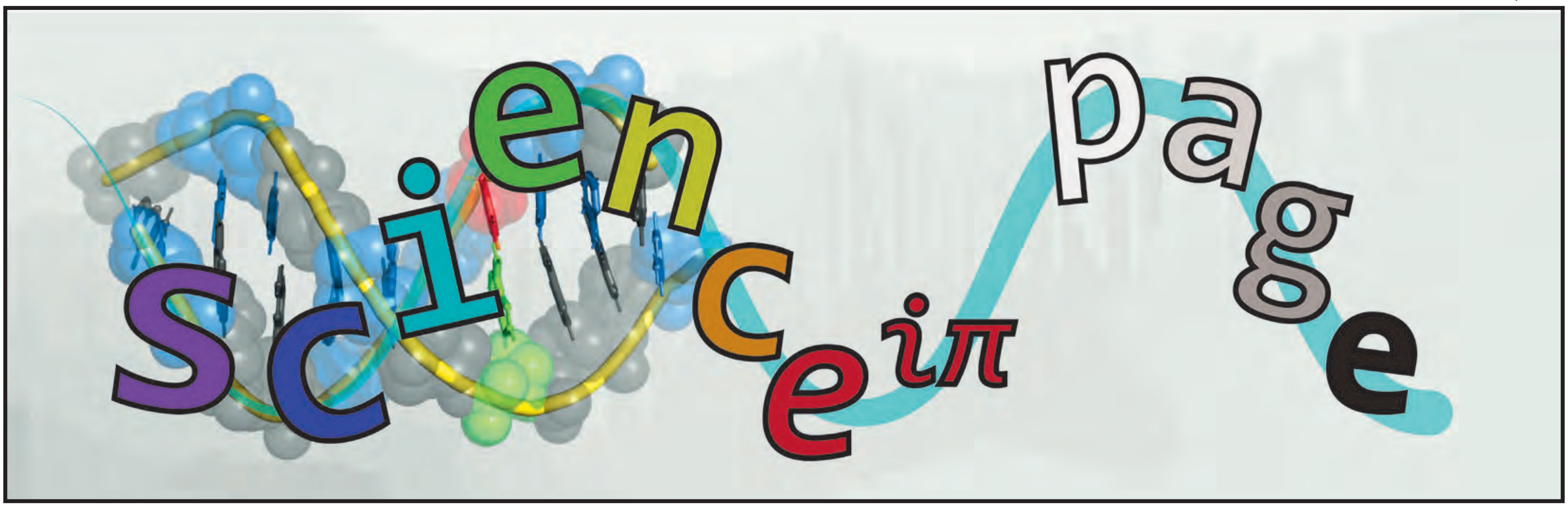


MEDICINE

Managing Stress

By CATHERINE DODDS, MD

TURNERS FALLS – The alarm blares. Bleary-eyed, you reach for your smartphone, the same one that kept you up too late again last night. The screen is full of news notifications – war in Europe, inflation, COVID-19 surges. You drag yourself to the kitchen to make the first of several cups of coffee. You make breakfast for your kids, and wonder if you'll have time to shower before heading into another day of work. And where on earth did you leave the car keys?

You can feel the stress building in you.

And suddenly, before you know it, your heart is racing, you're breathing quickly, you feel flushed and sweaty, and you startle at any sudden noises. Any hunger you had is gone. Your muscles are pulsing and tense, and you hear your heartbeat pounding in your ears. You feel ready to rush out the door, or to explode at the first person who talks to you.

What you're experiencing is the activation of your sympathetic nervous system, often called an adrenaline rush or a "fight or flight" response, named for what this system prepares you to do. Your sympathetic nervous system is a rapid-acting "on switch" that changes your body from its baseline calm, controlled by the parasympathetic nervous system, to a sudden state of danger.

Over millennia of human evolution, the sympathetic nervous system has been a lifesaver. See a lion getting ready to pounce? Run away. Facing an enemy warrior? Fight for your life. But modern life is making our body's survival adaptations backfire. Instead of protecting us, the stress response is now activated so frequently in response to non-lethal threats that it starts to harm us.

What happens during sympathetic nervous system activation is complex. However, two of the main actors are the hormones *cortisol* (sometimes called the stress hormone) and *epinephrine* (also called adrenaline). When activated briefly in appropriate situations, these hormones help prepare us to fight or flee. When activated repeatedly and over the long term, they directly contribute to the development of chronic inflammation, obesity, type 2 diabetes, high blood pressure, cardiovascular disease, anxiety, and depression.

Stress is a reality of our human existence. It can be limited and managed, but not avoided entirely. Some people have naturally higher levels of sympathetic nervous system activation, and have to put more effort into maintaining calm and dealing with stress.

The basic approach to stress is to recognize that your body's responses are often exaggerated compared to the actual level of threat, and to then use therapeutic exercises to change your responses and re-engage your body's natural calming system. Easier said than done, perhaps, but this is absolutely fundamental to managing the stress of daily life and preventing long-term harm from chronic stress response activation.

What can you do to help reduce the effects of stress on your body?

In the moment, when you are experiencing high stress levels, try to deliberately engage your calming, parasympathetic nervous system to reverse the adrenaline rush. You can do this by taking six deep breaths in a row: inhale deeply through your nose for a count of six, hold the breath for a count of six, then exhale for a count of six.

Alternatively, try gently touching or massaging your lips, using one or two fingers and lightly running them over your lips five to ten times. Wash your hands prior to touching your lips, and use lip balm if your lips are dry or irritated.

The parasympathetic nervous system can also be activated by bearing down – hold your breath and bear down with your abdomen as though you are trying to pass a bowel movement. Hold this position for 15 to 20 seconds, if you are able.

Long-term, a healthy diet that limits sugar and caffeine and includes non-processed, whole foods and lots of antioxidants from fruits and vegetables will help repair damage caused by stress. Regular exercise, particularly getting outside in nature, is great for stress management. Getting adequate, restful sleep is also important. Chronic sleep deprivation leads to higher levels of the stress hormones.

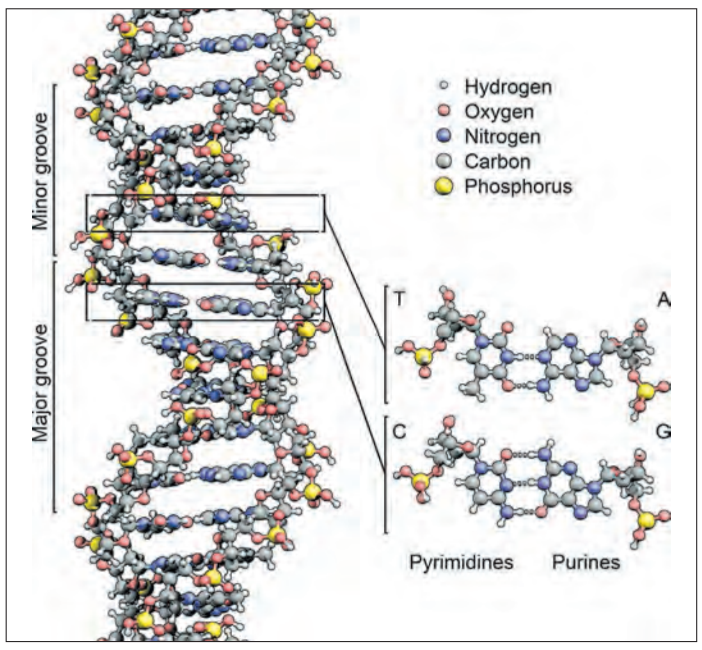
Our screens – whether televisions, smartphones, or e-readers – are wreaking havoc with our sleep patterns in the modern age. Take the televisions or other screens out of the bedroom and keep smartphones out of arm's reach and silenced overnight.

Other techniques to help reduce the damaging effects of stress include progressive muscle relaxation, meditation, visualization or guided imagery (envisioning yourself happy in a calm place), playing with a pet, journaling, listening to calming music, stretching exercises, yoga, tai chi, qi gong, and massage therapy. Many of these techniques have lots of information online or available at the library that give more specific details about how to use these in your day to day routine to manage your own stress.

In some cases, stress-related symptoms can be part of mental illness rather than a typical stress response. Diagnosed post-traumatic stress disorder (PTSD), major depression, generalized anxiety, bipolar affective disorder, or other mental illnesses should be evaluated and treated by a medical professional.

Age and DNA Damage

By SPENCER SHORKEY



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A, T, G, and C are the four chemical "letters" that make up the DNA alphabet.

MILLERS FALLS – DNA strands, like the short segment shown in the accompanying illustration, are the blueprints for building and maintaining living things. "DNA" is short for deoxyribonucleic acid, and is made up of four different types of nucleotides: adenine (A), thymine (T), guanine (G), and cytosine (C), which are essentially the four molecular "letters" of the DNA alphabet.

A set of human DNA has a length of about three billion nucleotide letters, and encodes the instructions for building the roughly 20,000 different molecular machines and structures used in our cells.

Nearly all of the cells in our bodies contain two sets of DNA, which amounts to 1.5 gigabytes of information per cell. Counting up all 30 trillion cells in a human body, we find there are six zettabytes, or 6 x 10^21 bytes, of DNA data in a single human – roughly the same size as mankind's total digital data storage capacity in 2020.

Although cells have many molecular machines devoted to maintaining, repairing, and protecting their DNA, some losses or alterations of the code inevitably occur, termed DNA "mutations." Mutations in DNA can occur from ultraviolet light-induced chemical damage, or simply from copying errors during DNA duplication. Just as corrupted data may cause a computer hard drive to fail, mutations in DNA can cause a cell to no longer function properly.

A groundbreaking study of DNA damage was published last month in *Nature*, titled "Somatic mutation rates scale with lifespan across mammals." In this study, scientists studied the DNA mutations accumulated by intestinal stem cells across 16 species of mammals, finding a remarkable connection between mutation rates and species lifespan.

Stem cells are with us for our entire lifespan, and their role is mainly to duplicate themselves in order to replenish cell populations. Every day in human small intestines, millions of stem cells divide from one cell into two cells, replacing cells of the intestinal lining that are constantly being lost or damaged. Each replication, known as a "cell cycle," entails making exact copies of their full set of DNA letters, and in humans is achieved with less than one DNA error or mutation on average.

However, over the course of a human lifespan, these intestinal stem cells copy their DNA and replicate around 10,000 times, eventually accumulating a few thousand mutations.

In the study, mice were found to have very high intestinal stem cell DNA mutation rates, nearly 800 per year, while humans had much lower mutation rates, just under 50 per year. Human DNA mutation rates were 17-fold lower than mice, which correlates well with our 23-fold longer lifespan.

Among numerous other animals in the study were cats, dogs, and horses, which had mutation rates of 290, 250, and 130 per year respectively. The cat, dog, and horse DNA mutation rates are 6.1, 5.3, and 2.7-fold greater than human's, and which correlates strikingly well with their lifespans being 4.4, 5.4, and 2.7-fold shorter than ours.

Mice and humans have similar lengths of DNA in their genome, at around three billion letters. While we differ greatly in lifespans, and rate of DNA mutation, we appear to accumulate a similar total number of DNA mutations per cell by the end of our lifespans: for mice, around 3,000 total mutations per cell over their 3.7-year life expectancy; for humans, a comparable count of 4,000 per cell over a much longer 83.6-year life expectancy.

It is remarkable that a similar total amount of DNA damage was measured by the end of life in these cases, as well as others in the study. This strongly suggests that the accumulation of a certain amount of damage, approximately one mistake per million DNA letters, predicts an animal's demise.

The correlation between DNA information integrity and species' lifespan makes intuitive sense, since DNA is the set of instructions that ultimately control cell functions. Mutations that change important parts of these instructions can result in cells not doing their jobs as well, or at all. Rarely, some mutations will actually give a cell new abilities, such as growing much faster and eventually becoming cancerous.

According to this study, the accumulation of DNA mutations above the count of several thousand mutations per cell appears to be a sort of limit, after which aberrant cellular behaviors have a significant impact on an animal's survival. This limit will likely serve as a benchmark in future studies of aging, which would do well to assess wider varieties of cell types and species, and use other measures of cell and tissue fitness. For now, it is really interesting to think that mankind's relatively low mutation rates could be fundamental to our long lifespans.