example of Einstein's Theory of Special Relativity and the twin paradox. Time is not fixed but depends on the speed of the observer; faster-moving objects experience time more slowly, most noticeably as they approach the speed of light. So, a twin moving quickly through outer space would age more slowly than one on Earth.

For those earthbound, science is currently looking for other answers to aging. In 2023, a lab experiment connected the blood supply of an elderly mouse to a young mouse, and the young mouse began to age rapidly. The older mouse's blood supply was then disconnected and the aging process in the young mouse rapidly reversed.

But wait, there's more: The 2012 Nobel Prize in Physiology or Medicine was awarded to Shinya Yamanaka for discovering genes that could reverse cellular aging and take the cell back to its roots as just a young stem cell. Stem cells are cells that can become anything; they have their whole lives ahead of them. Further research has shown that it is possible to reverse cell aging without causing uncontrolled growth (also known as cancer), revitalizing human tissues, extending the lifespan of mice, and improving vision in monkeys.

While we wait for science to find a hose to fill up our fountain of youth, there are some current medications that may be helpful. Metformin is a medication used to treat and prevent type 2 diabetes. It has defined health benefits in treating those with metabolic disorders, but it may also slow aging in those without type 2 diabetes. Don't get too excited; most of the research is on flies and rats, but roundworms can celebrate because a study found metformin increased the lifespan of *C. elegans* by almost 40 percent. The jury is still out on whether this could be an elixir of youth for humans.

Good news, bad news—no matter what choices we make, we are all still going to die, but aging gracefully is an art that most hope to master. Even if the Blue Zone's supposed supercentenarians do not exist, there is something to be said for a life of any length well-lived. It is important to recognize the quality of time, even if it is relative, should be measured in both health and happiness. But it is harder to be happy when you are not in good health, and no one wants to be trampled by the Four Horsemen of Death. The best current advice for ending up on top of the horse and not underfoot is to prioritize a healthy lifestyle, which remains hitched to preventative

medicine and the sometimes-tedious task of healthy diet and exercise. Unless you are a roundworm, then take metformin and live it up.

TORNADOES

One morning my husband and I were getting breakfast in our favorite southern kitchen, waiting for an outdoor table so our labradoodle could join us. Once we were seated at our patio table with a red umbrella, the waitress came over to introduce herself as Sara. Instead of talking about the specials, we started talking about tornadoes. I'm not sure how the conversation started, other than that I come from a family of talkers and she grew up in Oklahoma, in the infamous Tornado Alley.

Although every state in the US has documented at least one tornado, more than 75 percent of the world's tornadoes spin down the eight-state span of the central US known as Tornado Alley. While Africa, Asia, Australia, Europe, New Zealand, and South America collectively document a few hundred tornadoes yearly, due to an unfortunate mix of geography and atmospheric conditions, the US has more than a thousand.

We never found out the breakfast specials, but we were just as happy to order off the menu, in exchange for a lesson in tornadoes from our Tornado Alley local.

Sara had spent most of her life in rural Oklahoma, familiar with the siren sounds of tornado warnings. However, warnings are usually given only ten to fifteen minutes before impact, so Sara learned to look for the signs. The sky turns a burnt orange, not the color of the sunset but the color of warning. Others say the sky turns green, but not Sara. Then the train whistles begin. High-pitched screams through the dense air serve as the wind's last kindness, a warning of the impending devastation. Then the sound of a freight train begins, barreling toward you, and this is the last moment some will remember.

Curiously, most tornadoes occur in the US between 4 p.m. and 9 p.m. It may seem like tornadoes only hit rural areas, but cities only make up 3 percent of the land use in the US, making cities a small target. Texas has the most annual tornadoes, but everything is bigger in Texas, including the land mass. Florida, closely followed by Kansas, actually has the greatest number of tornadoes per square mile. Tornado season starts in the southern states in April and migrates to the plains states and Midwest through June.

Public warning sirens in towns as well as smartphones are used to give tornado alerts. National Oceanic and Atmospheric Administration (NOAA) Weather Radio, which sounds riveting, and local radio stations are a good source of information during any severe weather. The National Weather Service reminds you not to call 911 to ask what is happening when the tornado sirens go off. If somehow you don't know what the sirens mean, ask a friend with a Southern accent.

The National Weather Service has created a warning system to alert the public of impending tornadoes. The first level is the *tornado watch*, which is when all those in the possible path of a tornado take inventory of supplies, gather pets, and prepare storm cellars. A *tornado warning* signifies a tornado that has been seen on the radar or touched the ground and been seen by a "tornado spotter," an actual job that I can guarantee does not pay enough.* In a tornado warning, it is safest to get into a storm shelter, but otherwise, the National Weather Service recommends getting to the lowest floor of the sturdiest building away from windows. Do not stay in cars or mobile homes, as these can be picked up by the storm. A *tornado emergency* is a warning of a severe tornado that has already caused catastrophic damage, and the highest-level alert to seek shelter immediately.

The CDC and National Weather Service do not recommend driving in a tornado. Even though tornadoes generally move at ten to twenty miles an hour, they can speed up to sixty, and the surrounding storm can make driving dangerous or even impossible. Cyclones also don't follow traffic laws and may cut right through a pasture to sideswipe a vehicle. Avoid underpasses, as seen in the 2024 film *Twisters*, because these structures can collapse and the narrow passage under bridges can cause wind speeds to increase. Do not go to large open rooms such as auditoriums, theaters, gymnasiums, or cafeterias, because large open rooms are usually only supported by the outside walls, so it's easier for the roof to be torn off and the walls to cave in—*Twisters* messed this one up.

Fleetwood Mac was wrong: Thunder does not only happen when it's raining, but tornadoes only happen when it thunders, which is not a catchy lyric, so I approve of Stevie's use of poetic license. All tornadoes form from thunderstorms, most commonly supercell thunderstorms, which produce the most violent and destructive tornadoes. A supercell storm is characterized by a mesocyclone or rapid rotating updraft that is not visible but can be seen on radar. When this rising air is met by a shearing force of wind it can

form a cyclone, where warm air continues to rise through the center, and a funnel cloud forms. The funnel cloud can then extend down toward the earth, and when it touches the ground, it becomes a tornado. If the air on the ground is too cold, the descent of the funnel cloud will slow and be unable to touch the ground, and a tornado will not form.

While the tornado is made of wind and therefore cannot be seen, the flying condensation, dust, debris, or periodic cow allows the wind to be visualized, like throwing a sheet over a ghost. Once the tornado touches down, the average path of damage is one to two miles long.

Tornadoes are categorized using the Fujita Scale or the Enhanced Fujita Scale, which assigns an “F” rating to a tornado based on wind speed and the damage it produces. Like a diabolical ice skater, a tornado does not receive its score until the event is over. Tornadoes with a score of F0 have the lowest wind speeds and cause the least amount of damage, while an F5 is incredibly devastating to infrastructure with wind speeds over two hundred miles an hour. Since 1950 the United States has had fifty-nine F5 tornadoes, the last being in Moore, Oklahoma, in 2013, which killed twenty-four people and caused a reported \$2 billion in structural damage.

Avoiding tornadoes is not an option for everyone, so being educated and prepared is the best defense until atmospheric scientists discover a more advanced warning system or even, someday, a solution.

EARTHQUAKES & FIRES

As a California native, I grew up in classrooms that performed routine earthquake and fire drills. While every elementary student knows to stop, drop, and roll, fewer have the privilege of learning engineering principles at such a young age—in an earthquake you need to know where to go to avoid being smashed. We would “duck and cover” under desks, protecting our heads and necks.

There are a lot of rumors about safe spaces during earthquakes. For instance, there is a popular belief that standing in doorways is safer, due to enduring historical images of homes after California earthquakes where only the doorframe remained. In modern buildings, doors are no more structurally sound than the rest of the building and can be more dangerous due to falling debris.

During an earthquake, it is recommended by earthquake safety authorities that you drop to your hands and knees, crawl to the nearest cover, and hold on. Don't run—the ground is moving, it doesn't work. Running outside is especially dangerous. If you happen to be outside, if possible, move away from trees or buildings, take cover, and hold on. If driving, pull over to a clear area, set the parking brake, and remain seat belted until the shaking ends. Most earthquakes are short, lasting ten to thirty seconds, but they can last minutes. Usually, larger earthquakes not only shake harder but also last longer.

In modern buildings, doors are no more structurally sound than the rest of the building and can be more dangerous due to falling debris.

I don't know who designed Earth, but our feet rest on massive slabs of moving crust, called tectonic plates, that shift around at will. The place where two tectonic plates meet is a fault line. This shifting of land masses that once gave us the supercontinent known as Pangaea has since separated the land into the seven continents we recognize today, but this isn't a fast-moving process, taking hundreds of millions of years. As the tectonic plates continue their slow migration, their craggy rock surfaces catch against each other. When the plates finally slip past one another, an earthquake ensues due to the sudden movement. Following the main shock of an earthquake, the fault line readjusts and settles at the rupture zone, and this can cause smaller earthquakes to follow, known as aftershocks.

The location of fault lines determines where earthquakes will originate. While most fault lines are in the ocean, the Pacific Ring of Fire includes numerous fault lines that run from Alaska down to the tip of Chile, containing the Hayward Fault, one of the most dangerous fault lines in the world, which is a major branch of the San Andreas fault system located in the San Francisco Bay area.

Earthquakes are measured by how jiggly they are. These days the Richter scale has been retired, and the US Geological Survey reports earthquakes on the Moment Magnitude scale, which measures the energy released by an earthquake and is stated to be more accurate in measuring larger quakes. The magnitude of an earthquake is determined by a seismograph, which is basically a pencil suspended in the air that scribbles squiggly lines on a piece of paper during an earthquake's shaking. The

bigger the earthquake, the more the ground moves, the bigger the squiggles, and thus the magnitude of the earthquake.

Magnitude is reported on a logarithmic scale from 0 to 10. Earthquakes can usually be felt above a magnitude of 3, and begin to cause damage at 5 to 6, destroying communities at a magnitude of greater than 7. The largest recorded earthquake was a magnitude 9.5 that struck Chile in 1960, killing thousands of people, and resulting in a tsunami hitting Hawaii and Japan, causing further loss of life. Most tsunamis are caused by earthquakes with a magnitude of greater than 7, originating at shifting tectonic plates near or in the ocean. Sometimes the devastation of the tsunami is far worse than that of the originating earthquake.

Japan has an unfortunate proximity to multiple fault lines. The country is no stranger to earthquakes or tsunamis, but it was once largely believed that the nation could not experience quakes greater than 8.4 magnitude. One geologist, Yasutaka Ikeda, disagreed and stated that Japan could expect a 9.0 magnitude earthquake in the near future. Unfortunately, he was largely ignored, and Japan based its earthquake and tsunami preparedness on lower magnitude estimates. It was not until March 11, 2011, when the 9.1 magnitude Tohoku earthquake and subsequent tsunami hit Japan, killing upwards of eighteen thousand people, that the world understood that Ikeda had been right.

The National Earthquake Information Center identifies an average of fifty-five earthquakes a day worldwide, approximately twenty thousand earthquakes a year. Most are inconsequential to human life, but Earth is a mover and a shaker.

It is not only the magnitude of an earthquake that causes devastation, but also the preparedness, engineering, and infrastructure of a society, and not every society can afford to be earthquake-proof. On January 12, 2010, a 7.0 magnitude earthquake struck Haiti, killing more than 300,000 people, according to the then prime minister's estimates, displacing 1.3 million, and decimating the island.

Another concerning coastline that may lack preparedness is located in the Pacific Northwest, where tectonic plates meet in an area known by geologists as the Cascadia Subduction Zone. In modern history this fault line has been eerily silent, hiding its true nature. Due to this silence, the Pacific Northwest found little reason to fear earthquakes or tsunamis. There seemed to be no reason for buildings to be up to seismic code, and 15

percent of the city of Seattle was built on liquefiable land, meaning the solid ground can behave as liquid in an earthquake.

Despite the sly slumber of the Cascadia, geologists have identified the fault line as a ticking time bomb with a one-in-ten chance of going off in the next fifty years. This will cause a devastating earthquake and tsunami, which FEMA estimates will kill thirteen thousand people. It will likely take months to restore electricity, up to a year to restore water services to the area, and the I-5 freeway will be toast.

Those located in the Cascadia tsunami inundation zone, which stretches from California to Canada, will have ten to thirty minutes to evacuate, as it will not be survivable. Once it hits the shore, what starts as ocean water will become a further deadly wave of cars, buildings, and debris. Within the inundation zone are hospitals, schools, and homes, many of which are unlikely to preemptively move locations. Proactively relocating public structures in these communities could save lives, but sometimes Mother Nature is harder to outrun.

In 1906, after losing both parents, my great-grandmother Loretta moved from Ireland to San Francisco, California, accompanied by her aunt and younger sister. Three days after she arrived, she woke up to the earth shaking. For the next thirty seconds, one of the most devastating modern earthquakes would shake from Oregon to Los Angeles, centered under San Francisco. Thousands were left dead, and the city was in ruins, but that wasn't the end of the devastation. During the 7.9 magnitude earthquake, many of San Francisco's gas mains were ruptured, fueling an uncontrollable fire that burned for three days.

My family got tired of earthquakes, so they moved south to San Diego, which has historically been a tad less shaky. Unfortunately, we could not escape the fires, and when I was a senior in high school much of my community burned down in the 2003 Cedar Fire, which, at the time, was the largest fire in California's history.

Fires are unfortunately becoming more common and aggressive as the world warms up and dries out, but we continue to add kindling by relentlessly burning fossil fuels. In 2020, when nothing else disastrous was going on, the world caught on fire. This included the August Complex Fire, which is California's largest recorded wildfire. Around the same time, Australia caught on fire, enticed by record-breaking temperature highs. Next, South America surpassed its record for number of fires, with the

Amazon set ablaze in a fire so obscene that it was being watched from outer space. As of 2025, California wildfires continued to increase in severity and frequency, due to extreme heat and drought related to climate change. This culminated in the disastrous 2025 Palisades and Eaton Fires, where twenty-eight people lost their lives and real estate losses were estimated up to \$30 billion. It's hard to know where to move when everything is on fire.

In my final escape act, I moved across the country to Washington, DC, not historically a hotspot for earthquakes or fires. On the day I arrived, the nation's capital felt its first 5.8 magnitude earthquake, the largest ever recorded for the area, which cracked the Washington Monument. At this point I determined I couldn't run, especially in the earthquake, and reverted to the recommended "duck and cover," hoping nothing would catch on fire.

VOLCANOES

In 79 CE, the volcano Mount Vesuvius erupted, wiping out the city of Pompeii. Today Vesuvius is still regarded as one of the world's most dangerous volcanoes, with its last major eruption in 1944. In contrast, Iceland's volcanoes have been popping off, with an eruption every three to five years, but some types of volcanoes are more menacing than others.

Volcanoes are mountainous structures formed over time by magma, molten rock that rises from the Earth's mantle to the surface, often venting through a central crater. Most human fears are focused on the volcano's lava, but hot magma is all bark and slow bite. Lava is slow-moving and often not the cause of death in volcanic eruptions. In contrast, lahars are volcanic mudslides that move at up to two hundred miles per hour and can demolish cities. Some, but not all, volcano eruptions are explosive. In explosive eruptions, such as Mount St. Helens's, house-size pieces of ash called tephra fly through the air in a heated cloud known as a pyroclastic flow, which melts everything in its path.

There are four types of volcanoes: shields, stratovolcanoes (composite), volcanic domes, and cinder cones. Shield volcanoes are flat and wide with slow-flowing lava, like Hawaii's Mauna Loa. Stratovolcanoes, which include Mount Fuji and Mount St. Helens, are steep with a narrow base and known to have explosive eruptions as well as pyroclastic clouds. Volcanic domes, also known as lava domes, are squatty little numbers that slowly spill out lava and occur in clusters, such as those seen in California's Lassen

Volcanic National Park. Lastly, cinder cones are the world's most common and smallest volcanoes, found all over western North America. Cinder cones are heavily mined for their volcanic cinders, which are used for concrete, cinder blocks, and construction of roads.

When a volcano erupts it can be measured on the Volcanic Explosivity Index (VEI), from 0 to 8, 8 being the apocalypse, which last happened in Yellowstone National Park 640,000 years ago.

There are 1,350 potentially active volcanoes worldwide, with twenty erupting daily, which seems like a disaster, but volcanoes are necessary, and responsible for forming most of the Earth's surface. For instance, volcanoes are actively forming the archipelago known as Hawaii, and the big island is home to the largest active volcano on the planet, Mauna Loa.

The United States is home to the most Holocene volcanoes in the world, with an estimated 170 steaming Earth pimples that have been active during our current geological period, known as the Holocene period. For instance, Mount St. Helens in Washington had an explosive eruption in 1980, scoring a 5 on the VEI, followed by smaller eruptions from 2004 to 2008. The US is also home to the largest eruption in the twentieth century, which scored a 6 on the VEI and occurred in 1912 at Novarupta, on the Alaska Peninsula. The region with the most active volcanoes since 1950 is Indonesia, closely followed by the US, Japan, and Russia.

Volcanoes are made to erupt, and currently, there is nothing to be done about it, aside from considering relocation if an Earth pimple pops up in your backyard. But most magma mountains do not have to move, because people will walk right up to them. In recent history, humans have taken to volcano tourism, because it probably won't explode. This is a bad idea, but one can understand the interest; magma is neat.

In the early 1900s adventure tourism began to take off in New Zealand, and recently more than ten thousand tourists a year have flocked to explore the Ngatoro and Central volcanoes of White Island. While the Ngatoro Cone is extinct, the Central Cone remains an active stratovolcano—the explosive kind.

On December 9, 2019, during the summer season on White Island, adventure tourists set off for their day trip with local guides. Forty-seven people were physically on the island that day, and almost half of them would die with onlookers watching from boats as the volcano chose its moment to erupt. Initially, some tourists were excited by the prospect of

getting to see the volcano explode, until they understood what it meant. A cloud of burning volcanic ash quickly swept the area, and some adventure tourists narrowly escaped by jumping in the water. The Netflix documentary *The Volcano* gives survivors' accounts and footage of the eruption. The takeaway is that tourists wish they had not been there. The odds were that the volcano would remain silent that day, just like every other day, but if something is dangerous enough, the odds don't matter.

In an eruption the Red Cross recommends avoiding rivers and valleys, as this is where lahars will flow, wearing a mask to avoid breathing potentially deadly ash and gases, and having an evacuation plan. There is not a lot of good advice for avoiding death by volcano, other than avoiding the mountain.

[ALTITUDE SICKNESS](#)

Emergency medicine doctors are known to be wanderers and adventurers. They climb mountains, scuba dive, backcountry ski, and get shot into outer space. Emergency medicine fellowships are available in hyperbaric medicine, toxicology, space medicine, and disaster medicine, so you can see how the specialty attracts thrill-seekers.

I am not a seeker of thrills. I prefer to read quietly at home, and my husband has trouble getting me on airplanes, so no one will be shooting me into outer space. Sure, in my youth, I went skydiving and scuba diving with sharks, and I have been fortunate to travel the world, mostly via solo travel. But as I grew wiser and realized my mortality, I stopped testing the limits. Meanwhile, my friends in emergency medicine found new and terrifying ways to push the boundaries, running space programs and climbing Mount Everest. If I see one more social media photo of a friend at the Mount Everest base camp, I'm deleting my profile.

Mount Everest, located in the Mahalangur Himal sub-range of the Himalayas on the border of Nepal and Tibet, is the highest point on Earth at 29,029 feet above sea level. While no humans live on Mount Everest due to the scarcity of oxygen, the Sherpa ethnic group lives in the Khumbu Valley near Everest. The highest elevation to be home to a permanent population is La Rinconada in the Peruvian Andes, known as Devil's Paradise for its harsh living conditions at an elevation of over 16,000 feet above sea level.

But the people of La Rinconada are only a small percentage of the eighty million humans living above 8,200 feet throughout the world.

High-altitude hypoxia, or decreased blood oxygen, is experienced at elevations over 8,200 feet, because as altitude increases the air pressure decreases, which is why eardrums may experience a popping sensation in an ascending airplane.* When air pressure is lower the molecules of oxygen spread out in space, so in one breath of air there are fewer oxygen molecules, making it harder to breathe adequate oxygen to the lung tissue, blood, and organs. In outer space, the pressure is so low that, functionally, there is no oxygen. High-altitude lack of oxygen can be deadly, but there are those civilizations that have lived at altitude for centuries creating new, improved adaptations in human beings, reminiscent of X-Men superheroes.

Communities living at high altitudes for centuries have not only individual adaptations but also genetic adaptations that are passed down through generations. These changes are seen in high-altitude civilizations such as the Andeans and Tibetans. For example, the cardiac stress induced by altitude, which can result in heart failure for predisposed visitors, has naturally selected genetic mutations in Andeans to reinforce their cardiac systems to withstand chronic altitude and low oxygen. High altitude and low oxygen have been shown to affect fetal growth and decrease birth weight, but after generations at altitude, Tibetan and Andean women actually give birth to larger babies than populations at sea level due to adaptations in genes that regulate fetal growth, as well as a genetically coded increase in the diameter of the uterine artery, allowing for increased blood flow to the fetus. Genes that encode red blood cells and the body's reaction to stress have undergone natural selection in these populations for the strongest and most adaptable response to high altitude and low oxygen. Peruvian Quechua have a gene mutation that allows them to hold high concentrations of oxygen in their blood, and some Tibetan populations are genetically encoded to breathe 50 percent faster than average humans.

For those visiting or with less than a century of ancestral high-altitude living, none of these genetic modifications exist, although they are unnecessary at milder elevations. In the United States, the highest elevations are Denali in Alaska (20,310 feet) and Mount Whitney in the continental US (14,494 feet), which are high enough to induce high-altitude hypoxia. However, most of the highest settlements in the US are at less than 10,000 feet, located in Colorado, followed by Flagstaff, Arizona, and Big

Bear, California. Inhabitants may experience some physiological changes, but they tend to be less drastic.

Over months to years at altitude, even new inhabitants undergo changes to accommodate for the stress of low oxygen. The body increases the amount of hemoglobin in the blood to carry more oxygen, also increasing the volume and viscosity (thickness) of the blood. These changes can cause chronic mountain sickness, with symptoms of headaches, dizziness, palpitations, and shortness of breath, but in most new inhabitants these physiological augmentations will go unnoticed.

In select populations, ultrasound of the heart has shown high-altitude populations experienced thickening of the heart muscle and high pulmonary pressures. In sea-level populations, these changes are usually associated with heart disease and pulmonary hypertension, but they may not have the same significance at altitude. For instance, a research study done by the University of Colorado School of Medicine in partnership with the Harvard School of Public Health associated high-altitude living with a lower risk of ischemic heart disease and a potential increase in life expectancy. That being said, the American Heart Association does caution those with existing heart disease that traveling to high altitudes may be dangerous and induce heart failure.

Although the long-term effects of altitude may serve as inspiration for some of Stan Lee's greatest comic book heroes, most travelers are concerned with short-term altitude sickness. The most important predictors of altitude sickness are the rate of ascent and final elevation. Acclimation is key to avoiding acute illness, which is an issue when skiers land in the mile-high city of Denver only to quickly ascend to mountain towns the same day. Those exposed rapidly to altitude above 6,560 feet are at risk for acute mountain sickness, a generally benign and self-limiting headache, nausea, fatigue, and sleep disturbance.

Acute mountain sickness (AMS) affects up to 50 percent of travelers spending the night above 10,000 feet. While generally self-limited, it may become persistent or progress to life-threatening high-altitude cerebral edema (HACE). HACE is caused by swelling of the brain, resulting in confusion, difficulty walking, altered mental status, and eventually coma and death. High-altitude pulmonary edema (HAPE) can worsen HACE but is a separate disease in which an ascent, often to above 8,000 feet, causes fluid to accumulate in the lungs until patients can no longer breathe.

All these high-altitude-associated illnesses are incited by the quick transition into a high-elevation, low-oxygen environment, which places stress on the heart and blood vessels, causing fluid to accumulate in the brain (AMS/HACE) and lungs (HAPE). These diseases are treated with descent to lower altitudes and oxygen therapy through supplemental oxygen or hyperbaric chamber treatment.

Some individuals use high-altitude low-oxygen concentrations to their advantage. Olympic athletes have trained at altitude for short periods to build up fitness and theoretical oxygen capacity for a race. The winningest Olympian of all time, Michael Phelps, was reported to have slept in a hypobaric chamber that simulated an atmosphere of around 8,000 feet for almost a year.

There are ways to help prevent altitude sickness, the most important being acclimation via slow ascent, which is why I continue to be inundated with photos of thrill-seeking emergency medicine physicians spending weeks at the Everest base camp. For those living at sea level, the CDC recommends traveling no higher than 9,000 feet of elevation in one day and spending a few days at this altitude before continuing to increase elevation by no more than 1,600 feet per day. Stay hydrated, do not drink alcohol, and consider making day trips to higher elevations and returning to sleep at lower altitudes. There is a medication that can help prevent altitude sickness, acetazolamide, which causes patients to secrete bicarbonate in their urine. It makes their blood slightly more acidic, thereby increasing their resting respiratory rate to increase blood oxygen, which means they're basically emulating a Tibetan.

For those who are not mountaineering thrill-seekers or genetically equipped Tibetans, reading this book at sea level is a safe and fun alternative to high-altitude adventures.

DIVING: SCUBA & FREE DIVING

Both free diving and scuba diving come with dangers far beyond ocean flora and fauna. Most of these dangers are pressure-related. Similar to how pressure changes with high altitude can cause sickness, even a fraction of the 352 quintillion gallons of the ocean's water will make an impression.

Scuba divers wear tanks, most commonly containing atmospheric air. There are other gas mixtures used in diving such as nitrox, trimix, and

heliox, which contain different combinations of gases that allow for longer or deeper diving. When divers take a breath at the surface, the air in their lungs and the air around them is at atmospheric pressure. When they dive beneath the water's surface, the pressure quickly increases due to the water above, condensing anything that is compressible, like the gas in the diver's tank and lungs.

This phenomenon can be demonstrated by blowing up a balloon at the surface of a pool and swimming to the bottom. The balloon will shrink at increasing depths, as the gas in the balloon is compressed, which is called a *squeeze*. This pressure change at depth comes with dangers. For instance, if you were to fill the balloon with air while at the bottom of the pool, when you swam to the surface the pressure around the balloon would decrease, allowing it to expand and possibly pop.

This is how arterial gas embolisms cause death in diving, and the basis for the number one rule of scuba diving: Never hold your breath. As long as divers keep breathing, air will escape as the surrounding pressure changes, but holding your breath could pop a lung. If the lung tissue is damaged, an air bubble can get into the blood vessels of the lungs, which can cause sudden cardiac arrest if the air blocks a pulmonary artery, or stroke if the air travels to the brain. If a diver surfaces unconscious or dead, it is often from an arterial gas embolism. The key to prevention is slow ascent with exhalation. The golden rule of scuba diving is just keep breathing.

The number one rule of scuba diving: Never hold your breath.

Treatment for arterial gas embolism is immediate CPR for those without a pulse, and to get the patient to an emergency department immediately. These cases have not had good outcomes historically, with 90 percent reported mortality, but some modern treatments have been shown to decrease mortality and improve patient outcomes.

Perhaps the most infamous danger of diving is *the bends*, also known as decompression sickness. The bends are another gas problem. Most of the air we breathe is nitrogen gas, which is safely exhaled at sea level. When diving, the nitrogen gas we breathe is forced into the bloodstream by the high pressure of surrounding water. While the oxygen we breathe is metabolized, the nitrogen sits around in the blood doing nothing and accumulating. When a diver ascends from the depths, pressure decreases,

allowing nitrogen to come out of the blood. If the diver ascends slowly, the nitrogen can reach the lungs to be exhaled out of the body, but ascending too quickly leaves no time for the gas to be exhaled, instead accumulating in the blood, forming small gas bubbles. This is the same phenomenon seen when opening a pressurized can of soda, as the quickly decreasing pressure in the can allows gas bubbles to escape from the liquid. The nitrogen bubbles in the bloodstream cause the bends.

Depending on where the gas bubbles form, different symptoms of the bends will arise. It is most common for nitrogen bubbles to form in the joints, causing pain, but bubbles can also cause skin rash, inner ear disturbance, and spinal cord injury, resulting in paraplegia or quadriplegia. If the nitrogen bubbles go to the heart and lungs, it causes *the chokes*, which in turn cause shortness of breath, cough, and chest pain, and can be fatal. The bends can also be experienced by astronauts who walk in space because this is another instance when surrounding pressure is decreased in a matter of seconds to minutes.

Treatment for mild symptoms of the bends is supportive, but more serious symptoms are treated in a hyperbaric oxygen chamber, where patients are placed back under pressure to force the nitrogen gas into the blood and then slowly decompressed so the nitrogen has time to dissipate appropriately.

With all these changes in pressure, it is important to realize the type of activities that will increase risk. If traveling from altitude, spend a few days acclimating at sea level. It is also not recommended to scuba dive within twelve hours of flying on a plane, a period that increases based on the number and depth of dives. Additionally, some heart defects can place divers at increased risk, so if you have a heart murmur, get checked out before diving. Scuba diving involves some complicated physics, allowing for life-threatening mistakes, which is why a PADI certification course is required.

Free diving is a diverse sport with a different golden rule: one breath, one dive. I spend a good amount of my time outside the hospital writing and one of my jobs is as a screenwriting consultant for television and film. One year at the Sundance Film Festival there were multiple films on free diving, including the film *No Limit*, inspired by the life of world record free diver Audrey Mestre.

No-limit free diving, historically the deepest discipline, allows divers to use a weighted sled to descend and an inflatable device to ascend, achieving depths greater than 500 feet. Audrey Mestre was training to break the world record in no-limit free diving when she went out for a practice dive to 561 feet. When she reached this depth, she opened her air tank valve to inflate her buoy and ascend, but the air tank was empty. This is generally something that undergoes multiple safety checks, so there were accusations of foul play. At this depth, it was impossible for her to ascend in time by swimming, and reports state that there were an inadequate number of safety divers, so tragically, Audrey died.

The most common cause of death of free divers is drowning. This can happen due to a free diver blackout, due to a lack of oxygen. Free divers will often hyperventilate in an attempt to exhale as much carbon dioxide as possible before the dive. Breathing is usually spontaneous; even during sleep it happens all on its own, and under normal circumstances the rate of breathing is determined by the level of carbon dioxide in the blood. Although a person can temporarily stop breathing, increasing levels of carbon dioxide in the blood signal the brain to take a breath, so it becomes increasingly difficult to resist breathing. Although breathing is triggered by the increasing level of carbon dioxide in the blood, what the brain is looking for is oxygen, as eventually a lack of oxygen will cause death.

Decompression sickness can happen with repetitive free dives, and arterial gas embolisms may occur if the free diver holds their breath during ascent instead of exhaling, but these are both more commonly seen in scuba diving. Nitrogen necrosis is also more common in scuba divers but can affect free divers as well. Known as the rapture of the deep, in depths greater than one hundred feet, divers can experience increased nitrogen coming out of the blood vessels in the brain, which is like your brain taking a hit of laughing gas, nitrous oxide. But a hundred feet underwater is not a great place to be laughing. Nitrogen necrosis causes divers to be confused and act intoxicated, but it quickly dissipates upon proper ascent.

All adventures come with risks, and diving is certainly a worthwhile endeavor for many. Safety in diving is not difficult, but the laws of physics must be followed. Scuba divers must keep breathing and complete needed decompression stops. All divers must perform safety checks, exhale on ascent, and avoid chumming the waters. Respect the ocean or she'll demonstrate how nature got the nickname Mother.

EXPOSURE: HYPOTHERMIA & HYPERTHERMIA

HYPOTHERMIA

In second grade we learned about a classmate's parents trapped by an avalanche while skiing. They made it out alive, but if memory serves, they lost several toes. I am unsure why a class of seven-year-olds was privy to this information, but I must imagine it was circle-time fodder and not a formal class presentation on amputations and the dangers of backcountry skiing.

Hypothermia comes in stages as the body gets colder. Normal body temperature can be confirmed by taking the temperature of any singer from the early 2000s boy band 98 Degrees. The first stage of hypothermia begins around 95°F with shivering. When the body temperature decreases to 89°F, stage two begins, as shivering ceases and consciousness begins to waver. By stage three, the patient is unconscious, and the body temperature is less than 82°F. Stage four, at less than 75°F, resembles death, but patients can still be revived. At a body temperature of less than 56°F, hypothermia is irreversible, and the patient is dead. In emergency medicine, there is a saying: "You are not dead until you are warm and dead." This is because warming a patient undergoing CPR who has an apparent death due to hypothermia could save their life.

Rewarming a hypothermic patient is a more complicated process than cooling a patient who is overheated. Rewarming is often done at a controlled rate because when blood begins to circulate to the limbs it can cause low blood pressure and shock to the organs. This is the reason the core of the body is always rewarmed first.

In mild hypothermia, patients are in the first and second stages, and still conscious. External rewarming with blankets and heating pads concentrated on the trunk is recommended, increasing the body temperature at a rate of at least 1°F per hour. For those with more severe hypothermia, warming is done as fast as possible in an emergency department with warmed intravenous fluids or extracorporeal membrane oxygenation (ECMO), which is a heart and lung machine that warms and oxygenates blood before returning it to the body.

Another issue encountered in the cold is frostbite. Frostbite also has stages or grades. The first grade of frostbite is known as frostnip; this is partial freezing of the skin that causes numbness, stinging, and redness. In later days the skin may peel, but you get to keep all your parts, as no

amputation is needed. Grade two is full-thickness freezing of the skin that will cause throbbing and pain, with swelling and blisters, followed by a black scab and skin loss days later. The next grade is when you start losing the tips of things. The skin starts to turn gray or blue and blood-filled blisters will form. In grade four frostbite the freeze extends to the bone, at which point the skin will turn from blue to a dessicated black scar that requires amputation.

Toes are not the only pieces you have to protect from the cold. Prince Harry, Duke of Sussex, shared a story in his memoir, *Spare*, about a particularly important piece of himself that endured a stage of frostbite. “Upon arriving home I’d been horrified to discover that my nether regions were frostnipped as well, and while the ears and cheeks were already healing, the todger wasn’t.” In an effort to save manhoods everywhere, this is how to heal frostbite:

First, remove wet clothing and jewelry. Avoid fires and rubbing tissue for rewarming. Rewarming of frostbite is accomplished by placing the affected area in heated water, but the temperature of the water is of extreme importance. The Wilderness Medical Society currently recommends warm water, 37 to 39°C (98.6 to 102.2°F), in a whirlpool, circulating the water. It is critical to avoid refreezing any frostbitten areas, so do not start rewarming if refreezing may occur. Get to a hospital quickly, because third- and fourth-degree frostbite can sometimes be treated with blood-clot-busting medications to try to save more of the extremity. That which can’t be saved may be amputated to avoid infection and death. Frostbite injuries often require long-term wound care, so anything past grade one will require a doctor’s care.

In the words of the late great Notorious B.I.G., “If you don’t know, now you know.” Fingers, toes, and todgers everywhere, rejoice, and maybe put an extra sock on if you are committed to backcountry skiing.

HYPERTHERMIA

Heat-related deaths have been increasing with the increase in global temperatures. In 2023, the US had its highest-ever number of heat-related deaths, with over twenty-three hundred reported. More than three-quarters of those deaths took place in five states: Arizona, Texas, Nevada, Florida, and Louisiana. Arizona has a built-in death trap known as the Grand Canyon that takes the lives of a dozen ill-prepared tourists annually, usually

ones hopping around in flip-flops and carrying no water. The second most common cause of death at the Grand Canyon is falling; again, sandals are not a recommended shoe choice.

The hottest places on Earth are mostly located in Middle Eastern countries where temperatures can reach 125°F or greater. While living abroad, I had the privilege of walking in this heat, where I discovered that it is possible to sweat from the eyelids. The world's hottest temperatures, however, are not in the Middle East. Death Valley, California, boasts the world's highest recorded temperature at 134°F. It seems the United States is dedicated to winning everything.

Even without frequenting Death Valley, exertional heat illness is a leading cause of death in young athletes, also seen commonly in military personnel and outdoor laborers. Risk factors for heat-related illness include high temperature, humidity, dehydration, lack of acclimatization, poor fitness, improper clothing, alcohol, and certain drugs, such as diphenhydramine (Benadryl) and decongestants.

There are several types of heat-related illness, but the three main categories are on a spectrum from heat exhaustion, to heat injury, to heatstroke. Heat exhaustion, the most common, is a rise in core body temperature to between 100 and 104°F, often causing collapse due to an inability of the heart to continue to pump enough blood during exercise and/or environmental heat. There is no damage to organs or brain dysfunction. Heat exhaustion is treated by removing excess clothing and having the patient recline. Dousing the patient with cold water or an ice bath can be done but it is not necessary before transport to the emergency department.

It is important to understand that athletes can have life-threatening heat-related illnesses and a normal mental state.

Heat injury is usually seen at a core body temperature of 104 to 105°F and is heat exhaustion that causes organ damage, such as kidney and liver failure, with no brain dysfunction. It is important to understand that athletes can have life-threatening heat-related illnesses and a normal mental state.

Heatstroke is seen as a core body temperature above 104°F and is a heat injury with associated brain dysfunction. *Heatstroke* is a term that gets thrown around a lot, but if the brain is still working, there is no heatstroke.

These patients will have confusion, seizures, and coma, and must be cooled down immediately to a temperature of less than 102°F with an ice bath or by dousing them in cold water. This is one emergency where the patient is treated immediately, before transporting to the ED, because rapid cooling is key to survival.

Temperatures refer to *core temperature*, which usually refers to rectal temperature. If there is no thermometer, or a resistant rectum, medical personnel concerned for heat injury or heatstroke will do a ten-minute supervised ice bath, circulating the water, and making sure the patient's head remains above water, before transport to the emergency department, where the patient will receive intravenous rehydration and further cooling.

These body temperatures are in the setting of heat exposure or exertion, not from an illness. Pediatric patients frequently have extremely high temperatures in the setting of illness, but fevers related to illness are not intrinsically dangerous to the brain or organs in the same manner. However, children are particularly sensitive to environmental heat, because they cannot regulate their body temperature as effectively. This is the reason children should never be left in cars or out in the sun.

There are other heat-related illnesses, such as muscle breakdown (rhabdomyolysis), fainting, heat rash (also known as prickly heat or miliaria rubra), heat cramps, and heat tetany. All these pathologies are related to sweating, dehydration, and electrolyte imbalances. Drink electrolyte-containing water, stay in the shade, and if you're feeling ill, get checked at the nearest emergency department.

DROWNING

During residency, I spent several months covering the surgical intensive care unit (SICU). Though my coresidents were some of my favorite people in the hospital, there was an attending physician who treated us terribly, earning the moniker *the fascist*.^{*} I will say on behalf of the fascist that the SICU is not a happy place; it is a place where terrible traumatic and surgical ailments are constantly challenging the limits of medicine.

One of my patients was a boy named Max. Max was at a sleepaway summer camp when he attempted to show off his new tumbling skills, performing a flip into the lake. What he didn't know was that the water

level had decreased due to drought, and he landed poorly in only several feet of water.

Coming into the trauma bay, Max was surprisingly calm. He could not feel or move anything below his shoulders. He had broken a lower cervical spinal bone in his neck, and it had injured his spinal cord. This is generally a permanent injury, although, with rehabilitation and healing, some mild improvement can be seen. Although Max sustained a terrible injury, he was fortunate not to drown.

Most accidental drownings in children under one year old occur in the bathtub.

It is easy to forget how dangerous shallow waters can be. It does not take much water to cause an emergency, as most accidental drownings in children under one year old occur in the bathtub. In the United States, swimming and diving injuries are the second leading cause of death in children under seventeen, and the leading cause of death in children aged one to four. While drowning incidents in younger children tend to take place in swimming pools, children aged fourteen to seventeen tend to experience drowning incidents in natural bodies of water.

Spending much of my life near the Pacific Ocean, I quickly learned the dangers of its currents. While the ocean openly displays her power with crashing waves, she also hides more insidious dangers—riptides that can swiftly pull swimmers out to sea.

Cynthia had spent plenty of time at the beach with her family, and as a teenager, she certainly knew how to swim. But on the day I met Cynthia, her lifeless body had been pulled out of the ocean waves and presumed dead. I was not present at the shore, but I was told a bystander had given rescue breaths before beginning CPR and Cynthia began coughing. In most cases of cardiac arrest, the patient will not wake up, even if the heartbeat resumes during CPR, but in immediately treated drowning victims, the patient will sometimes regain consciousness. Cynthia rolled into my emergency department on a stretcher, sitting up and appearing well. Her vitals were normal, and her chest X-ray did not show signs of aspiration or lung damage. She had cheated death that day and walked away relatively unscathed.

Drowning is any event where breathing is impaired due to submersion in liquid. Fatal drowning is self-explanatory, and near-fatal drowning is an

event where the drowning incident is stopped before death, although the patient may still lose consciousness.

Dry drowning is not a medical term, but a sensationalized term created by the media to describe a rare lung injury from significant water aspiration during a near-fatal drowning incident. This doesn't happen from drinking water or minor submersion. Like Cynthia, these patients have significant submersion events, such as being held underwater, that lead to aspiration. They appear to improve initially, but four to eight hours later when their lung injury develops, they will have coughing, difficulty breathing, blue skin, and altered mental status. I am not sure why the term *dry drowning* developed since nothing about this process is dry.

For drowning victims, the American Heart Association recommends giving rescue breaths before starting bystander CPR, and parents should take a pediatric CPR class. Remember to remove life jackets before starting chest compressions. Although swimming lessons are a great way to increase safety, they don't replace parental supervision, which is harder than it seems, as most drowning takes place with at least one adult present. Young children do not often display typical splashing, waving, or yelling while drowning, and it can take place in seconds, silently. Finally, all drowning incidents should be evaluated at an emergency department, even if the child appears to have recovered.

WARFARE

Anthrax

Other Biological Weapons

Chemical Weapons

Nuclear Weapons

ANTHRAX

What bacterium was used in bioterrorism in 2001 in the form of a deadly white powder enclosed in US mail? *Bacillus anthracis*, a Category A biological weapon. The FBI case, code-named Amerithrax, investigated anthrax letters sent to several senators, resulting in five unfortunate deaths.

Bacillus anthracis is mostly found in the soil. That's right, it's just hanging out in the dirt. Makes you think differently about your kid's sandbox, eh?

Anthrax is caused by *Bacillus anthracis*, a gram-negative rod bacteria covered in a protective endospore, like a nut covered by a shell. Because of the protective coating, this bacterium can remain in the soil awaiting activation for decades. In its dormant state anthrax is resistant to radiation, heat, drying, and oxidation, so put away your hydrogen peroxide. Its stability is what makes anthrax the ideal biological weapon. Nuclear weapons can be a little touchy, and way too potent to be portable.

Animals, such as sheep, horses, cattle, and camels, usually contract anthrax by ingesting spores in water or soil. It's been annoying farmers since at least 700 BC. Anthrax may have originated in Egypt, and scholars believe it may have served as the fifth plague of Egypt in the Bible, livestock pestilence. Old Testament God was ruthless.

Today we greatly avoid anthrax infections via vaccination in both humans and animals. Are you sensing a theme yet? Vaccines have saved you from everything you didn't know could kill you, and all the animals. Vaccines are the single greatest medical advancement of humankind, a virtual Noah's Ark. But humans often have trouble accepting the miracles they are given. As the statue of a saint came to life to say to the man who prayed every day to win the lotto, "For the love of God, please buy a ticket!"

In the 1950s, a human vaccine was created for anthrax, but it is reserved for those with exposure risks, such as US military personnel, anthrax lab workers, people working with infected animals, and known exposures to anthrax.

There are three common types of anthrax infection: pulmonary, cutaneous, and gastrointestinal.

The most common form is the least deadly—cutaneous anthrax. This accounts for over 95 percent of cases, with a fatality of approximately 20

percent without treatment. Cutaneous anthrax is the result of anthrax spores entering breaks in the skin. This causes black necrotic scabs called eschars.

Gastrointestinal anthrax is contracted via ingestion of spores. Stop eating dirt and avoid undercooked meat. A week postexposure, patients develop nausea, diarrhea, abdominal pain, and occasionally bloody vomiting. Gastrointestinal anthrax is 25 to 75 percent fatal, which is a ridiculous range, meaning we are not sure how fatal it is.

The final and most fatal form of anthrax is pulmonary. This is contracted when the spores are inhaled. Those at high risk include animal hide manufacturers, veterinarians, and those targeted in bioterrorism, such as emergency and military personnel. Initial flu-like symptoms can take up to two months to manifest. Pulmonary anthrax is fatal due to severe hemorrhagic pneumonia, which is a lung infection that bleeds. This form of anthrax has a mortality rate of over 80 percent.

There is one other form of anthrax infection that was not initially mentioned, as it is uncommon. It is possible for the anthrax bacteria to be injected directly into the bloodstream. This is most often seen in intravenous drug users. In 2009, fourteen people in Scotland died after heroin was contaminated with anthrax. This rare disease form has a flu-like prodrome including fevers and chills with eschar or abscess at the site of injection, but can also cause septic shock and meningitis.

The good news is that anthrax infections are treatable. They are susceptible to our very first antibiotic, penicillin, but they are also responsive to amoxicillin, doxycycline, erythromycin, ciprofloxacin, and streptomycin. Anthrax is treated with antibiotics, postexposure vaccination, and sometimes an antitoxin. Anyone with possible exposure to anthrax should report to the emergency department immediately.

OTHER BIOLOGICAL WEAPONS

At the beginning of the century, a Russian scientist, Dr. Vladimir Nekhorvich, working for the pharmaceutical company Biocyte, engineered a lethal virus to be used as a biological weapon. The virus, named Chimera, and its antidote, Bellerophon, were subsequently stolen and became a trafficked weapon, up for grabs to the highest bidder. Thankfully, this never actually happened—rather, it is the plot of the 2000s blockbuster *Mission: Impossible 2*. But it does highlight the dangers of biological weapons.

Biological weapons included fungi, bacteria, viruses, insects, and biological toxins released purposely to cause harm and often death. Fortunately, most contemporary biological weapon usage has been relegated to action cinema, but humanity does have past transgressions.

It is difficult to determine the first use of biological weapons, but in 1347 the Mongol army reportedly catapulted plague-infected bodies into an Italian seaport, which may have started the Black Death plague. One hundred and fifty years later the Spanish mixed wine with the blood of leprosy patients to sell to their French neighbors, with whom they were not on good terms. In 1650, the Poles reportedly used saliva from rabid dogs to create weapons against their enemies.

A more commonly known use of biological warfare came in the 1700s during the French and Indian War, in which Great Britain and France fought over Ohio, and involved the Native Americans who primarily aligned with the French. During this war, the commander of the British forces employed smallpox on blankets and other materials as biological weapons against opposing Native American tribes, which resulted in a smallpox epidemic. During the US Civil War, similar tactics were used by the Confederate troops against the Union troops.

During World War I, allegations were made that the Germans sent Trojan horses to their enemies in the form of actual horses infected with anthrax and glanders, a bacterium that causes respiratory infection. In response, postwar, the Geneva Protocol strictly prohibited the development of biological weapons. Which proved highly ineffective, as World War II swiftly followed, and world powers developed biological weapons programs in response to suspicions that other countries may have programs. Japan developed and used biological weapons during World War II, primarily on the Chinese, in one instance releasing fifteen million plague-infested fleas, which backfired and killed Japanese troops.

In 1972, the United Nations (UN) Biological Weapons Convention opened a treaty for the total disarmament of biological weapons, prohibiting the “development, production, acquisition, transfer, stockpiling and use of biological and toxin weapons.” It was signed by 189 countries, but according to the UN website, Chad, Djibouti, Eritrea, and Israel have still not signed the treaty as of 2025. President Nixon ended the offensive biological weapons program in the United States in 1970; however, there is

a defensive program that includes robot dogs, as pictured on the US Department of Defense's website.

The most recent use of biological weapons has often been in terrorist attacks, the latest US attack being anthrax.

While there are innumerable possible biological weapons, the Centers for Disease Control classifies the major biological concerns by risk. Category A is a high priority, posing a national security risk due to the high mortality of the biological agent and high infectivity, and includes smallpox, anthrax, botulism, plague, tularemia, and viral hemorrhagic fevers. Category B, which has lower mortality and is harder to disseminate, includes *Salmonella*, glanders, and water safety threats like cholera and typhoid fever. Category C is focused on new and emerging agents that could be used as biological weapons in the future, such as the Nipah virus and hantavirus.

It is difficult to prepare for a potential biological attack because the methods of deployment and outcomes are broad. The first line of defense is making sure all immunizations are up to date for you and your family, because many vaccine-preventable diseases can be used as biological weapons. Immunizations also exist for pathogens, like anthrax, that are not widely available to the public but are kept en masse by the US government. For instance, the US Strategic National Stockpile holds enough smallpox vaccines to vaccinate every person in the United States.

The first line of defense is making sure all immunizations are up to date for you and your family, because many vaccine-preventable diseases can be used as biological weapons.

For these types of disasters, it is recommended to have an emergency response kit, including food, bottled water, flashlights, masks, and an emergency plan with family members, such as where to meet in the event of a biological weapons attack. If you are exposed to a biological weapon, the US Department of Homeland Security recommends covering your mouth and nose with any available cloth, avoiding crowds, removing clothing to place it in a sealed bag, and then decontaminating with soap and water before putting on clean clothes and contacting the authorities.

There were unsubstantiated claims during the pandemic that COVID-19 may have been a biological weapons attack. There was no proof of this, but

even so, it demonstrates how a virus makes an uncalibrated and poorly aimed weapon, killing indiscriminately, creating a pandemic, which is not an effective war tactic. For this reason, most countries have agreed via the Biological Weapons Convention treaty that biological weapons should never be used.

Although the ban of these weapons is agreed upon, the punishments are variable. For instance, the use, development, stockpiling, or transfer of biological weapons by an individual in the US is punishable by life in prison, but the Biological Weapons Convention has no assigned punishment for nations breaking the biological weapons treaty. Effective diplomacy often requires speaking softly, but President Theodore Roosevelt found listening skills highly improved in the presence of a big stick, and it works even better if you cover the stick in embargoes.

CHEMICAL WEAPONS

Chemical weapons are toxic chemicals and their precursors designed to inflict intentional harm or death. They are relatively easy and inexpensive to produce, and one of mankind's most inhuman creations. An estimated seventy different chemicals or chemical mixtures have been created for use as weapons in the past century. These chemicals are often synthetic and come in gases, liquids, aerosols, and powders.

The Organization for the Prohibition of Chemical Weapons defines these agents in several categories: choking agents, blister agents (vesicants), blood agents, nerve agents, and riot-control agents. Nonlethal riot-control agents including "tear gas" won't be covered here, but if you are ever sprayed with these agents, wash off immediately, remove contacts from eyes, and wash eyes with clean water or saline for twenty minutes. Milk and baby shampoo could make things worse if there is any significant tissue damage. Blood agents, specifically cyanide, are covered in their own *99 Ways to Die* chapter.

The history of modern chemical warfare began in the early 1900s, during World War I. The first recorded use was chlorine gas, employed by the German troops on April 22, 1915, against Allied forces in Ypres, Belgium. Phosgene, lewisite, and sulfur mustard were also used during the war to kill and injure over a million people.

At the end of World War I, humanity realized it had done things that it shouldn't have, so the 1925 Geneva Protocol was created, prohibiting the use of chemical weapons in warfare. Unfortunately, the protocol was a bit too laissez-faire, failing to prevent the creation and stockpiling of chemical weapons, and allowing the use of chemical weapons against states that did not sign the protocol, as well as in retaliation for any chemical weapon attack.

One thing that no one saw coming was a country's use of these barbaric chemical compounds on its own citizens. During World War II humanity reached new sadistic depths, as chemical weapons were used in Nazi concentration camps, as well as throughout Asia. Nazi camps were infamous for the use of Zyklon B, a blood agent containing hydrogen cyanide, to murder millions of people in gas chambers. At the Nazi concentration camp Auschwitz, over one million people, 90 percent of whom were Jewish, were shuffled off arriving trains directly into gas chambers disguised as showers, where they were murdered and then burned in adjacent crematoriums.

Japan developed and used chemical weapons during World War II, largely targeting the Chinese. Many of these atrocities were performed under a covert detachment known as Unit 731, which performed chemical weapons manufacturing and lethal human experimentation on men, women, and children.

After World War II, the Cold War began, also known as the world's longest geopolitical pissing contest. As part of the posturing, chemical weapons were developed and stockpiled but not used.

During the Vietnam War, the United States used more than eleven million gallons of Agent Orange, a chemical warfare herbicide, to kill the dense foliage used for cover by the North Vietnamese. This consequently exposed millions of US soldiers to the herbicide. Still today the long-term health effects of the chemical weapon are not well understood, but Agent Orange has been associated with several types of cancer.

In the 1980s chemical weapons were again employed during the Iran-Iraq War. Although there is evidence chemical weapons were used by both sides, Iran's use was purportedly limited. Iraq used chemical weapons, including mustard gas and tabun, on both opposition soldiers and civilians. In the single largest chemical weapon attack, Iraqi forces used a nerve agent

to kill five thousand Kurdish civilians in the Iraq-Iran border city of Halabja as part of an attempted genocide.

Finally, in 1993, the Chemical Weapons Convention set up a disarmament agreement, eliminating the development, production, stockpiling, retention, acquisition, transfer, and use of chemical weapons by states. One hundred and thirty nations signed the initial agreement; I am not sure what the problem was with the other sixty-five countries. Most countries wised up and signed later, but, as of 2025, North Korea, Sudan, and Egypt still had not signed.

Although state use of chemical weapons has been outlawed, terrorist organizations have employed them. In 1994, sarin gas was used by a Japanese Aum Shinrikyo religious cult in Matsumoto city, and again in the 1995 Tokyo subway system attack.

Additionally, the weapons have been used in civil wars, such as within the Syrian Arab Republic. The 2013 United Nations inquiry determined that chemical weapons were being used in the Syrian civil war resulting in the deaths of both soldiers and civilians, and as of 2025, the UN has yet to see the country verifiably eliminate their chemical weapons program.

Lethal chemical weapons are divided into classes based on their effects on the human body: choking, blistering, nerve, and blood agents.

Choking agents irritate the airways when inhaled and include phosgene, chlorine, chloropicrin, and diphosgene. Phosgene is a colorless gas at room temperature, which often smells of “freshly mown hay,” which I assume smells like regular hay. If the gas has impurities, it may be a white, yellow, or green color. It is made of a carbon atom attached to an oxygen and two chloride atoms, carbonyl chloride for all the organic chemistry hotties. This gas is heavy, so it tends to sink to the ground. It was a principal chemical weapon used in World War I, responsible for the most chemical weapon-associated fatalities.

Phosgene causes choking and suffocation by destroying the lungs. It is a highly reactive chemical and when it enters the lungs it interacts with whatever it can get its grubby chemical bonds on. It starts by destroying the surfactant of the lungs, which is a chemical that lines the surface of the lungs to prevent the smallest parts of the airways from collapsing. When a baby is born prematurely, the lungs do not yet produce surfactant, and this is the key reason why babies born too early cannot breathe effectively. After destroying the surfactant, phosgene goes to town on the lung tissue, causing

inflammation and free radicals, destroying the tissue and causing the lungs to fill with fluid, so the patient effectively drowns.

If ever exposed to phosgene, it is important to immediately find fresh air, away from any type of hay smell, and quickly decontaminate. The CDC recommends immediate decontamination of an exposed patient's skin, hair, and eyes with water, then transfer to the nearest emergency department.

The CDC states that patients exposed to only phosgene do not pose a risk of secondary contamination to those outside of the chemical weapon hot zone impact area, so patients don't have a little Pig-Pen cloud of phosgene following them. It should be safe to get close to patients to help, but never enter a chemical weapon hot zone without protective equipment, as this only increases the number of victims. Phosgene is a severe chemical irritant, but it can have a delayed effect for up to forty-eight hours, so it is important to be at a hospital where breathing can be supported with medication, oxygen, and a ventilator.

Blistering agents, also known as vesicants, cause irritation and burns to any bodily surface they meet, including the respiratory and gastrointestinal tracts. These agents include sulfur mustard and lewisite.

Sulfur mustard, known as mustard gas, is an oily liquid at room temperature and, although colorless when pure, it is often a yellow-brown color when made for weapons purposes, smelling of mustard. Released as a liquid spray that can also contaminate food and water, mustard gas causes fluid-filled blisters to form on the skin, breakdown of the respiratory tract mucosal surfaces, as well as DNA destruction. The effects usually take hours to start, with lethality often occurring after at least twenty-four hours of suffering. There is no antidote, so removal from the exposure site and decontamination, via removal of clothing and washing of skin and eyes within minutes of exposure, is the only way to decrease the likelihood of damage. Sulfur mustard can cause secondary contamination, so rescue and healthcare workers must wear protective equipment including a full-face gas mask with an appropriate filter.

Nerve agents attack the nervous system by blocking acetylcholinesterase and include tabun, sarin, soman, cyclosarin, and venomous agent X (VX). These agents can be absorbed through the skin, lungs, or gastrointestinal tract. The "G-series" of lethal nerve agents, tabun, sarin, and soman, were developed by German scientists from organophosphate pesticides, and used by Nazis during World War II. The

even more potent and lethal VX nerve agent was later developed by the British.

In the chapter on poisonous plants, the mechanism of organophosphate pesticide poisoning was discussed, in that the chemical binds and inactivates acetylcholinesterase, the enzyme in charge of breaking down acetylcholine, a chemical that nerves use to communicate. This creates a buildup of acetylcholine causing the SLUDGE symptoms: salivation, lacrimation (tearing), urination, defecation, gastrointestinal upset, and emesis (vomiting), and can be lethal. This is the same mechanism used by organophosphate-derived nerve agents.

Patients exposed to nerve agents must be immediately decontaminated, and are sources of secondary exposure, so protective equipment must be worn when helping patients. The antidote is available in the form of a military Mark I Kit, which contains two auto-injectors of 2 mg atropine and 600 mg 2-PAM chloride, also known as pralidoxime. Atropine reverses the SLUDGE symptoms, while pralidoxime reactivates the acetylcholinesterase enzyme. Depending on the exposure the patient will likely need further medical care, so rapid transport to a medical facility after decontamination is critical.

Blood agents prevent human cells from using oxygen, causing functional asphyxiation, and include hydrogen cyanide, cyanogen chloride, and arsine. The most commonly employed blood agent, hydrogen cyanide, has an extensive history beyond use as a chemical weapon and thus has its own *99 Ways to Die* chapter. The mechanism of cyanogen chloride is similar. Cyanide-based blood agents cause asphyxiation at the cellular level, so even though a patient is breathing, the oxygen cannot be used by the body due to the chemical's effects.

The blood agent arsine gas, which is formed from arsenic and smells of garlic, enters the bloodstream and directly targets red blood cells, which are the cells that carry oxygen from the lungs to the rest of the body, so without red blood cells, cellular asphyxiation ensues. Some blood agents can be treated with specific chemical antidotes, so emergency medical care is needed immediately.

There are, unfortunately, several newer classes of chemical weapons. Psychotomimetic agents, which are not meant to be lethal but affect the central nervous system causing incapacitation, sometimes via hallucination or confusion, have not yet been developed into an effective chemical

weapon system. Fourth generation agents (FGAs), also known as Novichoks or A-series nerve agents, are organophosphate compounds and nerve agents designed to be persistent in the environment, untraceable, untreatable, undetectable, and highly lethal.

Have you given up on humanity yet? The good news is that it seems most modern-era leadership has deemed the use of these weapons indefensible under any circumstance via signing the Chemical Weapons Convention agreement, but there are still those who would employ them, which is why choosing competent leaders in the modern era is the pinnacle of importance.

The best practice is to ban the existence of chemical weapons, but if you're looking to be prepared for anything, buy a gas mask. If you're lucky enough to live in a democracy, be conscious of whom you place in power.

NUCLEAR WEAPONS

Curiosity may have killed Schrodinger's cat, but even so, scientists cannot stop asking, "What's inside here?" And the answer led us to the atomic bomb.

The atom is the basic building block of matter, any physical substance, and all known elements of matter on the Earth are listed on the periodic table—the table of elements you were forced to needlessly memorize in ninth grade. Each atom has a specific number of protons, giving it an atomic number on the table. For instance, hydrogen has an atomic number of one and thus has one proton, while uranium, atomic number ninety-two, has ninety-two protons. Smaller atoms, like hydrogen, are better for smashing together in fusion, and larger atoms, like uranium, are used for splitting apart in fission.

Nuclear fission was discovered just before World War II by Otto Hahn, Lise Meitner, and Fritz Strassmann. They discovered that by shooting a neutron at an atom you can split the atom's nucleus, which releases a tremendous amount of energy, as well as radiation. During this period of discovery, Meitner, a Jewish woman, was forced to flee Germany due to early Nazi pressures. Her friends and colleagues Otto Hahn and Fritz Strassmann remained in Germany during World War II, although they were reported to have opposed the Nazi regime. In 1944, Otto Hahn was awarded the Nobel Prize in chemistry for his work on nuclear fission, and in a

Rosalind Franklin–esque debacle, the work of Meitner went unacknowledged.

Given the presence of notable scientific minds in Germany at the beginning of World War II, Einstein was concerned that the Germans would succeed in creating a nuclear weapon, so he wrote to President Franklin Roosevelt, urging him to recruit scientists to research nuclear fission, an effort that would become known as the Manhattan Project, and develop the world's first atomic bomb. The project was spearheaded by American theoretical physicist J. Robert Oppenheimer.

Many scientists involved in the discoveries that led to nuclear fission were vehemently against the use of this technology in the creation of nuclear weapons and deeply regretted their contributions. Lise Meitner was reportedly recruited to the Manhattan Project but famously stated, "I will have nothing to do with a bomb." Einstein also later stated, "Had I known that the Germans would not succeed in developing an atomic bomb, I would have done nothing for the bomb."

And bombs were indeed made. The Manhattan Project found fission worked best for their purpose with the elements uranium and plutonium, which created Little Boy and Fat Man, respectively, the world's first and only nuclear bombs used in war.

The US dropped the uranium nuclear weapon on Hiroshima, Japan, on August 6, 1945, killing approximately 140,000 people over several months, with many dying later from radiation-induced illness. The plutonium bomb was then dropped by the US on Nagasaki, Japan, on August 9, 1945, killing an estimated 74,000 people. World War II ended with Japan's surrender on September 2, 1945, officially designated V-J Day, which I wish I was making up. World War II was the deadliest war in human history, killing an estimated 50 million people, most of whom were civilians.

The atomic bomb dropped on Hiroshima immediately decimated everything in a one-mile radius, with physical blast effects up to twelve miles, in concert with an initial blast of lethal radiation, quickly followed by a firestorm. Those who survived the initial atomic bomb were subject to radioactive fallout, due to radioactive particles in ash and dust from the blast, which settled on the surrounding landscape, emitting radiation over time.

The fallout zone for current fission weapons has been estimated to be twenty miles from the bomb detonation site, but depends on wind, with

radioactive materials potentially traveling as far as fifty miles. The radioactive materials used in current nuclear weapons decay quickly, with a tenfold decrease in radiation rate every seven hours and at least 80 percent of total radiation given off in the first day, but the rate of decline of radiation depends on the element and the isotope used in the bomb, which we won't get into, as it's a bit much.

If you are present during a radioactive fallout, the US disaster preparedness website advises to take cover, shelter in place, remove all clothing exposed to radioactive materials, and decontaminate yourself from radioactive dust or particles as soon as possible. Pets should be decontaminated and brought inside. For the first twenty-four hours, it is recommended to remain in the most protective location available, such as basements or the center of large buildings.

There are different types of ionizing radiation released by a nuclear bomb—alpha, beta, and gamma—and without getting too far into the weeds, they are all different degrees of bad. For those not exposed to an immediately lethal dose of radiation, acute radiation sickness can be lethal over several months. Initial symptoms of acute radiation sickness include nausea, vomiting, headache, dizziness, and lethargy. The patient then briefly improves during the latent stage until days twenty through sixty after radiation exposure when the manifest stage begins, causing bloody diarrhea, brain swelling, cardiovascular collapse, and death. For those who survive this stage of acute illness, there is still a risk of long-term illness.

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Radiation primarily affects the body's dividing cells, which is why it is so detrimental to growing children, and targets the gastrointestinal tract, skin, and blood cells in adults. Radiation destroys and mutates human DNA, causing cell death and such diseases as cancer. In Hiroshima, there was a large increase in many types of cancer for several years following the atomic blast, especially leukemia in the pediatric population. Mercifully, today Hiroshima is no longer reported to have increased radiation.

Only a few years after World War II ended, the arms race known as the Cold War began, primarily between the Soviet Union and the United States.

In response to the Soviet Union's efforts to create its own atomic weapons, the US was determined to make something worse, so nuclear fusion was employed to make the hydrogen bomb, first tested in 1954.

The hydrogen bomb, also known as the H-bomb or thermonuclear bomb, is a thousand times more powerful than an atomic bomb, which was already a terrible idea. The H-bomb is initially fueled by old-school atomic bomb fission, which creates the heat and radiation needed to spark the nuclear fusion reactions of hydrogen molecules, with each fusion reaction causing further fusion reactions in surrounding atoms. Think of the H-bomb like a line of an octillion standing dominos, except that every tapped domino explodes.

Not to be outdone, several other countries began developing nuclear weapons, such as France and Israel, and later Pakistan, India, and North Korea. Although no country aside from the US has fired a nuclear weapon in war, the United Nations projects that more than thirteen thousand nuclear weapons remain in stockpiles, and more than two thousand nuclear tests have been performed.

Today the countries with nuclear weapons are the United States, Russia, China, France, the United Kingdom, India, Pakistan, Israel, and North Korea, with around 90 percent of these weapons in US and Russian custody. In 1996, the Comprehensive Test Ban Treaty, banning all nuclear explosions whether in wartime or testing, was signed by the United Kingdom, Russia, and the United States. Of the forty-four countries deemed "nuclear-capable," only India, Pakistan, and North Korea had still not signed the treaty as of 2025.

The Arms Control Association estimates ten thousand nuclear weapons are currently in military service, and the Federation of American Scientists estimates four thousand nuclear weapons are deployed with operational forces, including on bomber bases and submarines. The detonation of a nuclear weapon in a large city has the capacity to kill half a million people. The United Nations continues to press for a total disarmament treaty, with the goal of eliminating nuclear weapons.

Perhaps what most scientists had in mind with their discovery of nuclear fission, other than the desire to answer the question "What's in here?" was its potential as a source for renewable energy. Nuclear reactors use atomic fission to heat water, producing pressurized steam, which turns turbines to create energy. Nuclear energy is renewable and produces no greenhouse

gases. Several countries use nuclear energy as a large source of electricity, such as France where 68 percent of the country's electricity came from nuclear power in 2023. The hottest new energy technology is the small modular reactors, which are mini nuclear power plants that can be used to power data centers, and are likely to be the power source for future artificial intelligence (AI) technologies. Nuclear energy does produce nuclear waste, but it can be recycled, although the US Department of Energy's website states this is not currently done in the United States.

Another challenge is that nuclear energy uses the same technology as the atomic bomb, so clearly there is inherent volatility. Major historical nuclear reactor malfunctions include Chornobyl, Fukushima, and Three Mile Island, near Harrisburg, Pennsylvania. Fukushima's malfunction occurred during Japan's largest earthquake, while both Three Mile Island and Chornobyl were due to faulty equipment. All these events released life-threatening amounts of radiation, but some species survived. A yeast was found in Chornobyl that eats radiation in a process known as radiosynthesis. NASA even took the fungus to space to see if it could decrease the radiation exposure of astronauts.

It's easy to ignore that nuclear weapons exist on most days, but many leaders of world powers are running around with nuclear footballs capable of decimating mankind. Until the UN achieves cooperation in a total disarmament treaty, if a nuclear bomb drops, dust off and try to find a basement.

THE AFTERLIFE

INT. HOSPITAL EMERGENCY DEPARTMENT-NIGHT

RESIDENT

I'll take report.

PARAMEDIC

Twenty-eight-year-old male, unknown past medical history, found down.

RESIDENT

Was there any bystander CPR?

PARAMEDIC

No.

(The patient is transferred by backboard from the EMS gurney to hospital bed.)

RESIDENT

Set up for the airway and get him on the monitor.

(The patient is hooked up to monitors and defibrillator pads. RESPIRATORY THERAPIST takes over bagging. CPR continues.)

RESIDENT

Give one milligram of epi and get a second line.

NURSE 1

Time for a pulse check.

RESIDENT

We have V. fib. on the monitor. Let's shock him.

NURSE 2

Charging. Everyone off the patient. Clear!

(The nurse presses the defibrillator button, shocking the patient, and he jolts off the bed, gasping for air and sitting upright with a scream!)

Stop, stop, stop. This was getting good, but I have to stop you. Most patients will not pop up like a spring daisy after CPR. Only 10 percent of out-of-hospital cardiac arrests will come back to life at all, regaining a heartbeat and then, hopefully, regaining consciousness hours to weeks later.

Patients don't wake up immediately after CPR. Only 10 percent of births start with the water breaking. Serial killers aren't diabolical geniuses, just narcissists, and trauma surgeons do not search for bullets.

Ten years ago, I began having conversations with screenwriters and producers to increase medical accuracy in Hollywood. Since then, I have worked on dozens of TV shows and films, including Hulu's *The Act* and *The Handmaid's Tale*, CBS's *Bull*, ABC's *Station 19*, NBC's *Chicago Med*, and Netflix's *Purple Hearts*, to name a few. The purpose of my work is to create truth in art, giving viewers a more valid theatrical experience that is passively educational and avoids health misconceptions.

Viewers of medical programs that depict inaccurate CPR have been shown to have worse CPR techniques. While the American Heart Association and patients prefer you take a CPR class, passive education through media is better than nothing, and misinformation will certainly

make things worse. While I work to prevent medical inaccuracies in TV and film that don't mirror the reality we live in, there are still miracles. Most people who receive CPR will pass, but occasionally, things happen that science can't explain—for instance, the Lazarus phenomenon.

The Lazarus phenomenon is when a patient dies, and CPR is discontinued because the efforts are deemed futile. The patient is pronounced dead, but then comes back to life, like Lazarus resurrected from the dead. This is a rare, unexplainable event. One paper on this effect found only seventy-six cases recorded in twenty-seven countries. This is not something anyone should expect to see in their lifetime, but it has happened. A few of these patients had a meaningful recovery to life, while most did perish over the next days to months.

Death is poorly understood, and though I face off with the grim reaper daily, I can tell you nothing about the afterlife. My stories can only take you to the front door; I have no idea who is home, and, like most, I prefer not to find out yet.

It is natural to fear death, an evolutionary requirement. But, regardless of religious beliefs, we must acknowledge death as more than an end. It is the force that defines human life as a temporary, precious spark of magic. *99 Ways to Die* is a celebration of that spark, an appreciation of all the near misses and seldom-savored moments when we are shown miracles. And while not every event seems as miraculous as Lazarus rising from the dead, given the dangers and probabilities, we are surrounded by miracles.

Astrophysicist Frank Drake sought to define the science of this miracle in 1961 with the Drake equation, which attempts to estimate the number of civilizations within the Milky Way galaxy. The odds of you existing is less than one in ten billion trillion. Beyond the unlikelihood of your existence, there are also an infinite number of ways to die, some of which can now be avoided, given that you read the previous few hundred pages. Against all odds, you are here reading my book, and that is a mathematical improbability, inexplicable by science, otherwise known as a miracle. And now that you have this life, what will you do with it?

May I recommend a few things?

When using a table saw, ensure there is a safety stop. Take the gun out of the pants pocket. Never ignore chest pain. Don't give infants honey or water. Always get treated for strep throat and finish the full course of antibiotics, unless you have a rash that could be Stevens-Johnson syndrome,

in which case discontinue immediately and go to the emergency department. If you wake up with a bat in your room, get immunoglobulin and vaccinated for rabies immediately. Get checked for STIs because, like high blood pressure and serial murderers, they are silent killers. Remember acetaminophen (Tylenol) and iron supplements are some of the most dangerous overdoses, but they can be counteracted if you get to an emergency department quickly. Get a carbon monoxide detector, as they are absent in many homes. Avoid eating pufferfish, questionable bacon, and mystery mushrooms. If you have an allergy, always carry an EpiPen and remember that airplanes and schools might not have one. Don't run in an earthquake, and stay in your car during a lightning storm, but don't touch the doors. If things go nuclear, find a basement and stay put. Find your adventure while wearing a seat belt or helmet and avoiding snakes and hippos, and for God's sake, get your vaccines.

Get out there and live your miracle, and, until you absolutely must, don't die.

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