Insight

Why should a neurologist worry about climate change?

Climate change is a feature of the Anthropocene era. Whilst individual extreme events remain difficult to ascribe to a given cause, collectively such occurrences are happening with a frequency that is beyond random chance. Why, as medical professionals and neurologists, should climate change concern us and what, if anything, can we do about it?

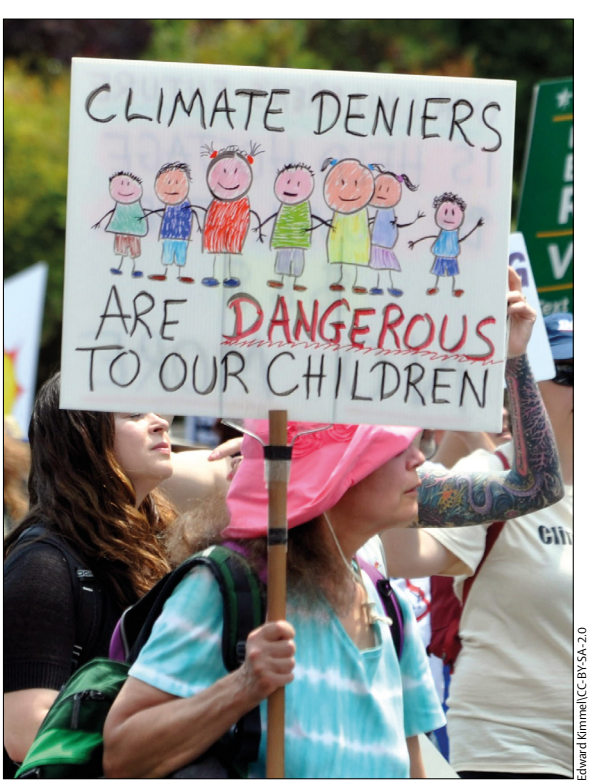
For some people with epilepsy, effects of climate change will interact directly with biological pathways. For example, Dravet syndrome is usually caused by mutations in *SCN1A*, a gene that codifies for a neuronal sodium channel subunit; the function of the protein is exquisitely sensitive to ambient temperature, a phenomenon that might be exacerbated in the mutant protein. Anecdotal evidence suggests that heatwaves are dangerous for people with Dravet syndrome. During the high temperatures of last summer, parents reported to their UK support group that their children with Dravet syndrome were experiencing more seizures and lethargy. In Australia, a girl with Dravet syndrome, who had been free of seizures with antiepileptic drug treatment for about 2 years, went walking outside on the hottest day in Melbourne for years, with a peak temperature of 46·5°C. She was later found dead; the extreme temperature was suspected to be the cause. Many other genetic changes (for example, mutations in *GABRG2*, *PCDH19*, *CHD2*, *STX1B*) predispose to epilepsy, with seizures often provoked by fever or, possibly, higher ambient temperatures, although the underlying mechanisms remain poorly understood.

Epilepsy is a prevalent neurological disease worldwide, but disproportionately burdens low and middle-income countries. Those living in poverty, or with limited or no access to healthcare, and therefore scant access to antiepileptic drugs, are more likely to have epilepsy, its consequences and comorbidities, and die early as a result. Even in rich nations, epilepsy is both more common in disadvantaged socioeconomic groups and is typically associated with worse quality of life. People who are economically deprived are likely to have reduced resilience to the pervasive effects of climate change.

Climate change is altering the severity and frequency of extreme events. Hurricanes, floods, the spread of vectors for infections causing fever or epilepsy are amongst the challenges overloading already-teetering economies, and adding to demands on well-resourced nations. These events will all have serious consequences for people with epilepsy. Poor sleep and anxiety can aggravate seizures in all epilepsies, even if seizures are otherwise well controlled: it must be difficult to sleep if you have lost your home to a landslide. Sustained extreme temperatures might affect the stability of some medications. There are likely to be many other unforeseen downsides to climate change and the management of epilepsy.

Climate change has received little attention in neurology, and conversely neurologists have had little to say about the dangers of climate change for people with epilepsy or other neurological disorders. We have barely any information about the effects of climate change on fundamental biological parameters, from gene mutation rates to gene expression, brain network changes, or the clinical manifestations of neurological disease. We can expect that unpredictable environments, rapid changes in circumstances, and disruptions to supply chains will have major impacts on medical practice, so we should put this discussion on the agenda.

Action to remedy climate change requires concerted efforts. There are now lobbying organisations and special interest groups (eg, the UK Health Alliance on Climate Change), as well as local action groups. As a particular example, The Low Carbon Hub (Oxford, UK) has carried out dozens of solar panel installations on schools, businesses, and community assets, funded by community investors, and is estimated to save around 1500 tonnes of carbon dioxide annually. But individuals must also make their own



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For more on **climate change** see http://www.ipcc.ch/report/sr15/

For more on the **UK Health Alliance on Climate Change** see http://www.ukhealthalliance.org/

For more on **The Low Carbon Hub** see https://www.lowcarbonhub.org/

For more on **carbon emissions** see www.icao.int/environmental-protection/CarbonOffset

For a **carbon-offset programme** see https://thepointsguy.com/guide/a-guide-to-airline-carbon-offset-programs/

For more on **reducing the footprint of academic travel** see www.flyingless.org

changes. We face growing problems that affect healthcare in new and pervasive ways. Climate change is a crucial new concern with which we, as clinicians, must engage.

Air travel might be our biggest contribution to carbon emissions. We have estimated that the total carbon emissions for a typical year of conference travel of the four of us is 22·5 tonnes (ie, ranging from a 22% to 96% excess over the average annual carbon emissions per person). But conferences are important because of formal learning, off-line meetings that drive science forward, and peer conversations that improve practice around the world. Moreover, the value of face-to-face contact is undoubted. Such events also generate organisational income. We need to establish their cost-effectiveness and value, and factor them into calculations of carbon cost and environmental impact.

We estimated the carbon emissions due to travel of the approximately 3200 participants at a recent international epilepsy conference to be 2000 tonnes of carbon dioxide. Many conferences are substantially bigger than a typical epilepsy conference but, even if they were similar, travel to the about 1500 medical meetings that are organised each year would alone result in 3 million tonnes of carbon dioxide being emitted annually, which is equivalent to the total annual emissions of Madagascar (population 25 million). Madagascar has been identified by the World Bank as a country being particularly vulnerable to climate change. Is this equitable? How can fairness in this context be calculated? We need more data and advances in technology to bring people together virtually, but with the same warmth and social nuances of personal meetings (calculating the relative environmental costs of such technology also). In the interim, carbon offset programmes exist but, to make a real difference, we should consider flying less.

Climate change is happening and, from the perspective of attempting to provide holistic healthcare, it will affect both our patients and our profession at many levels. If there are steps we can take that might make a difference—and might help to prevent consequences for people with epilepsy—we should take them. As many have pointed out before: "There can be no Plan B, because there is no planet B". We cannot stay idle whilst the temperature rises.

Sanjay M Sisodiya, Ingrid E Scheffer, Daniel H Lowenstein, Samantha L Free

Lifeline

For more on **LEADS** see https://leads-study.medicine.iu.edu/

Liana Apostolova is a neurologist with a special interest in cognitive disorders and Alzheimer's disease research. She is the Barbara and Peer Baekgaard Professor of Alzheimer's Disease Research at Indiana University School of Medicine (Indianapolis, IN, USA). Her research focuses on the early stages of Alzheimer's disease, including the development of imaging and genetic biomarkers, and on early onset of the disorder.

What has been the greatest achievement of your career?
The successful launch of the multi-site Longitudinal Early-Onset AD Study (LEADS) focused on a rare form of Alzheimer's disease that affects middle-aged individuals. The impact of Alzheimer's disease on these young patients and their families is particularly devastating as they are often gainfully employed, raising families, and not ready to retire.

What inspires you?
My two biggest inspirations are all questions that remain unanswered after many decades of research into Alzheimer's disease and the need for a cure.

If you wrote an autobiography, what would be the title?
Living the American Dream. I am a foreign medical graduate and am so thankful that I was given the opportunity to direct such a large scale multi-site scientific project as LEADS. I never imagined I would be able to breathe life into such an impactful project.

How would you improve the public's understanding of research?
I would love to be able to teach each and every person that working together is the only way to succeed in eradicating human disease and suffering. Everyone can make a difference—by volunteering for research studies; raising awareness by speaking of their own experiences as a patient, caregiver, or even observer; and donating their time or providing philanthropic support for research into health conditions that have touched their lives or for a cause that inspires them.

What one discovery or invention would most improve your life?
Having the latest and greatest scientific and technological achievements readily available in clinical practice would be a game changer for physicians. Such access would make a difference in our ability to accurately diagnose and treat our patients. In the Alzheimer's disease field we have imaging technology that allows the detection of amyloid plaques in the living human brain, but the lack of insurance coverage makes it impossible for us to implement it.

If you were Bill Gates, how would you spend your fortune?
I think Bill Gates needs no lessons in how to enable science or strive for eliminating poverty, hunger, and deadly diseases. His very recent philanthropic efforts directed to Alzheimer's disease research prove he truly appreciates the need to prioritise diseases that have a global impact.