WORRIED?

SCIENCE INVESTIGATES SOME OF LIFE'S COMMON CONCERNS

by Lise Johnson and Eric Chudler

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INTRODUCTION

For most of human history, people lived in pretty much the same way. No one was born in a hospital, be-cause there were no hospitals. There was no such thing as organic farming, because there were no synthetic pesticides. Nothing was made of plastic. There were no microwaves or cell phones or airplanes or antibiotics or energy drinks. Not coincidentally, no one worried about these things. There were, of course, lions and tigers and bears, but our relationship to these animals was more straightforward. Overall, the potential threats, while arguably much greater in magnitude, were much easier to identify. But as the ever more numerous miracles of tech-nological innovation continue to improve our lives, they also make it more complicated. Now, not only do we have things we didn't have be-fore, we know things we didn't know before. There are clearly some things to worry about, but what are they? News media, social media, and every mom blog in the world will give you plenty of things to put on your list of worries. At the same time, there are many more places to get information than there have ever been. When these sources conflict, whom should you trust? As we struggle to make healthy and re-sponsible choices for ourselves and our fami-lies, all of this ambiguity can be very stressful.

Here's the thing: stress, in and of itself, can cause health problems. Chronic stress can lead to digestive complaints, sleep problems, headaches, depression, irritability, high blood pressure, cardiovascular disease, diabetes, and stroke. It can also suppress your immune sys-tem so that you are frequently ill and make you look haggard and prematurely old. You can treat some of these symptoms with medication, but it would be much better to treat the under-lying cause of the problem. Namely, it would be better to stop being so worried. There are a few things that can help. For example, some people find that regular exercise, meditation, or prayer helps them cope. These approaches might help with your stress level, but they don't address

the underlying problem, which is that there are lots of potentially dangerous things in the world. But there is another complementary approach you can try, and that is to take control of the situation.

In this case, taking control means critically evaluating potential threats, determining what poses the greatest danger, and prioritizing your actions to minimize adverse outcomes. Knowledge is power. This is a good strategy because a sense of personal control is associated with positive mental health and lower levels of anxiety and depression. At the same time, you will reduce your overall risk of harm. It's a two-for-one deal.

The central task then becomes evaluating potential threats, which can be difficult. The world is a complicated place and becoming more complicated all the time. Unfortunately, evolution did not prepare your brain for the world it lives in. Humans tend to be tribal; we trust members of our own groups more than we trust outsiders. In addition, we are motivated much more strongly by stories than we are by statistics. These features were highly adaptive when most of us lived in small family groups, and they are still important today. But these instincts can also lead us to make bad decisions when they are applied to complex issues. Science is here to help, but only if you understand how to use it.

Science is a tool that helps us to understand why things happen. Further, it helps us predict what will happen in the future. Science is not magic; it is in fact the opposite of magic. There is no mystery about it. Fundamentally, science is a formalized way to evaluate cause-and-effect relationships rigorously. In a way,

we are all scientists because babies learn to understand the world through cause and effect. But scientists bring some powerful tools to this fight: controlled experiments and math. A controlled experiment is one that eliminates potential confounds; this allows us to attribute the right cause to the effect. Math, particularly statistics, is how we know whether an effect is likely to be real, or whether we are observing something by mere chance. These points may seem nitpicky, but they allow us to draw appropriate conclusions when our intuitions might otherwise lead us astray. This is not to say that scientists are never wrong. Scientists are people, and people make mistakes and have biases that will sometimes lead to inappropriate conclusions. But the scientific method is a very reliable way to reveal underlying cause-and-effect relationships. If you are skeptical, remember that science is what puts airplanes in the sky, mobile phones in our pockets, and, for most of us, food on our tables.

We, the authors, believe that using scientific evidence is the best way to systematically evaluate potential sources of worry. We are also people living in the same dizzyingly complicated and confusing world as everyone else and are therefore subject to the same concerns and questions. This is, in fact, what motivated us to write this book. We are both scientists, but most of the topics discussed in this book are outside our area of expertise. In writing this book we relied on our scientific training to identify credible sources, to read and understand scientific publications, and to interpret data. In the following chapters we present our findings in the hope that they will be useful to others, but we do not claim to have the final word on any topic. We are research scientists,

not medical doctors; we do not provide any medical advice. If you have medical concerns, you should consult your health care provider. We encourage readers to investigate issues that interest them further.

For each topic that we cover, we have assigned a worry index. This is a way to quickly understand the relative risk posed by each issue. Please recognize that this is a subjective score meant to be illustrative, not definitive. Of course, individuals will have different priorities and may emphasize different factors accordingly. This is absolutely appropriate. In general, we believe that you should only worry about things that are (a) likely to happen, (b) have the potential to do great harm, and (c) can be avoided or mitigated through personal action. You will find that some things are very unlikely to happen, and therefore you can stop worrying about them, as there is no need. There will also be some things that are very likely to happen, but which you cannot stop. You can stop worrying about these things too, as worrying will not help. Finally, there are some things that are likely to happen, but the consequences won't really be so dire. We recommend that you also stop worrying about these things, because life is short.

We found this book tremendously interesting to write and hope that you will find it interesting to read.

MEDICAL ERRORS

If you are like most people, when you consider how you are likely to die, medical error doesn't jump to mind. But it probably should. Medical errors are far more common than you might think, and while most of them are not serious, some can be fatal.

When most of us think of medical errors, we think of people like Willie King, a diabetic patient who famously had the wrong leg amputated in 1995. But as complex as health care has become, there are many other, less dramatic, kinds of errors that can be made. For example, failing to order tests, ordering the wrong tests, misinterpreting test results, ordering the wrong medication, filling the wrong medication, administering the medication in the wrong dose, failing to take into account possible drug interactions, not properly setting up equipment, and not having the proper equipment and resources on hand. Simply failing to wash hands is a medical error that can lead to an adverse event.

In 1999 the Institute of Medicine (now the National Academy of Medicine) dropped a bombshell of a report (*To Err Is Human: Building a Safer Healthcare System*) about medical errors in the United States. Extrapolating from two contemporary studies, the authors of the report estimated that between 44,000 and 98,000 people died every year from medical errors in hospitals. Presumably even more deaths occurred in outpatient, nursing home, in-home, and ambulatory care settings. The seriousness of the problem comes into perspective when you consider that 41,826 people died in motor vehicle accidents in 1998. The number of deaths caused by medical errors is large; it's a big problem. The committee that wrote the report made a number of suggestions for improving the safety of the system that focused on creating national leadership, enforcing mandatory reporting, changing practitioner and administrative attitudes, and implementing safeguards.

The authors include a "Worry Index" graph at the end of each chapter to give a visual impression of what the worry factor is for each chapter. Although explained in greater depth in the book, this graphic gives a clear sense of how the graph is created. Our two excerpts include their worry index graph.
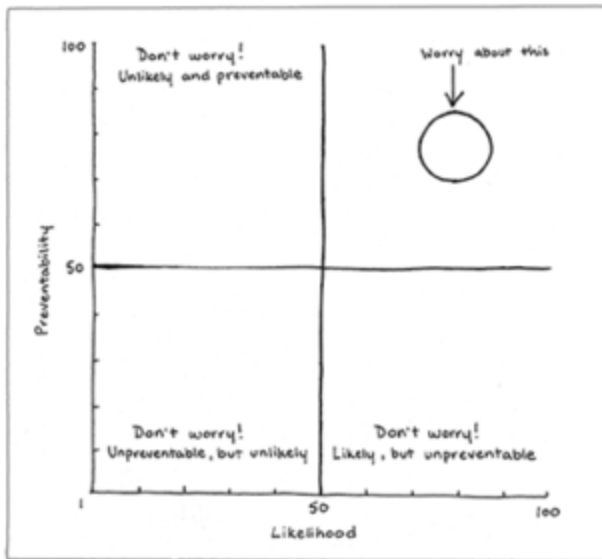
Of course, 1999 was a long time ago. So how are we doing now? Unfortunately, not so great. In 2016, a group at Johns Hopkins University published an article in which they analyzed results previously published by other research groups after 1999 (Makary & Daniel, 2016). Extrapolating from this meta-analysis, the researchers estimated that 251,454 hospital patients died per year from causes related to medical errors. If this estimate is valid, then medical error is the third leading cause of death in the U.S., following heart disease and cancer. Again, this estimate only accounts for hospital patients, so it is likely an underestimate. And while the estimate is controversial and somewhat misleading (because most patients are seeking medical care for some underlying problem), it is not a heartening result. One of the major issues pointed out by the authors of the study   is that we can only make rough estimates of the actual number of medical errors leading to death because this information is not collected. Death certificates list the immediate cause of death based on the International Classification of Disease. But they do not record any information about contributing factors. So, if you go into cardiac arrest because you are given an incorrect dose of medication, the death certificate will record the cause of death as cardiovascular. Unfortunately, this means we don't know how big the problem is, but we know medical error is a problem.

Why are there so many medical errors? Because doctors, nurses, and other health care professionals are people, and people make mistakes. Certainly, there are some cases of gross negligence or incompetence, but many medical errors are just slip-ups. People get tired, especially at the end of a long shift. People get distracted. People make math errors, or grab the wrong bottle, or misread someone else's handwriting. Consider how many small mistakes you make during the course of any given day. Now imagine that any one of those mistakes has the potential to do real harm to someone. That is the situation health care providers find themselves in, and that is why experts believe that in order to make an impact, the problem needs to be addressed at the system level. Peo-

ple will always make mistakes. The key is to expect that this will be the case and set up safeguards so that the mistakes are caught.

One of the most fundamental ways to do this is to use a checklist, an idea that is commonly used in other complex industries such as aviation. The use of checklists is gaining some traction in the medical community. Studies show that this very low-tech tool is effective in reducing the death rate after inpatient surgery and bloodstream infections related to venous catheterization. Other more high-tech tools are also proving useful. Computerized medical records make it easier for health care providers to have complete information, and computerized prescriptions reduce handwriting errors and can catch potential drug interactions or dosing errors. Automated medical devices can also help as long as personnel are appropriately trained to use them. In many ways, one of the most important changes is cultural. When medical professionals commit to prioritizing procedures and when medical administrators commit to an environment of open communication and non-punitive reporting, things are far more likely to change for the better.

But if the burden of change is on the medical system, where does that leave the rest of us? One of the best strategies is to be an informed consumer. If you have the choice, choose health care providers and facilities that have expertise in the condition for which you are seeking treatment. This is especially important for children, who are the most vulnerable to medical errors. Always take children to pediatric emergency rooms, urgent care clinics, and primary care providers when you have the option. Ask a lot of questions before, during,

and after interventions, even if your provider seems busy. Don't be intimidated or assume that people know what they are doing. If something seems wrong or unclear, speak up. Insist that people wash their hands. Make sure you know what medications are being prescribed to you and how you should take them, and verify your doctor's instructions with the pharmacist. If you are giving medication to children, double check that you are giving the right dose at the right time. Don't assume that your doctor knows about your medical history, allergies, or other medications you are taking. Always provide more information rather than less. Do not withhold information because it is embarrassing. If you are seeing multiple providers or have a complex condition, make sure that one of your doctors (for example, your primary care physician) is coordinating your care. Finally, if you are being hospitalized, it is always a good idea to designate a friend or family member who can advocate for you when you are unconscious or otherwise impaired.

When it comes down to it, you don't have the power to prevent all medical errors. But take heart—modern medicine is still more likely to cure you than kill you.

SUMMARY

Preventability (17)

Unfortunately, you don't have a lot of control over medical errors. The best you can do is try to pick a good doctor and medical treatment facility.

Likelihood (79)

Reporting gaps make it difficult to know how common they are, but it is certain that

medical errors are far more common than we would like to think.

Consequence (92)

Not all medical errors will end badly, but some certainly do.

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SUGAR

To a chemist, sugars are rings of carbon atoms decorated with hydrogens and oxygens, sometimes chained together into strings. In other words, they are carbohydrates. Sugars can be simple or complex, depending on how many rings are strung together. Simple sugars have just one ring and are called monosaccharides. Likewise, if two monosaccharides are
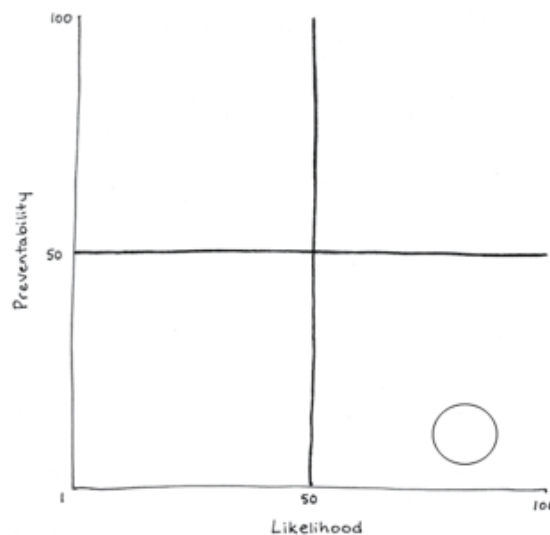
strung together you get a disaccharide, and if you add any more than that you just call it a polysaccharide.

Sugars taste sweet, and we like to eat them. This is likely because sugars are extremely important biomolecules. Notably, glucose, a monosaccharide, is the human body's primary source of energy. It is circulated throughout the body in the bloodstream and is particularly important for the brain, which demands glucose as its exclusive fuel. Sugars serve critical functions elsewhere in the body as well. Most other organisms also rely heavily on sugars. For example, the disaccharides starch and cellulose are used by plants to store energy and provide structure, respectively. Historically, humans had to either make sugars themselves or ingest them from plants. Sucrose, a disaccharide consisting of a glucose and another monosaccharide, fructose, is found in many plant sources, especially fruits. One plant that is particularly high in sucrose is sugarcane.

Sometime in the distant, murky past of civilization, someone in India figured out how to refine sucrose crystals from sugarcane. This new product (and technology) gradually spread around the world, reaching Europe during the medieval period. Everyone, everywhere, liked sugar, just as we do now. So, there was clearly a demand. But extracting sucrose from sugarcane was difficult and expensive. Unfortunately, it wasn't until the mid-18th century that anyone realized you could get the same product from a humble beet. And in pursuit of that valuable market share, Europeans began cultivating sugarcane in the New World on huge plantations made possible by slave labor. This made sugar more broadly accessible, and sugar transitioned from an exotic spice to a household staple. It's not exactly a sweet legacy, to put it mildly.

In modern Western society, refined sugar is a ubiquitous ingredient. It is still derived from sugarcane, but also from beets and corn. It is no longer expensive, and it still tastes great. It is a prime ingredient in all manner of desserts, sauces, condiments, and, of course, sugary drinks. Sugars included in prepared food are called added sugar. We eat a lot of added sugar. Way, way too much.

There is some debate about how bad for us sugar really is, but everyone agrees it's bad. Sugar consumption is linked to tooth decay, obesity, type 2 diabetes, and heart disease. These conditions lead to risk factors for other diseases, like cancer and blindness.

So how did something that is vital to life turn into something that is making us flabby and slowly killing us? Sucrose is naturally found in fruit, and fruit almost always gets a nutritional thumbs up. The problem arises when you remove the sugar from the fruit and consume it in a different context. In addition to sugars, fruit is full of fiber and other vitamins and beneficial compounds. This is important in at least two ways. First, fiber slows down absorption of sugar. Second, it limits the amount of sugar you can eat in one sitting without getting full or experiencing gastrointestinal distress. In contrast, a can of soda has no fiber, no protein, no vitamins, and can contain up to 12 teaspoons of sugar, which causes a huge spike in blood sugar. Sugary drinks are especially problematic because, in addition to having high caloric loads, the body doesn't register those calories in the same way as it does with food. The same number of calories is not equally satiating, and therefore it is very easy to consume a lot of calories without even realizing it. Humans evolved in an environment where calories were scarce, and therefore our bodies store them rather than eliminate them when we overconsume.

One of the more common added sugars, high-fructose corn syrup, may be extra bad for us. This is because, as the name implies, this sugar has a slightly higher ratio of fructose to glucose than table sugar. Unlike glucose, fructose has to be metabolized by the liver before it can be used by the body. Some of the by-products of fructose metabolism are undesirable, like triglycerides—fats that are associated with heart disease. This is somewhat controversial, but regardless, most of us need to cut back on the refined sugar that we eat (and drink). This includes natural sweeteners like evaporated cane juice, honey, agave nectar, and maple syrup.

As it happens, sugars are not the only com-

pounds that taste sweet. Some sweet-tasting compounds like ethylene glycol and lead acetate are incredibly poisonous, but others are innocuous. This latter category is appealing to people looking to reduce their sugar intake. Aspartame, saccharin, stevia, and sucralose are examples of nonnutritive sweeteners. They are sweet, much sweeter than sugar, but they usually don't taste quite the same. Nevertheless, they can make a passable substitute and have become very popular among the calorie conscious. Unfortunately, they don't appear to have any positive impacts in terms of body mass index or cardiovascular health. On the contrary, they are sometimes associated with increased weight gain, high blood pressure, diabetes, and cardiovascular problems. That sort of defeats the point, so at present there does not appear to be a good alternative to curbing the sweet tooth, except in the case of tooth decay. Sugar-free gum is unambiguously better for your teeth than sugar gum, as it even helps to prevent cavities.

The easiest way to reduce your added sugar consumption is to stop drinking sweet beverages such as sodas, blended coffee, energy drinks, powdered drink mixes, and even fruit juice. The next categories to tackle are candy, desserts, and processed foods. For healthy people, whole fruits are a healthy food. However, not all fruits are created equal, and some will have more sugar than others.

Sugar isn't really bad for you, per se. It's the quantity that's important. It's okay to indulge in sugar as an occasional treat—as long as you don't define occasional as several times every day.

SUMMARY

Preventability (77)

Sugar is in most processed foods. You can cut back, but it is hard to cut it out completely.

Likelihood (75)

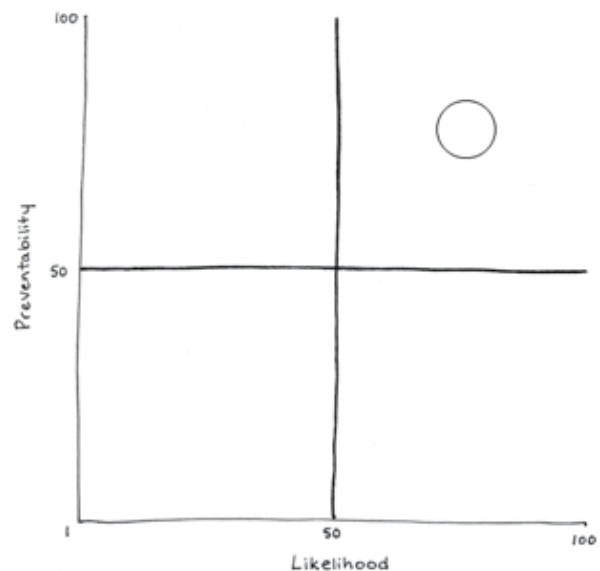Eating too much sugar is very likely to damage your health.

Consequence (65)

Obesity, heart disease, diabetes, and tooth decay are all quite common. They can also be quite serious.

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