

## As Extreme Heat Becomes More Common, the Unprecedented Pacific Northwest Heat Dome Offers Lessons

Jennifer Abbasi

In early summer of 2021, in the middle of the COVID-19 pandemic, another public health emergency was unfolding in the Pacific Northwest region of Canada and the US. The extreme heat event came to be known as a *heat dome* as an area of high pressure trapped warm air beneath it for days on end. Daytime temperatures climbed to well over 100 °F, with little overnight relief. June 29 reached 121 °F, or 49 °C, in Lytton, a small town in British Columbia, becoming the hottest day on record in Canada.

Estimates have put the number of heat wave-related deaths that occurred in Canada's provinces of British Columbia and Alberta and the US states of Oregon and Washington at nearly 900. Most of the deceased were older adults who lived alone and died at home.

More than 600 of the deaths occurred in British Columbia. But the cities of Seattle, Washington, and Portland, Oregon, weren't spared. Together, they saw nearly 200 heat-related deaths. There, the heat dome lasted from June 25 to June 30. Temperatures reached 116 °F (46.6 °C) in Portland—more than 40 °F (22.2 °C) higher than normal.

Researchers have since classified the 2021 event as one of a handful of the most extreme heat waves on modern record. But it wasn't an anomaly. A recent study in *Nature* found that the summer of 2023 was the hottest in the Northern Hemisphere's nontropical regions in the past 2000 years. And this August, researchers reported in *JAMA* that heat-related deaths in the US have been steadily increasing since 2016.

To reflect on the Pacific Northwest heat dome 3 years later, *JAMA* Medical News recently spoke with Jeremy Hess, MD, MPH, an emergency medicine physician and professor in the schools of medicine and public health at the University of Washington and director of the UW Center for Health and the Global Environment, and Andrew Phelps,



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An administrative coordinator with a street outreach team in Portland, Oregon, tries to cool off while loading supplies in the summer of 2021.

Nathan Howard/AP Images

who was director of the Oregon Department of Emergency Management at the time of the event. Phelps is a member of the US Federal Emergency Management Agency (FEMA) National Advisory Council and is now chief operating officer at Colorado-based AC Disaster Consulting. The two discussed lessons learned that can be applied as extreme heat and its health outcomes become more common.

The following interview has been edited for clarity and length.

**JAMA:** I'd like to start by setting the scene for what happened in 2021.

**MR PHELPS:** For context, we were well into year 2 of our COVID response and all the challenges that presented. We had had in Oregon one of the most devastating wildfire seasons we had ever had. And in February of 2021 we had a historic ice storm that impacted a lot of Portland. So from an emergency management standpoint, we had been operational for really 16, 17 months

straight heading into June of 2021. As we got toward the middle of June, we started seeing our weather apps on our phones saying within a week the temperatures would be 112 °F, 115 °F. About 5 or 6 days before the heat hit, the National Weather Service in Portland started issuing extreme heat advisories and validating the forecast.

So it was a very well forecast event. We knew we were going to be seeing record-setting temperatures for multiple days, but these temperatures were so much higher than anything we'd ever experienced in the Portland Metro that we didn't necessarily know how infrastructure was going to withstand the shocks of these temperatures. With record-setting temperatures, we would expect record-setting energy usage for air conditioners. Although, I will say too that Portland has one of the lowest per capita air conditioning rates in the country. So many folks that live in the Portland Metro don't have it because historically folks haven't needed it.

**JAMA:** What happened in Seattle?

**DR HESS:** We got reliable forecasts about 5 days before the event, and they really were for unprecedently high temperatures both during the day and at night. There was actually a reasonable amount of disbelief here and dismissiveness of the forecasts because they just were so far outside of our historical experience—temperatures that were going to be about 40 °F above our usual seasonal averages. There was a bit of disbelief on the part of the general population that it could be that hot in Seattle for a sustained period of time.

This level of extreme heat is not a hazard that we're familiar with here. And so there was a lot of concern both about utilities and infrastructure as Andrew mentioned, but also for the human health impacts. There was an effort to quickly put together a number of health protections for communities that we know from prior experience here, but elsewhere mostly, are particularly vulnerable.

Within our health facilities, we had warnings go out to staff members communicating the forecast, letting people know about our heat health-risk protocols, mobilization of the required supplies and other things in our EDs [emergency departments]. And then there were a number of different efforts on the part of public health—Seattle, King County, and other city and county health departments and the state department of health—to mobilize protections like cooling centers and make sure that people could get relatively easy access through free bus rides and other things.

As Andrew mentioned, all of this was complicated by COVID considerations. I think we were actually in the middle of a bit of a surge. And so there were tensions there about how you improve access to cooled spaces *and* make sure that you protect people against the next round of COVID.

**MR PHELPS:** I think we had around 200 or 220 cooling centers established across the state. And a lot of engagement with the media to get the word out. But again, something that's so far out of the norm was certainly met with a healthy dose of skepticism. And you can't underemphasize the importance of being in the midst of COVID. For 14, 15 months, we had been telling people to avoid congregating together and being in crowds and then suddenly the message for something like this is "If you don't have

air conditioning, if you have underlying medical conditions, get yourself to a cooling center and congregate." Masking protocols were in place here in Oregon statewide, but it was perhaps a contradictory message for some folks.

**JAMA:** What did you end up seeing at those cooling centers? What was the public's uptake of those resources?

**MR PHELPS:** In the Portland Metro and throughout Oregon they were being used, and that was something that made me feel optimistic about the messaging that we had been doing. So as we learned later what the impacts were of this event and the number of fatalities, that was one of the things that I really struggled with and I think the emergency management community in Oregon really struggled with. When you had resources available and tried to make them as accessible to multiple communities throughout the Portland Metro as possible, why did some folks not have the access that we thought they would to these cooling centers to be able to take advantage and find a way to cool off? They were very well publicized, we thought. And that was what made it so much more difficult to understand where we had failed to ensure that everybody that needed access could access them and was willing to access them.

**JAMA:** What was the Seattle experience?

**DR HESS:** The Seattle experience was one of searing heat, and it worsened steadily over 3 days. June 28 was the worst and the day that we saw the most impacts [in the ED]. Despite our best efforts, there were pretty significant health impacts. They impacted the communities that we know are vulnerable to extreme heat. This includes people at the extremes of the age spectrum, particularly elders who have more underlying chronic conditions. People who are impoverished and may not have the means to avail themselves of protective measures like fans or certainly air conditioning. People who have substance use disorder and maybe didn't get the messages. People who don't speak English as a first language and don't get some of the preventive messages. And people who are isolated for any number of reasons and didn't have people checking on them or maybe not frequently enough.

And so we saw a number of [emergency department visits](#) during the heat dome as-

sociated with heat-related illnesses—heat exhaustion, heat stroke, exacerbations of chronic diseases that were caused by stressful exposure to the heat, and drowning. People were flocking to the water because it's cooler there, and in some cases, we had drowning as a result. So we definitely saw a spike in all of these different injuries and illnesses, and it correlated directly with the temperature.

I worked the night of the 28th at Harborview, which is our level 1 trauma center and serves as a regional coordinating center for disasters. One thing I was struck by was that we had patients who had contact burns from hot pavement, which hasn't historically been a frequently seen injury from extreme heat events. We're a burn center, and so we had a number of those patients in the ED. We also provide online medical control for prehospital care providers at Harborview. That phone was off the hook. We were getting lots and lots and lots of calls from the providers in the field treating patients with heat stroke. A number of those patients never arrived in the ED. They didn't make it to us.

We were stressed, but we're also a pretty well-resourced county hospital that is staffed to surge, so we were okay. But one of our other facilities in UW Medicine Valley Medical Center was in crisis. Over the course of the evening, they received so many patients with heat stroke who were intubated, and there are a number of factors that drove that local outbreak of heat stroke.

Luckily the heat broke the next day and pretty quickly thereafter, we saw a reduction in heat-related illnesses and injuries. But a few days later working at another one of our facilities, I saw patients who had other nonfatal complications related to the heat. I saw new onset of severe kidney disease, kidney failure requiring dialysis, and other events that were striking several days after the event—people who had thought they were adequately protected and then had sequelae of the heat exposure.

**JAMA:** Andrew, one of the things you mentioned at a FEMA-sponsored extreme heat summit that was held in Chicago this year was that the emergency departments did not seem inundated in Portland and that it was later that the excess deaths told the story of what was happening in people's homes.

**MR PHELPS:** From the statewide view of emergency management, one of the things we look at is whether hospitals go on divert and what their status is. And we certainly weren't receiving those types of reports. Frankly, as we came out of the heat event and the heat broke, we breathed a bit of a sigh of relief thinking, okay, "We didn't have those utility outages. We didn't have hospitals having to divert patients due to an overwhelming number of people seeking medical treatment. We didn't have Interstate 5 buckle due to the heat." It wasn't until 2 or 3 days later that we learned through the state medical examiner that they were investigating north of 100 heat-related fatalities. And that was just such a shock to the system to hear. It was one of the more sad moments of my career to understand that we came up short with trying to protect Oregonians during this record-setting event.

**JAMA:** So what happened? Why were there these unaccompanied deaths in people's homes?

**MR PHELPS:** We immediately sought to understand the why, and a lot of that was understanding who died. And what we found was that the overwhelming majority of heat-related fatalities during this event were White males, most of them living either in multifamily housing, apartments, single-room occupancy-type homes, or manufactured housing, mobile homes, etc. They were mostly between the ages of 60 and 80 and male. And when you think about folks that maybe don't always seek help or medical attention when they're not feeling well, that's the demographic.

It caused us to really think about how we message for events like this. It is a fine line when you're doing public communications during an emergency of elevating the message enough so that folks know they need to take it seriously, but not trying to use scare tactics to get folks to take action. So a lot of our messaging pre-event and during the event was: "This is abnormally hot. We've never seen temperatures like this. We have cooling centers set up. Please check on your neighbors and your family." And I think based on conversations we had with victim's relatives, with emergency managers, with the communities, that "check on your neighbors" wasn't the right message.

We had heard, anecdotally, folks saying, "I called my uncle at 11 in the morning and he was fine. By 10 at night, he was dead."

I think 15% of the fatalities were in homes that had air conditioning. But these were people oftentimes on fixed income who were afraid they couldn't afford the extra utility bill, so they never turned their air conditioning on. And that was devastating as well, that there were solutions available to help these folks, that these deaths were preventable. And that through a combination of missing the mark on messaging, the inability or the unwillingness or the fear of folks having to pay extra utility bills to turn on the air conditioning, and for multiple reasons not being able to get to or take advantage of the cooling centers, we had these fatalities.

During the rest of 2021 and into 2022, we had a number of other excessive heat events, not nearly the 116°F-days that we had in Portland earlier in the year, but 104 °F, 105 °F, pretty hot temperatures for the Pacific Northwest and Portland in particular. And so we shifted our message to be much more stark. Not "check on your neighbor." It was "go and put eyes on your neighbor, on your family members, on your co-workers. If they do not have a way to stay cool, if they don't have air conditioning, get them someplace where they can cool off for a little bit. This level of heat will kill you if you don't find a way to cool off and stay cool." We worked with public transportation in and around the Portland Metro to offer not only free rides to the cooling centers, but also making recommendations like if you've got a bus to set up on a street corner or if you allow folks to just ride a bus and cool off in the air conditioning in the bus, that's a way for folks to avoid these types of temperatures.

So there were some of those short-term immediate impacts that we were able to leverage and implement. But this is not a short-term problem. And this is certainly not an anomaly or an outlier. In my mind, it's an indicator of things to come. So we need to take the same approach to excessive heat that we take to other hazards and threats like wildfire or hurricanes or earthquakes. Disasters ultimately are policy issues. The decisions that are made by policymakers often related to how we build and where we build, and we need to make substantive changes in how we build and where we build to address this persistent and increasing threat of excessive heat and high temperatures.

**JAMA:** Jeremy, do you have anything to add in terms of the deaths that occurred in

Seattle? What were the patterns that you saw there?

**DR HESS:** Overall, we also saw that there was a disproportionate number of people who were older among the folks who died. In our case, there wasn't as much of a gender disparity, I don't believe. There was a higher-than-expected risk for people who were Black and for Native Americans and Pacific Islanders.

But all the things that Andrew mentioned are very familiar from other heat epidemiology work. And listening to him talk about it, I can tell this is painful. It was painful for us too, because we knew that these are preventable injuries, illnesses, and deaths, and yet it's very difficult to, on a very quick basis, deploy all of the protections that you need. I really struggled with this event because I do have expertise in this space. This is the kind of thing that really I felt like I should have helped my community prevent more effectively than I did. And I've struggled with that since the event.

**JAMA:** It's striking to hear you both say that.

**DR HESS:** But I also recognize as I've reflected on it that...we used to refer to the health effects of heat as entirely preventable. I don't think we generally do that anymore. And I think that's appropriate because it's actually very difficult to fully protect the population against extreme heat, which is not to say that we should expect any certain level of mortality associated with these events, but that we should, as Andrew said, really respect how hazardous these events are and how complicated it can be to protect people who are vulnerable and susceptible for any number of different reasons. And it certainly has to do with how we build and how we manage our built environments and how we manage things like utility subsidies and how we support outreach and all sorts of other things.

But we also live in a community that, at least here prior to this event, had very little protective reflex around heat. We had never experienced anything like this before. I've lived in very hot places and when warnings go out, people know what to do. There's certainly a trend in preventive messaging related to disasters to do exactly what Andrew outlined—be very explicit about what to do and what the risks are. And we certainly need to do that in our messaging here. But also, we were dealing with a very short time-frame to mobilize a massive protective

response within a community that had never experienced that kind of hazard before. So I think we also have to be a little gentle with ourselves recognizing that that was a very difficult context within which to operate.

The other thing that I'll say is the Pacific Northwest heat dome of 2021 affected all these different communities in the Pacific Northwest in different ways. This event was one big regional disaster, but it was also a bunch of different, more local disasters. Here in Seattle, it's much cooler than it is in eastern Washington. Even though the temperatures they experienced were also clearly well above normal, they have better protective resources and reflexes than we do over here in the Puget Sound because we just never have experienced anything like this before. We also had a relatively short event, whereas some other parts of the Pacific Northwest suffered under heat for considerably longer, and then some had compound disasters. Up in BC [British Columbia], their heat exposure was much longer and they also had wildfire exposure during the event. And that created a completely different set of hazards and in some ways a more impactful disaster for them. [Editor's Note: The town of Lytton was destroyed by a wildfire the day after Canada's temperature record was broken there.]

That too is an important thing to recognize. It's important to recognize the locality of every disaster and this specificity of context but also that as these events become more common, as we get closer and closer to the thresholds of what we're able to deal with relatively quickly, we have an increased risk of significant compound effects from cascading hazards.

Here in Seattle, we've taken to heart a lot of lessons from this event. The 28th was the busiest day for [Seattle King County Medic One](#) in its history, until December 2022 when we had another weather-related disaster related to an ice storm. So the highest demand that we've put on our prehospital care here has been related to weather-related disasters. And so I think there's an enhanced understanding these are really significant events potentially for us. We've started to create planning scenarios informed by climate science and projections of climate change for the region, recognizing that compound hazards are in fact fairly likely at this point, and that the scenarios may on their faces seem almost outlandish, but they're now actually a poten-

tial reality and that we need to at least drill for the possibility of cascading failures and the health impacts that may result.

**JAMA:** Andrew, could you share what lessons you learned and could be taken away by other regions that may not be accustomed to this type of heat?

**MR PHELPS:** There's quite a few things that have emerged for me, especially as an emergency manager. The importance of messaging, as I stated, is critically important. Being clear and direct about how dangerous these events are. The Pacific Northwest in many ways is an early adopter, as it were, of climate-driven hazards, whether it's wildfire or excessive heat or flooding in areas that wouldn't historically flood. And we're seeing these types of hazards migrate east across the country. We're seeing more wildfires and more excessive heat in places like the Midwest and the East Coast. So as my colleagues across the country plan for what I think is in many ways an inevitability, understanding the messaging, understanding the demographics of your community, understanding that one message may not resonate with the entire community so different messages that are geared toward the demographics, the cultural specificity of your community, is really important.

Some of those stopgap measures like what we've done in Oregon with our air conditioning program: if you qualify for certain medical assistance, you can receive a free air conditioner and then there's also offsets for utility bills for folks in need. Worker safety is huge. We've got a tremendous agricultural industry in Oregon and the Pacific Northwest. So an intentional approach to ensuring that those folks that are out working, whether it's in the fields or the orchards or the vineyards, that they have protections in place. That they're not made to work when it's a 100 °F, 105 °F, 110 °F outside without breaks, without cold water, without some level of protection from those heat events. That goes a long way as well.

But when we look further off to the horizon, thinking about things that we can do to make the built environment better able to withstand the shocks and stressors, there are a number of studies that show the cooling effects of green space. The city of Portland after the heat event in 2021 successfully requested and received funding for the planting of, I think, 10 000 trees in

mapped heat islands. These are areas that have a higher ability to retain heat due to concrete and the built environment. Through this FEMA grant and the [Building Resilient Infrastructure and Communities program](#), they're now able to reduce the impacts of these heat islands and make those areas a little bit cooler. These heat islands oftentimes translated exactly to where those folks lost their lives in the 2021 heat dome event.

So for emergency managers to understand again that this is not just about high temperatures, but our built environment and how we build and where we build, that goes a long way toward reducing the impact and mitigating against the effects of what is going to become, in my mind, more frequent excessive temperature events. This is the trend we've seen for the last 80 years. The highest years on record since 1850 have been within the last 9 or 10 years. This is not a problem that's going to abate anytime soon.

**DR HESS:** I completely agree that we need to be more mindful and attentive to how the built environment amplifies risk in some places. Planting trees is really important, and there's huge historical inequity in green space and blue space access that we need to rectify as quickly as possible. But some of those interventions are going to take 20, 30 years to mature. And we also have to recognize that most tree planting will occur on privately owned land and will require the owners to maintain those trees. There's a high mortality rate for a lot of those efforts. It's a complicated intervention. Trees are a wonderful infrastructure, but they're actually expensive infrastructure to maintain and develop. And it worries me sometimes that there's so much attention and investment going into that kind of infrastructure and not recognizing that right now we need to deploy heat pumps. We need to deploy subsidies for power bills. And we need to deploy cooling centers and buddy programs and other proven strategies for protecting highly vulnerable people right now for the next event because those other preventive measures are going to take a long time to reach their full mature protective effects.

**JAMA:** What's a heat pump?

**DR HESS:** A heat pump is a mechanical air conditioning that is much more efficient and so uses less energy. It provides the same amount of cooling but reduces the load on

the grid and reduces the greenhouse gas emissions that come from electricity if it's not produced through renewable sources.

**JAMA:** Energy subsidies have been mentioned by both of you several times, and it's something that seems to be coming up more and more in [our reporting](#). How important do you think energy subsidies are going to be going forward to protect people from heat?

**DR HESS:** I think it's one of several effective strategies. Unfortunately, there's been pretty systematic underinvestment in investigations around interventions to reduce health risks from heat. We're slowly getting more information about modifications in the built environment and what their treatment effects are. And so eventually, we'll be able to answer that question with more precision. But right now, I think it's a basket of interventions that you need to invest in. And energy subsidies certainly don't seem to be harmful, and they do seem to be protective. But how protective they are relative to some of the other interventions that we could pursue, I'm not sure.

**MR PHELPS:** I would echo that. It's one piece, one mechanism to help reduce some of the impacts, not just in the summer for cooling and to avoid heat-related injury and death, but also in the wintertime when you have folks that can't warm their homes. But again, it's not a total solution to this problem.

**DR HESS:** There are a number of different interventions that actually can reduce risk for a bunch of different climate-sensitive hazards. So some kind of mechanical cooling if

coupled with the appropriate air filtration, can protect you against extreme heat, extreme cold, and particulate air pollution during wildfire events. It's a useful intervention for a number of the problems that we are seeing. You want to make sure that you are deploying it thoughtfully and that you're not adding to the problem by increasing greenhouse gas emissions. And you also want to make sure that you do it in a way that doesn't overwhelm your grid, so you don't want to create additional problems through the interventions that you're promoting.

**MR PHELPS:** I think my call to action on this is that we need to find that sense of community again. The thought of someone losing their life in a heat event by themselves in an apartment or in a mobile home that was 125 °F, 130 °F, 140 °F inside is devastating. There's no reason in a city like Portland, in a metro area like Portland, in a place like the Pacific Northwest, that someone should be alone and suffering without a neighbor or someone being able to come and check on them. The notion that we have to try to take care of each other a little bit during these types of events is one of the things that I keep coming back to when I reflect on the 2021 heat dome. We have to take care of each other. That's the bottom line for me.

**DR HESS:** I absolutely agree, and I have one other thought that I want to make sure that I insert. The problem was that we didn't really apply all of the knowledge we have about what makes communities vulnerable and to some degree individual

people vulnerable in those communities. What creates pockets of vulnerability hotspots, if you will. And we didn't and haven't invested adequately in infrastructure to support surges wherever they may take place. Our challenges as a health system during this event were mostly related to concentrations of vulnerability and illness and then capacity. And this is particularly important when you start to think about cascading hazards that can quickly overwhelm your capacity, particularly if you operate, like many of our facilities do, near full capacity and occasionally over full capacity on a regular basis. Our staff are highly trained. They knew exactly what to do, but they bumped up against the limitations of the system. ▀

**Author Affiliation:** Director, Medical News & Perspectives, JAMA.

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**Correction:** This article was corrected on September 13, 2024, to fix the higher-than-normal increase in temperature experienced in Portland, Oregon, during the summer of 2021, from 4 °C to 22.2 °C.

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**Note:** Source references are available through embedded hyperlinks in the article text online.