Seizure prediction

Do we know when we are going to have a seizure?

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One of the most difficult and frustrating aspects of seizures is that they are unpredictable. In our busy lives, we are constantly multitasking. We juggle work, school, taking care of family, and any number of other tasks. A seizure can disrupt those plans. For some people, the recovery time can be hours or days. Not only are plans interrupted, but they may be put on hold while the person gets back to the usual routine. The fear of “Am I going to have a seizure today?” plagues people with epilepsy.¹ If only there was a way to predict when seizures were going to happen. That way, a person could plan ahead. Work or school could be alerted. A babysitter could be arranged. Someone else could pick up the kids or run to the grocery store. Nowadays, we turn to technology to help. However, how good are we at predicting our own seizures? It was this question that Dr. Privitera et al.² tried to answer in “Seizure self-prediction in a randomized controlled trial of stress management.”

Seizure prediction could change the lives of people with epilepsy. If a seizure was coming, could an abortive treatment be taken? Perhaps the person could engage in an activity to prevent the seizure. Maybe a medication could be given. In addition, the person could minimize activities that might cause an injury during a seizure. A person could alert family, friends, and coworkers, adjusting the schedule accordingly. However, we do not yet have a reliable seizure predictor.

If we cannot predict seizures, is there a way to at least identify times when a person is at risk for a seizure? In epilepsy surveys, as many as 9 out of 10 people with epilepsy report at least one seizure trigger. Most often, people report that stress brings on a seizure. This could be an emotional stress or a significant life event.³ Other factors that may precipitate seizures include changes in mood and number of hours of sleep. In short, people report that poor sleep may bring on a seizure. Dr. Privitera and colleagues evaluated many seizure triggers, including mood, stress, poor sleep, and the effects of circadian (day–night) patterns, and how these help to predict seizures.

How was the study done?

The study was done at 3 major US medical centers: The University of Cincinnati, Montefiore Medical Center (New York), and the University of California San Francisco. The participants were all adults (over 18 years old) with partial epilepsy. They were having about 2 or more seizures per month. Since many people with seizures are not always aware of the timing of their seizures, it was important that the participants were always aware of their seizures. Each person kept a detailed seizure diary, and kept electronic records of both seizures and seizure precipitants using a smartphone.

In both the morning and evening, the participants answered questions. If a seizure occurred, the participants also submitted an electronic record and report. Each person scored items like “pleasant, alert, stressed, excited, happy, sad, nervous, worried” using a visual scale (0–100). Participants kept track of sleep hours, and reported physical symptoms like dizziness, blurred vision, thirst, hunger, and difficulty concentrating. They had to be diligent in their record-keeping. Anyone who missed diary entries for 3 days straight, or who missed 2 days in a 5-day period, would be asked to exit the study.

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There were 64 people in the study. Almost two-thirds (62%) were women. They had epilepsy, on average, for 26 years. They had been on a stable regimen of seizure treatment for more than 30 days before entering the trial. During the course of the trial, which lasted a total of 20 weeks (8 weeks was the baseline, and 12 weeks was the study), no changes in medicines or treatments were allowed. Keeping medicines the same during the observation period was important. If medicines were adjusted, this could influence mood, sleep, and any number of seizure symptoms and seizure precipitants.

What were the results?

Of the 64 people, only 3 withdrew from the study (all chose to leave the study). They were excellent at keeping their seizure diaries. They submitted 85% of the morning diaries and 82% of the evening ones. In total, the group reported 3,126 seizures during the course of the study. Each person had about 1 seizure per week during the 20-week trial (the median number of seizures was 5.5 per month). In short, each person was having about 2 seizures per week. Most of the participants (86%) reported that stress was a seizure trigger. In addition, one-third (36%) reported that tiredness was a seizure precipitant. One-fourth (24.6%) said thirst as a trigger, while 8.6% reported light sensitivity, 7.1% noise sensitivity, and 4.3% dizziness as seizure triggers.

Of the group, there were 14 people (21.9% of the 64) who were good predictors. In other words, when looking at when they thought a seizure was going to happen, there was a high likelihood that a seizure would occur within the next 12 hours. When analyzing the good predictors vs the remainder of the group, there were no observable differences to explain why these people were so good at predicting their seizures. For instance, some people have seizures more often when they first wake up. If a person had this type of seizure pattern, they would be much more likely to “predict” that a seizure was going to happen. However, when comparing

the good predictors to the rest of the group, there was no difference. The good predictors group did not have a specific characteristic that made them better at predicting their seizures.

When looking at mood as a seizure predictor, the investigators split mood symptoms into 2 groups. There were positive mood symptoms like “pleasant, alert, excited, happy” and negative ones like “sad, nervous, worried, tense.” A positive mood significantly decreased the odds of predicting a seizure. Negative mood and stress increased the odds of seizure prediction.

What does this mean?

This is the largest trial to look at factors that could predict seizures. It seems that many people with epilepsy have some ability to predict when their seizures are going to happen and that some people are better at predicting their seizures than others. Why they are good at this is unclear. However, even the good predictors were not always able to tell when a seizure was about to happen. Interestingly, participants were much better at predicting days when they were unlikely to have a seizure.

Further study is needed. For instance, there are published studies that have looked at EEG (electroencephalography, or brain wave studies) and how abnormalities on EEG might help to predict seizures. Although helpful, these studies have not identified specific factors that would help to anticipate that a seizure is coming. In addition, there are wearable devices that detect seizures. What if we combined patient symptoms, data from wearable devices, and some form of EEG? Perhaps a combination of technology plus patient reports could enable people with epilepsy to predict their seizures. If this is possible, we may be able to give seizure preventatives, reduce injury (from seizures), and improve quality of life for people with epilepsy.

About epilepsy and stress

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What is a seizure?

Nerve cells communicate by sending both electrical messages and chemical ones, which we call neurotransmitters. Sometimes, brain cells send the wrong messages. Our brains have their own autocorrect, but just like a cell phone, sometimes an error still goes through. When the wrong signal is sent, other brain cells respond to the error by sending abnormal signals. If enough brain cells start sending the same, wrong message, a seizure occurs.

One way to think of this is that the brain works like an orchestra. There are different sections in an orchestra, each with its own instruments. Although each instrument plays its own part, it is only when they all play together that complex music is made. While playing, each member of the orchestra has to listen to the other members. As a team, playing together and listening to one another, the best music is made. In other words, when all of the brain cells are working together, a person can think clearly and logically.

However, what if one person in the orchestra began playing a different tune? At first, no one would notice that someone was playing the wrong tune. Nearby orchestra members would become confused: which tune were they supposed to play? As more members of the orchestra began playing the different tune, it would eventually become noticeable. At some point, the different tune might become louder than the original music, drowning out the original tune. At the point that the seizure drowns out the usual music, the person loses awareness, and from an observer's standpoint, the person may appear confused and stare blankly.

This is similar to how a seizure gets started, and keeps going. The nearby brain cells start playing the wrong tune. They encourage other brain cells to do the same thing. Eventually, 2 different tunes are being played at the same time. For an orchestra, the combined music would be confusing and might turn into noise as opposed to music. When a person has a seizure, at some point, the seizure is loud enough that the person can no longer think clearly and logically. If this worsens, a person can no longer stay aware of what is going on. It is at this point that the person loses consciousness.

What is epilepsy?

Just as there are many kinds of seizures, there are many kinds of epilepsy. Using a combination of medical tests along with a detailed medical history and examination, doctors can narrow down the list of possibilities to arrive at the correct epilepsy diagnosis. Epilepsy is diagnosed in a person who has had 2 or more unprovoked seizures.

How is epilepsy diagnosed?

The doctor will need to know as much as possible about what happened immediately before, during, and after the seizure. How often do the seizures occur? Is there a warning sign? Does the person remember anything about the seizure? All of these questions help the doctor better understand the kind of seizures and the kind of epilepsy that the person is experiencing. In addition, someone who has seen the person's seizures can provide valuable information. For instance, if the person who had the seizure cannot remember the seizure, the observer may be able to provide information that the patient may not know.

Medical testing can also help us better understand a person's seizures. EEG is a simple and painless study that records the brain's electrical activity. The brain waves are picked up by tiny electrodes that are applied to the person's scalp. The EEG is reviewed, looking for specific brain wave patterns that happen during or between seizures in patients with epilepsy. These patterns provide critical information about the person's epilepsy and help with the diagnosis.

Imaging studies are critical in understanding the cause of a person's seizures. The 2 most common studies are MRI and CT. Modern CT and MRI provide very detailed pictures of the brain, and are critical in locating tumors, scars, or other abnormalities that may cause seizures.

How are seizures treated?

There are many treatments for seizures. Medicines are tried first. If these do not work, a doctor may consider special diets, brain surgery, or devices for the treatment of seizures. Usually, the physician tries to stop all seizures while causing no side effects. It is important to tell the doctor about the kinds of problems you might experience while on a medication (or any treatment). Together, you and your doctor will make the best choice of treatments.

What is stress?

One dictionary definition of stress is "a state of mental or emotional strain or tension resulting from adverse or very demanding circumstances." Stress can be the result of a demanding work or school schedule, a frustrating commute, personal problems, or the problems of friends and family. In addition to emotional stresses, there are physical stresses like viral illnesses, trauma, high blood pressure, diabetes, and many other medical conditions. Some stress can be positive, motivating us to complete important tasks. However, most people think of stress in a negative way.

What are the symptoms of stress?

Stress can manifest in many ways. Some of the more common symptoms are as follows.

Headache

When stressed, muscles tend to tense up. Neck muscles and upper back muscles connect to the back and sides of the skull. The muscle tension causes pressure-like headaches. We often refer to this kind of headache as a tension or stress headache.

Stomach problems

Stress can cause stomach upset. Sometimes stomach upset is mild, causing a vague nauseous sensation. Other times, the stomach problems can include diarrhea or constipation. Stress can also affect gastrointestinal motility. In other words, it

affects how quickly food moves through your system, and the way your intestines absorb nutrients.

Reproductive issues

Stress can cause changes in sex drive. Women may experience irregular or painful periods. In men, impotence and problems with sperm production can occur. Both men and women may have reduced sexual desire when under a lot of stress.

Increased heart rate and blood pressure

When stress is high, it triggers an inborn reflex called the fight-or-flight response. In the wild, this reflex protects us from the dangers of predators like lions. The reflex causes the adrenal glands to release the hormones cortisol and adrenaline. These hormones make the heart beat faster and increase blood pressure. In some instances, stress can cause irregular heart rates.⁴

How does stress influence medical illness?

Stress is not something that is easily measured. For instance, there is no blood test or MRI to assess how much stress a person is experiencing. In addition, stress affects each of us differently. Some people seem to handle large amounts of stress easily. Others seem to crumble under small stressors. In addition, people's reactions to stress vary. Some of this may be related to mood. When we are in a negative mood, we may not be able to handle stress in the same way as when we are in a good or positive mood. This makes studying stress, and its effect on medical illness, challenging.

When it comes to the brain, some studies have shown that stress causes inflammation in the brain. In addition, the effects of stress can be long-lasting. Some studies suggest that events that occur in youth can change the response to stress when the individual is older.⁵ In a review of medical research in this area, Calcia and colleagues⁵ reported that psychosocial stress causes inflammation in the hippocampus (a structure responsible for memory formation) as well as other brain areas. They proposed that cumulative life stresses were important to understanding the cause of mental disorders and other neurologic illnesses.

We need to learn a lot more about stress, and how it affects medical illnesses. Perhaps by understanding the link better, we may develop improved ways of addressing stress and its physical manifestations.

For more information

Brain & Life

brainandlife.org/

Epilepsy Foundation

epilepsy.com

Citizens United for Research in Epilepsy

CUREpilepsy.org

References

1. Fisher RS, Vickrey BG, Gibson P, et al. The impact of epilepsy from the patient's perspective I: descriptions and subjective perceptions. *Epilepsy* 2000; 41:39–51.
2. Privitera P, Haut SR, Lipton RB, McGinley J, Cornes S. Seizure self-prediction in a randomized controlled trial of stress management. *Neurology* 2019;93: e2021–e2031.
3. Spector S, Cull C, Goldstein LH. Seizure precipitants and perceived self-control of seizures in adults with poorly controlled epilepsy. *Epilepsy Res* 2000;38:207–216.
4. McIntyre WF, Connolly SJ, Healey JS. Atrial fibrillation occurring transiently with stress. *Curr Opin Cardiol* 2018;33:58–65.
5. Calcia MA, Bonsall DR, Bloomfield PS, Selvaraj S, Barichello T, Howes OD. Stress and neuroinflammation: a systematic review of the effects of stress on microglia and the implications for mental illness. *Psychopharmacology* 2016;233:1637–1650.

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