

Not the Last Word

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# Not the Last Word: Climate Change Comes to Orthopaedics

Joseph Bernstein MD<sup>1</sup> 

In the past two years, leading orthopaedic journals have published pieces on the topic of climate change [13, 23]. More such articles no doubt are coming. Leaving aside for the moment the question of whether orthopaedic journals are the apt forum for climate-related research studies, orthopaedic surgeons indeed should learn about climate change. The issue is competence.

The first facet of competence is scientific. Physicians must make sure they understand climate change to avoid misleading their patients. Physicians are broadly trusted professionals, and their

remarks about scientific topics—even in casual conversation—are bound to be taken seriously by the patients who hear them.

The second facet of competence is cultural. William Osler famously observed that “it is much more important to know what sort of a patient has a disease than what sort of a disease a patient has” [25]. In that sense, climate change must be understood in order to deliver good care, for attitudes toward climate change have become “a matter of core cultural identity” [12]. In fact, for some people, concern about the environment has taken on a decidedly religious flavor [9, 14].

Consider a recent essay by Andreas Malm in the *New York Times*. In a piece defending sabotage to protest global warming, the professor wrote, “There is a whole planetary layer of stations, pipelines, platforms, derricks, terminals, mines and shafts that must be shut down to save humanity and other life-forms” [22]. To my ears, that’s an admonition more suited to an 18th-century Sunday sermon from Jonathan Edwards or Cotton Mather than an op-ed piece on a scientific topic. We can also hear theological undertones in the names

climate advocates use to define their opponents: the *climate skeptic* and the *climate denier*. If nothing else, these names define a reciprocal term: the *climate believer*.

This observation isn’t intended to disparage. Many climate believers appear sincere in their desire to make the world a better place. Moreover, many core claims about climate change are undeniably true—they’re certainly convincing enough to get me onboard.

Despite all this, I am not convinced that orthopaedic journals are a suitable place for climate-related articles. To be sure, the topic is important, and if authors have articulated a climate-related orthopaedic question, their answers belong in an orthopaedic journal. On the other hand, climate-related orthopaedic questions are rare, and qualified peer reviewers, with expertise in both realms, may be rarer still.

I am more unreservedly opposed to including the topic of climate change in medical school curricula, as some have advocated [16]. The chief reason is that there is a shortage of uncontested climate-related material to teach. As noted by Steven Koonin [20, 21], the former undersecretary for science in the Obama administration Energy Department, climate science is insufficiently settled (Fig. 1). Theories must percolate through journals and into textbooks before they are appropriate for medical school curricula.

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<sup>1</sup>Department of Orthopaedic Surgery, University of Pennsylvania, Philadelphia, PA, USA

J. Bernstein ✉, University of Pennsylvania, 424 Stemmler Hall, Philadelphia, PA 19104, USA, Email: orthodoc@uphs.upenn.edu

## Not the Last Word

An even more fundamental reason not to add climate science to medical school syllabi is bandwidth. Instructional time is constrained by the clock, meaning that every minute devoted to a new

topic is a minute taken away from existing subjects.

This issue of curricular crowding is particularly germane to orthopaedics. An Association of American Medical

Colleges white paper on musculoskeletal medicine education [2] reported that, although “it is important that medical schools provide learning experiences that will allow students to gain an

1. The Earth is approximately 2°C warmer than it was 150 years ago. **True or False?**
2. Human activity in the form of industrialization and the emission of carbon and other pollutants has contributed to global warming. **True or False?**
3. Over the recent ~150-year timespan during which there was a 2°C rise in global temperature, industrialized nations’ per capita wealth increased tenfold and life expectancy more than doubled. **True or False?**
4. Oceans hold most of the globe’s thermal energy, yet data on their temperature history is lacking. Climate predictions that are based on computer models—as all are—might be critically flawed. A robust model requires reliable inputs. **True or False?**
5. Global temperatures are projected to increase from a current mean of 59°F to a mean of 62°F—about the difference between the current mean temperatures of Philadelphia, PA and Sacramento, CA. Also, most of the projected increase will be due to milder winters rather than hotter summers. The planet is not “burning,” as some may claim. **True or False?**
6. Some forms of human pollution can have a cooling effect, for example, the release of aerosols that reflect sunlight. Along those lines, some non-polluting product of human ingenuity might be used to engineer global cooling, by increasing the ability of surfaces to reflect sunlight (“albedo”) or by some process of which we haven’t yet dreamt. **True or False?**
7. Global warming may impose costs on people living near the coasts but can be beneficial to those living in colder, inland areas. In a much warmer world, Russia, for example, might gain acres of farmland and miles of coastline. **True or False?**
8. There are more deaths in the US each year from exposure to excessive cold than from exposure to excessive heat. **True or False?**
9. There are more deaths worldwide from exposure to local pollution (such as smoke from wood-burning stoves) than from the warming effects of carbon dioxide. **True or False?**
10. Increased carbon dioxide in the atmosphere can stimulate photosynthesis and increase crop yields. **True or False?**
11. Nuclear power plants emit very little carbon. Logically, if you can believe that carbon emissions should be shut down to save humanity and other life-forms, you should avidly support nuclear energy. **True or False?**

**Fig. 1** To get a sense of just how “unsettled” the science of climate change may be, Dr. Joseph Bernstein created this 20-question true/false exam on climate change. He invites you to take the test, and share it with friends who might disagree with you, too. For what it’s worth, Dr. Bernstein circled “True” for all of them, but your mileage may vary.

## Not the Last Word

12. The world 100 years from now is likely to be wealthier than it is now. Future generations might afford to adapt to the consequences of climate change more easily than we can afford to prevent them now. **True or False?**
13. Internal combustion engines spew very visible exhaust fumes, whereas the processes used to mine lithium, cobalt, and nickel to make electric car batteries—to say nothing of the coal-fire generators producing electricity for those batteries—are out of sight. This disparity creates an “availability bias” that may lead one to overestimate the environmental benefits of electric cars. **True or False?**
14. The US emits ~10% of the world’s carbon. China emits about 25%. Accordingly, unilateral reduction of carbon emissions by the US by even 50% will decrease world levels by no more than ~5%. Limiting global carbon production is thus a classic “collective action problem.” **True or False?**
15. In general, citizens of rich countries care about pollution more than those of less-wealthy countries. As such, one strategy to constrain pollution is to help less-wealthy countries become richer by industrialization. **True or False?**
16. The greenest city in the US, despite its reputation for grime and grit, is New York. Owing to its robust public transportation networks and tall buildings, per capita carbon emissions in New York are less than half of what’s measured in more seemingly bucolic places such as Provo, UT. **True or False?**
17. The whole aim of practical politics, as claimed by H.L. Mencken, is “to keep the populace alarmed (and hence clamorous to be led to safety) by an endless series of hobgoblins, most of them imaginary.” **True or False?**
18. Wind turbines generate electricity only when the wind is blowing; solar panels generate electricity only when the sun is shining. And because today’s batteries can store less than 1% of the world’s energy needs, we cannot match instantaneous production to instantaneous demand, for people want electricity even on cloudy, windless days, too. This mismatch renders wind and solar energy a poor replacement for fossil fuels, at least for now. **True or False?**
19. Americans use approximately 185,000 Kcal of energy per person per day to maintain their lifestyles—more than 50 times the daily energy budget of prelapsarian hunter-gatherers. Modern life, including modern medicine, requires ample and affordable sources of exogenous energy. **True or False?**
20. The ideal approach, in politics and in medicine, can be determined only after weighing both costs and benefits. **True or False?**

appreciation of the importance of [musculoskeletal] conditions...Medical schools may not be accomplishing this educational goal since the attention paid to the conditions in the usual medical school curriculum is not commensurate

with the prevalence of these conditions.” In other words, many schools have failed to offer adequate instruction in musculoskeletal medicine [5], and with that, students have failed to master the topic accordingly [15].

Before we can consider including topics like climate change in the curriculum, we must ensure that fundamental subjects such as osteoarthritis and osteoporosis are thoroughly covered. We must prioritize and perfect the teaching

## Not the Last Word

of core subjects before incorporating new areas of study. First things first.

### Jason R. Saleh MD, FAAOS

Assistant Clinical Professor, Stanford University

I started reading Dr. Bernstein's piece on climate change with great enthusiasm, but the enthusiasm quickly waned. While I appreciate the additional attention that will surely come to climate issues because of this column, and I certainly agree with his stance that surgeons should educate themselves on climate science, our agreement abruptly ends there.

Dr. Bernstein's essay espouses the time-honored false equivalence that there are two equally valid sides to the climate debate. His use of the term "climate believer" implies a fanciful, magical-thinking system based on one's convictions alone. I believe in tomatoes. I believe in gravity. As critical thinkers, we don't have the option not to believe in tomatoes or gravity. They're real.

Is climate change settled science? I encourage people skeptical of climate science to approach it the same way we approach journal club with our residents. What's the source? Who's the author? What's the study design? Who published it? Does the conclusion make sense? Do other leaders in the field agree? When we apply a few of these questions to Dr. Bernstein's references [20, 21], which question the validity of accepted climate science conclusions, we see that one is a newspaper article and the other is a book (not a textbook), both authored by the same person who has admitted massive conflicts of interest in this area and has been refuted by scientists in this field. Would we listen to a resident if he or she suggested a treatment for one of our patients based on a similar level of evidence?

What does "settled" even mean? Do all scientists have to agree? Is 97% enough? Is biceps tenodesis settled science? How about fixing a proximal humerus in a 70-year-old? For many of the procedures we perform, there are many articles telling us they are unnecessary, of questionable value, or altogether unhelpful. I would argue that climate science is more "settled" than what most people reading this do all day long. Myself included.

Dr. Bernstein questions the publication of climate articles in orthopaedic journals (of which I've written a few). Where, then, should orthopaedic surgeons go to learn about the climate impact of their work? Dr. Bernstein suggests true climate-related orthopaedic questions are rare. How about, what's the climate impact of what I'm doing? How can I decrease the carbon footprint of my job? These seem like valid, reasonable questions. The shortage of experts in climate in our field is a problem, but it is no reason not to develop those experts. Better studies come from an awareness of the problem.

Dr. Bernstein is also "unreservedly" against the inclusion of climate in medical curricula based on limited available bandwidth and the "insufficiently settled" nature of climate science. The idea of being "unreservedly" against including anything in a curriculum is frightening. Students—those in our profession who will feel the effects of climate change the most—have voiced a desire to learn about this topic. While I concur with Dr. Bernstein in that I would love if every medical student knew osteoarthritis and osteoporosis inside and out, putting forward the idea that the teaching of climate and musculoskeletal knowledge are mutually exclusive is a scare tactic. Climate should be baked into the decisions that doctors

make starting from the very beginning. They can always remind themselves which one is the "fibia" later when it comes up. I would also remind Dr. Bernstein that in a previous column [4], he explained in detail the unsettled science of the human diet while simultaneously suggesting that it be added to our curriculum.

Over 200 medical journals (such as the *New England Journal of Medicine* and other highly reputable publications) have recently published a statement that climate change is the most pressing issue to public health worldwide [3]. We're supposed to be doctors first, orthopaedic surgeons second. The US medical system accounts for an estimated 9% of greenhouse gas emissions, and worldwide healthcare in general creates over 2 billion tons per year (about 5%) [10]. This is an unfathomably large number. We don't know what the specific contribution of orthopaedic surgery is because no one in our field has given it the attention it needs through formal study. Other societies have devoted research funding, committees, and position statements to climate change. In fact, our own American Academy of Orthopaedic Surgeons has an official opinion on working to fight climate change [1].

We have already waited for the glacially paced (pun intended) changes in our climate to become an urgent matter. We don't have time to debate something that is no longer debatable. It's everyone's job to do better, including orthopaedic surgeons. And learning about it in our curricula and our journals is a start.

### Jeffrey A. Mann MD

Private Practitioner, Cal Sports & Orthopaedic Institute

Dr. Bernstein's questioning of whether the issue of climate change is "settled



## Not the Last Word

science” was answered in the last week of July’s headlines. Vermont’s capitol and much of the state was underwater from one of the heaviest storms ever recorded in the area. Parts of Texas, Arizona, and California were experiencing temperatures over 120 degrees, resulting in 80 million people across our country facing dangerous levels of heat. The water off the coast of South Florida reached 101 degrees. Globally, every region of the northern hemisphere is experiencing record-breaking temperatures this summer. The environment is changing rapidly.

The Intergovernmental Panel on Climate Change (IPCC) reports provide peer-reviewed scientific evidence of global warming to any climate skeptic, especially those schooled in the scientific method as we orthopaedic surgeons all are [18]. This report represents the unanimous opinion of thousands of the world’s leading scientists from 195 countries, finding indisputable evidence of human-caused global warming.

There are several reasons why we should have these discussions in medical education and orthopaedic journals. In September 2021, over 200 medical journals across the world published an editorial recognizing that global temperature rise was the “greatest threat to global public health” [33]. Physicians are currently treating more patients who suffer from climate-related health issues, a trend that will increase over the coming decades. Extreme heat is causing more deaths and exacerbating preexisting illnesses every year. The pulmonary effects of wildfire smoke were witnessed by much of the East Coast several weeks ago, indirectly affecting many orthopaedic patients. Direct effects occur as well. In California, my patients make decisions about when to undergo elective surgery based on fire season,

as they may need to evacuate their homes on a moment’s notice. People experiencing extreme heatwaves may need to cancel surgery or office visits, when being outside the house for even a short time could be a life-threatening event. All parts of the country are experiencing more frequent hospital shut-downs or even evacuations from climate-related events such as hurricanes, floods, fires, and tornadoes.

Lastly, it is our obligation as orthopaedic surgeons to learn about climate change because we need to be part of the solution. The medical field contributes 10% of our country’s greenhouse gas emissions, the primary driver of climate change. Because we perform many resource-intense procedures—those with multiple trays and expensive implants—we have a larger carbon footprint than most (if not all) other specialties [27].

Orthopaedic surgeons can lower emissions without affecting patient outcomes in many ways. By decreasing waste in the operating room, especially regulated medical waste by proper sorting, we save energy in waste disposal. Each tray we open when performing surgery uses energy and water to sterilize. We can work with our implant company partners to decrease the number of trays necessary to perform procedures, and encourage them to create more reusable, recyclable, and fewer single-use items. As individuals, we should develop customized procedure packs that will prevent throwing away items we don’t use in routine cases.

As orthopaedic surgeons, we are privileged to be able to relieve a great deal of human suffering in our daily work. However, we need to think of ourselves as more than joint replacers or fracture fixers. We are part of the community of global health. This should start with educating our society

members about climate change through mediums such as this (Fig. 2), and develop ways to heal our patients while decreasing our energy and resource use. If you would like to be part of this process, please contact me.

### Eric M. Bluman MD, PhD

Associate Professor of Orthopedic Surgery, Harvard Medical School

Co-Director, Program for Research in Sustainable Medicine (PRiSM)

Vice-Chair for Safety, Quality and Patient Experience, Brigham Health

Past President, Orthopedic Foot & Ankle Foundation

Climate change has indeed come to orthopaedics. The question is whether orthopaedics will respond and address its role in climate change.

In 2023, the multidisciplinary science is mature, and the data are overwhelming: Anthropogenic contributions to climate change are incontrovertible [7, 8, 17, 31]. As such, Dr. Bernstein’s statement that climate science is insufficiently settled does not hold water. The expert he cites in support of this statement has been widely discredited with respect to the climate change denial that he espouses [6, 28, 31].

Some climate change scientific manuscripts may have a homiletic flavor, but undergirding these reports is solid peer-reviewed data and conclusions. The healthcare industry has been estimated to produce approximately 10% of US greenhouse gas emissions [11]. Orthopaedic surgery contributes to this total as a result of our heavy reliance on the fabrication and transport of implants, imaging, operating room use, and travel [29]. This latter category includes greenhouse gas production from surgeons, advanced practice providers, and industry representatives attending continuing

## Not the Last Word

4. Climate models around the world demonstrate remarkable consensus regarding the expected temperature rise. If anything, models may underestimate the severity of climate consequences of the temperature rise, as positive feedback loops may destabilize global climate systems such as the jet stream and polar ice caps [18].

5, 7. With a current elevation of the mean global temperature of just 1.1°C and an expected 2.5°C rise by midcentury [18], the earth has already experienced increased intensity of winter and summer storms and more severe heatwaves. Every place in the world will be affected by these weather extremes, even if the mean temperature of a certain city increases to a more “comfortable” level.

9. Elevation of CO<sub>2</sub> levels are causing all of the health and climate impacts I have mentioned above. It is true that combustion of wood for cooking is a huge health problem in the developing world, primarily due to particulate matter pollution. Likewise, the combustion of fossil fuels are estimated to cause 10 million premature deaths worldwide due to particulate pollution [32]. Additionally, fossil fuel combustion directly causes global warming by elevating CO<sub>2</sub> levels.

13. A fossil fuel economy requires 535 times more mining than a clean energy economy [19]. Although some rare minerals are required to manufacture batteries for electric vehicles, these batteries are likely to last the entire lifespan of the car and can be recycled after use. Fossil fuels have to be extracted every time you fill up your gas tank. New battery technology is advancing rapidly.

14. It is true that China emits more CO<sub>2</sub> currently than the US, although the US is responsible for a much greater proportion of the world’s historic CO<sub>2</sub> emissions than China (25% vs 15%) [26]. It is also important to acknowledge that a substantial portion of Chinese emissions goes to manufacturing goods for US consumers. It is indeed a “collective action problem.” We each have an important and consequential role to play in slowing down the warming of our planet with choices in our daily lives at work and home.

**Fig. 2** Dr. Jeffrey Mann found Dr. Bernstein’s questions thought-provoking, but misleading. In this figure, he addresses and reframes a few of the questions that he believes are most important to accurately understand. Responses are numbered based on the numbering provided in Figure 1.

medical education events and other “academic tourism” offerings. We, as orthopaedic surgeons, need to be part of the solution, not only because we are sizable contributors to the problem, but also because we are the subject matter experts with the best knowledge and perspective on how musculoskeletal care can adapt to diminish professionally associated emissions. We have the responsibility to set the example for the rest of society as practitioners of one of the most trusted professions.

Dr. Bernstein suggests that “physicians must make sure they understand climate change to avoid

misleading their patients.” I certainly have had patients speak to me about healthcare contributions to climate change, but these interactions have been exceedingly rare. I posit that understanding this problem is necessary to find solutions to decrease healthcare industry-related contribution to climate change rather than being for patient education. The difficulty is that these solutions need to be workable while maintaining high levels of patient care, scientific inquiry, and surgical education.

The burden of making the necessary choices now will not be rewarded for decades, potentially at a time beyond

which many of us will be able to bear witness. We cannot let these challenges push us down a path of least resistance. As we have described in our article [24], this is a problem akin to the “Tragedy of the Commons” in which our tendency to act in our own self-interest when using a limited shared resource results in an irrecoverable loss for all.

I agree with Dr. Bernstein that orthopaedic journals are not a suitable place for general climate-related articles. However, they are the most suitable place for orthopaedic surgeons to learn about how their professional activities (be they clinical, research, or

## Not the Last Word

educational) contribute to climate change.

Regarding the issue of curricular crowding, perhaps graduate educational programs are not the most appropriate forum for health-related climate science syllabi. Thought should be given to including this topic in premedical or undergraduate medical education as a component of a mandatory public health curriculum. Currently, there is a plethora of germane topics for inclusion in such a curriculum: heat-related injuries, modulation of infectious disease epidemiology, health issues secondary to climate-induced migration, and, of course, healthcare's contribution to climate change.

I am concerned that despite being faced with clear evidence that orthopaedic factors contribute substantially to climate change, we have ignored science and minimized our responsibility in correcting this problem. Science tells us that this denial and maintenance of the status quo will worsen the climate crisis. Achieving CO<sub>2</sub>-equivalent emission reductions that will halt and reverse anthropogenic climate change will be difficult. It will require substantial sacrifices and changes in our professional lives. This problem is ours to solve. We will be happier having a hand in formulating the solution rather than having one thrust upon us.

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## Not the Last Word

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