

# One billion people worldwide stop breathing while they sleep. Are you one of them?

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Illustration of obstruction of ventilation. Credit: Habib M'henni / public domain

I thought I was dying.

During the day, I was so tired my knees would buckle. Driving the car, my head would dip and then I would catch myself. My face was lined with exhaustion.

At night, I would sleep fitfully, legs churning, then snap awake with a start, gasping for breath, heart racing.

My doctor was puzzled. He ordered blood tests, urine tests, an electrocardiogram—maybe, he thought, the trouble was heart disease; those night-time palpitations...

No, my heart was fine. My blood was fine.

He ordered a colonoscopy. It was late 2008 and I was 47 years old—almost time to be having one anyway. So I forced down the four liters of Nulytely to wash out my intestines so a gastroenterologist could take a good look inside.

My colon was clean, the doctor told me when I regained consciousness. No cancer. Not even any worrisome polyps.

However. There was one thing.

"While you were under," he said, "you stopped breathing at one point. You might want to check that out. It could be sleep apnea."

I had never heard of it.

Sleep is marked by dynamic changes throughout the body. It's made up of different phases, and as you move through them, your breathing, blood pressure and body temperature will all fall and rise. Tension in your muscles mostly stays the same as when you are awake—except during REM phases, which account for up to a quarter of your sleep.

During these, most major muscle groups ease significantly. But if your throat muscles relax too much, your airway collapses and is blocked. The result is obstructive sleep apnea—from the Greek *ápnoia*, or "breathless."

With sleep apnea, your air supply is continually interrupted, causing blood oxygen levels to plummet. You then stir, gasping, trying to breathe. This can happen hundreds of times a night, and the ill-effects are many and severe.

Apnea puts strain on the heart, as it races to pump blood more quickly to compensate for the lack of oxygen. Fluctuating oxygen levels also cause plaque to build up in the arteries, increasing the risk of cardiovascular disease, hypertension and stroke. In the mid-1990s, the US National Commission on Sleep Disorders Research estimated that 38,000 Americans were dying every year of heart disease worsened by apnea.

There's also growing evidence that the condition affects glucose metabolism and promotes insulin resistance—leading to type 2 diabetes—and encourages weight gain.

Then there's the exhaustion of never having a full night's sleep, which is associated with memory loss, anxiety and depression. Lack of sleep also causes inattention that can lead to traffic accidents. A 2015 study of drivers in Sweden found that those with sleep apnea are 2.5 times more likely to have an accident than those without. It also fuels absenteeism, and people with apnea are fired from their jobs more frequently than those without.

One study found that people with severe sleep apnea were, all told, three times as likely to die during an 18-year period as those without.

But, as with smoking during the first decades after it was discovered to

be lethal, there's a disconnect between the harm that the condition causes and the public's perception of it as a threat. "They fail to link sleep apnea with its many serious comorbidities," says a report commissioned by the American Academy of Sleep Medicine, which estimates that it affects 12 percent of US adults—but 80 percent go undiagnosed. This prevalence is also found globally: nearly a billion people around the world suffer from mild-to-severe sleep apnea, according to a 2019 study.

Research is now scrambling to catch up. Medical science has been working overtime to find a solution, from in-depth studies of hypoxia—how the body reacts to lack of oxygen—to new types of surgeries and appliances for treating the condition. But at the highest medical levels, interest is lacking. In the announcement that the 2019 Nobel Prize in Physiology or Medicine had been awarded for work on how cells adapt to changes in oxygen levels, diseases such as cancer and anemia were mentioned, but the most common hypoxia-related ailment of all, sleep apnea, was ignored.

Of the billion or so people across the globe struggling with sleep apnea—most probably not even aware of it, never mind receiving treatment—I have deep psychological insight into just one: me. As the possibility that I could be facing an under-researched but potentially life-threatening health problem dawned on me, my central concern was simple: how can I fix this?

While there are enduring risk factors for sleep apnea—such as obesity, a large neck or large tonsils, a small jaw, or getting older—it doesn't present itself until after an individual falls asleep. The only way to diagnose it is to monitor someone's sleep.

So in early 2009, prompted by both exhaustion and the suggestion from my doctor, I made an appointment at a place called Northshore Sleep Medicine in Northbrook, Illinois.

I was met by Lisa Shives, a specialist in sleep medicine. She peered down my throat, then suggested I take a polysomnogram—a sleep study, where my breathing, blood oxygen levels, heart rate, and brain and muscle activity would be recorded.

I returned for this a few weeks later, on a Thursday at 9pm—an odd time for a medical appointment. It was dark outside.

A technician showed me into a small bedroom containing a double bed and an armoire. Behind the bed, a horizontal window looked into a lab-like room stuffed with equipment. I changed into some flannel sleep pants and called the technician back in. She stuck electrodes over my chest and head, then gave me a fishnet shirt to put on to hold the wires in place.

I caught sight of myself in the armoire mirror. "A bad look," I muttered to my reflection. With my haggard round face, electrodes held on by squares of tape on my forehead, cheek and chin, I looked irretrievably middle-aged. And tired.

At about 10pm I clicked off the light and soon fell asleep.

I woke up at 4.30am and fuzzily volunteered to try to go back to sleep, but the technician said they had six hours of data and I was free to go. After I got dressed she told me that my apnea was "severe" and that Dr. Shives would give me the details later. I had planned to take myself out to a celebratory breakfast, but instead I just went home. I wasn't hungry; I was scared.

Several weeks later I was back at Northshore, this time during daylight. Shives sat me down in front of a screen full of multi-colored squiggles and numbers, with a small black-and-white video of me sleeping in the corner. It was unsettling, like seeing a crime scene image of myself,

dead.

Speaking of death, I had stopped breathing, Shives told me, for as long as 112 seconds—almost two minutes.

A normal level of blood oxygen saturation, as measured by a pulse oximeter, is between 95 and 100 percent. People with chronic obstructive pulmonary disease might have a reading in the upper 80s. Mine at times had dipped to 69 percent.

How bad is that? The World Health Organization, in a surgical guide, suggests that should a patient's blood oxygenation fall to 94 percent or below, they should immediately be checked to see whether an airway is blocked, a lung has collapsed or there is a problem with their circulation.

My options were few. I could, Shives said, have a uvulopalatopharyngoplasty, a procedure as ghastly as its name: removing tissue from my soft palate and widening my airway at the back of my throat. But it would be bloody, and recovery could be long and troublesome. Shives raised the possibility only to immediately dismiss it, which I later suspected was to take the sting off the second option: the mask.

For the first decade and a half after sleep apnea was identified, there was only one treatment option. You could have a tracheotomy—a surgical procedure where a hole called a tracheostomy is cut low in your throat to bypass your collapsing upper airway. It offered reliable relief but had significant complications of its own.

"In the early days, doctors didn't know much," says Alan Schwartz, who recently retired as a professor of medicine at Johns Hopkins University in Baltimore after years of pioneering exploration on sleep ailments. "In the Eighties, when I began, we were seeing the tip of the iceberg, the

most severe apnea patients. They'd wake up with a headache, from their bodies' tissues not getting enough oxygen. Feeling very fatigued, as you might expect. They'd become depressed, there were mood changes, short temper."

Despite these woes, patients were understandably wary of having a tracheotomy, which today is "a surgical option of last resort" performed only in cases of extreme medical urgency.

"I was always a very loud, aggressive snorer, waking up in the middle of the night, gasping," says Angela Cackler of Hot Springs, Arkansas, who was diagnosed with sleep apnea in 2008, though she believes it began when she was "tiny."

By 2012 her heart was failing.

"I went into the emergency room because I was really tired, not feeling well," Angela says. "I found out it was heart failure. The next morning, they said, 'We are going to do a tracheotomy.'"

And how has she adjusted to the tracheostomy after seven years?

"It's a battle to deal with," she says. "There is a lot of cleaning. It's nasty. It's work. You don't breathe normally. Your natural humidifier is completely gone. You have to supplement that. You're susceptible to infections." The biggest drawback for her is that it keeps her from swimming, a recreation she once enjoyed. She also hates the looks she gets from people.

That said, the procedure did eliminate her apnea. "I don't snore and I can breathe and sleep better."

Would she have it done again?

"If I had to do it again, yeah, absolutely," she says. "It has saved me."

Though they work in treating sleep apnea, the life-altering drawbacks of tracheotomies inspired Colin Sullivan, today a professor of medicine at the University of Sydney, to invent the Continuous Positive Airway Pressure machine, or CPAP, that would become the new first-line treatment.

In the late 1970s, he had gone to the University of Toronto to help a sleep researcher, Eliot Phillipson, investigate respiratory control in dogs during sleep. The research involved delivering experimental gases to dogs through a tracheostomy. Returning to Australia, Sullivan designed a mask that could fit around a dog's snout to deliver the gases that way instead.

A human patient scheduled for a tracheotomy but "eager to know if there was anything else that might work"—Sullivan's words—inspired him to try to modify the dog mask for use by people.

Sullivan took plaster casts of patients' noses, creating a fiberglass mask that tubing could be attached to. The blower was salvaged from a vacuum cleaner, with a head harness crafted from the inside of a bicycle helmet.

In a 1981 paper, he and his colleagues described how, when fitting the mask over the noses of five patients, CPAP "completely prevented the upper airway occlusion."

Sullivan patented the device, and after a few years of development, he had a version that could be given to people with apnea for use outside a lab. Today, millions use CPAP machines, though success often requires perseverance.



"There was an adjustment period," says Steve Frisch, a Chicago-area psychologist who began using the mask in 2002. "The first two years, not every night but often, I would wake up and the mask wasn't on me. I don't have any memory of taking it off."

Once he became used to the mask, his condition improved dramatically.

"The benefits of it are I get a more restful sleep," says Frisch. "I sleep for longer periods. I don't wake up with a racing heart. I don't wake up gagging for air the way I do during the day when I nod off."

But as more patients were treated and the CPAP machines' technology was refined—they can now upload data automatically to the cloud for analysis—doctors made an unwelcome discovery: their primary treatment often didn't work.

"In the late Eighties, we'd sit down with a patient and ask, 'How's it going with the mask?'" recalls Schwartz. The patient would report, falsely, how well the mask was working. "Until we began to put electronic chips in the machines in the late Nineties, we never appreciated how little they were using their machines."

The chips tracked how long the masks were used, and doctors found out they frequently weren't being worn at all. "The mask is like something from a bad science fiction movie: big, bulky and obtrusive," a New York Times article reported in 2012. Studies suggest somewhere between a quarter and half of users abandon their machine within the first year.

I certainly did.

The CPAP did make me feel better the first night I wore it—again under observation at Northshore. I woke refreshed, alert, feeling more energized than I had in years.

But the positive effect of the mask tapered off considerably after that first deliciously restorative night. Outside of the lab I couldn't reproduce the benefits. That first C in CPAP is for continuous, meaning that it pushes in air when you breathe in but it also pushes in air when you breathe out. You are fighting against it as you exhale, and I would wake up suffocating. There was the continual embrace of the mask, clamped to my face. Air would leak out around the edges and dry my eyes, even though they were closed.

Then there was the unspoken shame of getting into bed next to my wife and tethering myself to this breathing machine with what looked like a ribbed hairdryer hose. She tried to put a bright spin on the situation.

"You look like a fighter pilot!" she said, gamely. I didn't realize how lucky I was: spouses of other mask-users ridicule them. ("Elephant nose!" one Polish user recalled her husband calling her—"Alien!"—before he went off to sleep in the guest room.)

Despite their drawbacks, the masks have become commonplace. But I was among the many who couldn't wear one. Most nights at some point I would wake up and rip the mask off. In the morning, I would check the stats and see how little it was working. I went back to Northshore, where Shives would fiddle with the pressure settings or encourage me to try other masks. I returned several times, and began to feel like a regular. Nothing seemed to work.

Finally Shives, exasperated, said, "You know, if you lost 30 pounds, the problem might go away."

That seemed like a plan.

While it is possible to be thin and have sleep apnea, obesity multiplies the probability.

I'm 5'9 and weighed 150 pounds when I graduated from college. In 2009, I weighed 210 pounds.

So in 2010, I decided to lose the weight. I had a goal—the 30-pound figure Shives recommended. And I had a plan, what I called the "Alcoholism Diet." In 2006 I had stopped drinking, learning two vital things about shedding addictive substances like alcohol or sugar.

First, you need to cut them out, not a bit, not mostly, but entirely. You can't drink just a little; it doesn't work. You have to eliminate the danger completely. Ditto for high-calorie foods. So no cookies, cake, candy, ice cream or donuts. Zero. To check myself, I counted calories and vigorously exercised.

The second important factor was time. The weight took years to go on; I had to give it time to come off—a full calendar year to lose the 30 pounds. And I did it, going from 208 pounds on 1 January 2010 to 178 pounds on 31 December. It helped that I had a sharp opener I planned to use in my newspaper column crowing about the triumph, but only should I succeed.

"Unlike you, I kept my New Year's resolutions..." it began.

"What else helped?" I wrote. "I had a debilitating condition—sleep apnea—and a doctor said, if I lost 30 pounds, it might go away."

The apnea, in a rare twist, was now a positive, an inspiration to dieting. And losing the weight did the trick. No more mask.

I'm surprised I admitted in print that I had apnea. It was embarrassing. I'm not sure why. It wasn't as if it were an ailment classically suffused with shame. It wasn't like having gonorrhea. I suppose it just seemed a feeble aging fat man's complaint. I'd see the elastic marks on the red

flabby faces of my fellow commuters at the train station in the morning and I'd pity them for it. I hated the thought of being among them.

But it turns out I mistook winning a single year's battle with victory in the war. The pounds I had lost somehow found me again, 20 of the 30 creeping slowly back on over the next decade. And with them, the apnea came back. Not that I realized it until the summer of 2019, when I underwent spine surgery. The presurgery questionnaire at Northwestern Memorial Hospital in Chicago asked if I sometimes snored, if I was often tired and if I had ever been diagnosed with sleep apnea.

Yes, yes and yes.

"It's important to screen people for sleep apnea because it could be a risk when having surgery," says Phyllis Zee, director of the Center for Circadian and Sleep Medicine at Northwestern University's Feinberg School of Medicine. It can be a risk factor for poor outcomes afterwards as well.

The questions about snoring and exhaustion are important because, despite the efforts of medical science to spread the word, most people with apnea don't realize they have it.

A 2017 German study found that while obstructive sleep apnea might be present in as much as 40 percent of the general German population, only 1.8 percent of hospital in-patients were identified as having it, which the authors said was possibly due to low awareness of the condition among both patients and hospital staff.

"Our choice of anesthesia might change based on sleep apnea," says Ravindra Gupta, anesthesiologist and medical director of the post-anesthesia care unit at Northwestern Memorial Hospital. "Several medications can cause the airway to collapse, or when you start adding

multiple medications, those effects build up and layer one on another."

After surgery, people with apnea have to be monitored longer, Gupta says.

According to an article in the *New England Journal of Medicine*, there's an "epidemic" of sleep apnea among US surgical patients. One in four candidates for elective surgery have it, but for certain groups, the rate is even higher—eight in ten patients being treated for obesity, for instance, have it, resulting in a range of risks.

"Patients with sleep apnea undergoing orthopedic or general surgery appeared to be at increased risk for pulmonary complications and need for intensive care services, which significantly increase health care costs," the authors noted.

My revealing on the presurgical questionnaire that I previously was diagnosed with sleep apnea had immediate effects. My spine surgery was done quickly—taking place a week after I first went over my MRI with a surgeon—but in that brief period the hospital insisted I undergo a home sleep study to gauge the severity of the apnea. Instead of going to a sleep center, I brought home a kit that instructed me how to place sensor bands around my chest, a pulse oximeter on my finger, and a clip under my nose to monitor breathing. There was no EEG, and one drawback of these take-home tests is the units never know if you are actually asleep or not while the readings are being made.

Still, lowering the cost and inconvenience of diagnosis offers hope that more people will discover they have apnea—the expense and time needed to have an in-lab polysomnogram is thought to be one reason diagnosis rates are so low.

The test found I had moderate apnea—perhaps a function of keeping

that last 10 pounds off—information the anesthesiologist used when putting me under.

"Weight loss is curative," says Philip Smith, a professor of medicine at Johns Hopkins School of Medicine and a specialist in pulmonary disease and sleep apnea. "The problem is, people can't do it."

Add to this the fact that many patients can't use CPAP, and it becomes clear that there's a "critical unmet need," says Schwartz. So over the past two decades, a series of other treatments have been rolled out.

In the mid-1990s, a dental appliance began to be used by those who couldn't tolerate the mask.

"Obstructive sleep apnea happens in the back of your mouth," says David Turok, a general dentist with a practice concentrating on apnea. "Basically, your tongue doesn't have enough room in your mouth and pushes back into your airway. CPAP forces the tongue out of the way by forcing air down. An oral appliance brings the lower jaw forward, and the tongue comes with it."

Think of it as a brace, using upper teeth as an anchor to push the lower teeth, and with them the lower jaw, forward, widening the airway at the back of the throat.

Like CPAP, the oral appliance is also an imperfect solution. It holds the jaw in an unnatural position, so it can be uncomfortable, and prolonged use can change your bite, leaving the jaw forward. The pressure of it can also alter the position of your teeth a little bit.

Yet in his years of working on apnea treatments, the majority of Turok's patients have had success with an oral appliance.

"But these are mild-to-moderate cases," he says. "For someone with severe sleep apnea, CPAP is preferred. I never say you have a choice. You've got to try CPAP first."

He says that the surest way to address apnea, for patients who can't adjust to either CPAP or oral appliances, is jaw-advancement surgery, a better procedure than widening the soft tissue of the throat.

"Recovery is easier because it is bone healing instead of tissue healing," Turok says. Though the surgery is not without drawbacks, including the need to break your lower jaw in two places and have your mouth wired shut after surgery.

Treatments are moot, however, if you don't know you have apnea. Turok observes that since the problem still goes undiagnosed in so many for so long, dentists have an important role to play in identifying it.

"Sleep apnea is very much an oral condition," he says. "Not every dentist should be treating sleep apnea, but every dentist should be looking for it."

A further strategy is, in essence, an electrical version of the oral appliance: hypoglossal nerve stimulation (HNS), where a small electrical charge is used to make the tongue contract and stop it falling backward during sleep.

"We started the original work about 20 years ago," says Smith. It uses "a very small pacemaker—the same as a cardiac pacemaker."

The pacemaker device is implanted in soft tissues just below the collarbone, with an electrical lead tunneled under the skin, and near the jaw it is attached to the hypoglossal nerve—which controls the tongue—with a cuff electrode. The patient using the device activates it

before sleep by pressing a button on a remote control.

A 2014 study—funded by Inspire Medical Systems, a company that makes HNS devices—found that this "upper-airway stimulation led to significant improvements in objective and subjective measurements of the severity of obstructive sleep apnea."

"It's actually quite well tolerated," says Schwartz, who has consulted for a number of companies exploring HNS. "If you are awake, you feel your tongue is stiffening up or moving a little bit forward. In general, patients sleep through it really quite well."

The UK's National Institute for Health and Care Excellence, though, urges caution. "Current evidence on the safety and efficacy of hypoglossal nerve stimulation for moderate to severe obstructive sleep apnea is limited in quantity and quality," it says.

Despite the range of treatments, there's a general consensus about how to approach obstructive sleep apnea—use the mask, and try to lose weight.

If that doesn't work, then you'll have to find something else that does.

Lawrence Epstein, assistant medical director of the Sleep Disorders Service at Brigham and Women's Hospital in Boston and past president of the American Academy of Sleep Medicine, calls CPAP "the recommended first-line therapy," but says treatment ultimately is "more about knowing all the options and trying to tailor the therapy both to what the patient has and what they would be willing to use."

He points out that while obstructive sleep apnea is viewed as a single condition, it is prompted by a multitude of causes—facial and throat configuration, muscle tension, obesity—and so not every treatment works the same for every patient.



"We have very effective treatments, but all have some downsides. It's a matter of matching the right treatment to the right patient."

There really is only one test: "Make sure it works," he says, noting that "we still have a ways to go" when it comes to perfecting treatment.

Much hope is centering on that treatment someday being a pill.

"The future is neurochemical," says Smith of Johns Hopkins. "We can treat apnea in a mouse. Probably in the next ten years, maybe five, you'll be able to take medication for sleep apnea, because it's a neural-chemical problem. It's not obesity itself, not fat pressing on the airway, but fat excreting certain hormones that makes the airway collapse." Schwartz is more circumspect—he thinks "it's a combination of the two"—but has also been investigating hormones secreted by fat cells.

There are also promising human trials. Phyllis Zee was co-lead author of a 2017 paper that found that dronabinol, a synthetic version of a molecule found in cannabis, is "safe and well tolerated" and lowers the severity of sleep apnea compared to a placebo.

"The CPAP device targets the physical problem but not the cause," Zee said at the time of publication. "The drug targets the brain and nerves that regulate the upper airway muscles. It alters the neurotransmitters from the brain that communicate with the muscles."

There are other hopeful signs. A small double-blind international study of two drugs used in combination—atomoxetine and oxybutynin—found that they "greatly reduced" apnea, cutting airway obstructions during sleep by at least 50 percent in all of the participants.

But for a person like me, struggling with apnea now, the wait might be a long one.

"They've been predicting in 20 years we're going to have some drug to deal with the problem," says Schwartz. "The only problem is, it's been a rolling 20-year backlog. We'll get there, I have no doubt. There are a couple of promising pharmacological approaches that may be on the horizon."

Patience and healthcare are often linked, whether waiting for new treatments creeping to market, waiting for changes in lifestyle to bear fruit, or even waiting to see the right specialist. For me, it was back to long-term dieting and an appointment with a sleep specialist at Northwestern.

As an indicator of just how many people are dealing with this condition, I got in touch with Northwestern in July, when I had my surgery and learned the apnea had returned. They said they would schedule me for the first available appointment—not until late October.

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