The Deadliest Wildfire in California History - VICE News
[Evacuation alarm blares in background]

Man's voice
The evacuation area is getting bigger, so I urge people to pay attention. If they are urged to evacuate, please do so.

Reporter
The episcenter of the so-called "Camp Fire", the deadliest and most destructive wildfire in the state's history.

Evacuee
This entire neighborhood has been leveled. The fire has taken out every house here.

[*melancholy music fades in from news clip*]

Number of missing in California Camp Fire spikes - Canadian Broadcasting Corporation
Reporter
A week after the town of Paradise was destroyed, the number of people missing is spiking. More than 600 people now unaccounted for, the highest count yet.

The Camp Fire has destroyed more than 6,700 buildings in Northern California - ABC News
Reporter
And as you're walking along, it looks like a bomb exploded across this community, leaving nothing but rubble, and heartbreak.

The ruins of Paradise: Inside the California fire zone - CBC News
Reporter
For evacuees and their families, there's been a haze of confusion and miscommunication. People are scattered and homeless. There's the stress of losing everything, followed by the dread of not being able to connect with a friend or relative.

ABC News
Evacuee
The fire was right on me, my pants were catching on fire. I thought I was going to die, right there.

CTOR tag

Camila
Wildfires have always been a part of the California landscape, but climate change and human activity means that fires are getting larger and more destructive each year. And it's not just about the damage done in the wake of the fire. Smoke goes *everywhere* the wind takes it - not just around the west coast. In extreme cases, it can reach all the way across the *Pacific Ocean*!

And it might not surprise you to learn that breathing in wildfire smoke isn't exactly good for you - have you ever been downwind of a campfire? That's uncomfortable enough. What makes it so *bad*, though? What is the smoke even *made* of? What does it mean for those of us who live in fire-prone areas?

Borough - Blue Dot Sessions

My name is Camila, you're listening to Carry the One Radio, and today, we're learning all about wildfire smoke and its impact on our health. Our expert is Dr. Mary Prunicki, the director of Air Pollution and Health Research at the Sean Parker Center for Asthma and Allergy Research at Stanford University. Her immunology lab studies how air pollution, wildfires and environmental exposures impact immune health.

So, let's get to know our guest a little bit. Mary, how did you get interested in immunology, and more specifically, air pollution?

Mary

The reason I wanted to go into immunology is because all three of my daughters have food allergies and our lab also is heavily focused on the immunology of food allergies. And so, I wanted to focus on topics that were passionate to me for one reason or the other. And um, I like this field of research because it will hopefully help shape policy and make the environment better for our children, because even fetuses are being impacted by what's going on in the environment right now.

Camila

So allergies are an immune response. Can you quickly break down what the immune system is?

Mary

So with your immune system, there's kind of two types. There's the innate immune system and there's the adaptive. And with the innate immune system, that's kind of our first line of defense. And then there's the adaptive immune system and that, you don't get an immediate response. You get a process where you develop antibodies.

Camila

Okay. So, in short, there's the innate immune system that will actively fight off an infection while the adaptive immune system will make antibodies to remember and fight off the invader that got you sick in the first place. For example, with the COVID-19 virus, you developed a fever from your innate immune system fighting off the infection, but you didn't get sick again - at least, from the same strain - because your adaptive immune system had developed specific COVID antibodies against it.

So, does the immune system react the same way to air pollution and wildfire smoke as it does to a virus? How do you even begin to understand the immune response?

Mary

We're actually looking at the actual immune cells, how they shift in proportion, how they function, how the DNA of the immune cells change when they're exposed to pollution or wildfires. So we take a finger prick, so a drop of blood, or they have this new device where you can stick it on your arm and it doesn't even hurt and it draws a small amount of blood. And we can look at that with different technologies.

Camila

You might be familiar with the idea of microsampling in the context of Theranos and its founder and CEO, Elizabeth Holmes. So Theranos is a now-defunct health technology company, which claimed that it could make sophisticated diagnoses from miniscule amounts of blood - like from a finger prick. Well, that turned out to be false in a *big* way, like "Holmes was accused of defrauding patients and convicted of defrauding investors"-big, and if you're interested in learning more, we've linked some resources for you to check out in the show notes.

But actually, the idea of analyzing small amounts of blood is totally legitimate and more widespread, thanks to real advances in technology. So Mary collects around 100 microliters, or like 2 drops of blood per person, which is incidentally *10 times* more blood than Theranos claimed to use. So, you can use tiny little needles to collect fresh blood, or use dried blood to look for things like molecular indicators - or biomarkers - of blood disorders. And, specifically, Mary's group collects blood from people in the city of Fresno, in Central California, 2.5 hours south of Stanford and inland from the coast.

Mary

The director, Kari Nadeau, noticed that she had a lot of patients coming in with allergies and asthma from that location and the kids that live in the Fresno area actually have quite a bit higher rates of allergies and asthma than the general population. Some of our cohorts, almost a third of them have asthma, um, which is much higher than the national or state averages for kids with asthma. And so, she knew that it had something to do with the immune system, and started working with others from Berkeley and different groups looking at, what is going on, immune-wise, to cause these shifts and how does pollution play a role?

Camila

So before we get more into Mary's research, let's answer a basic question. What *is* pollution, and specifically, what is *air* pollution? Well, the World Health Organization defines air pollution as "contamination of the air by any chemical, physical or biological agent, and this contamination is harmful to living beings." So, for example, things like carbon dioxide, dust, radioactivity from the Earth's crust, and, well, wildfire smoke.

So, levels of air pollution are actually typically measured in a unit called PM2.5. If you live somewhere that is affected by wildfire smoke, you have likely seen this on a website monitoring air quality. And to be clear, the surrounding environment can be polluted even if you don't *see* anything, like smog.

Mary

So PM stands for particulate matter. And 2.5 is the *size* of the particulate. So PM2.5 are particulate matter that are 2.5 microns and smaller.

Camila

For comparison, that is *30 times smaller* than the width of a human hair!

Mary

So the reason that the size is so important is because that determines how far it can get in your body. So when we talk about PM10, which are larger particles, 10 microns - when we inhale those from smoke or just regular air pollution from traffic or industry - those particles can make it part way down your respiratory tract. But when we talk about PM 2.5 or smaller, those particles are small enough, they can go all the way to the base of your lungs, cause a reaction there, but then also cross over there into the bloodstream and wreak havoc throughout the body.

Cicle Gerano - Blue Dot Sessions

Camila

Mary's lab has been studying air pollution in the Central Valley for over 10 years, and they noticed that the area got exposed to a lot of the wildfires in and around Yosemite National Park. But then, in 2018, with the Camp Fires, they decided to really focus on how wildfires impact our immune health, because there just wasn't much information about that.

The 2018 Camp Fire was the deadliest wildfire in California's history. It was caused by a faulty power line and drought. It burned for 17 days over a total area of more than 150,000 acres - for reference, the city of Chicago is only about 150,000 acres. It caused over $16.5 billion in damages and killed 86 people. It destroyed over 95% of structures in the towns of Paradise and Concow. Resulting air pollution forced school closures in the Bay Area and Central Valley. And smoke was even visible in New York City! As of 2019, the population of Paradise, California is only 10% of what it was in 2010.

So, yeah, it's worth knowing how a disaster like this affects your health, which is why Mary's team started looking at wildfire air pollution.

Mary

In the past, the most surprising thing is that we looked at a hundred teenagers living in Fresno, and these are healthy kids, normal, healthy, high schoolers, and they were exposed to a wildfire in Yosemite and it was about 70 miles away. So we could see on the pollution monitors in the town that there were increases in pollution during the wildfire. It wasn't anything super dramatic like what we experienced in the Bay in 2020, but there was, you know, an increase in pollution. And we looked at subjects who had their blood drawn after that fire. And we actually saw increases in biomarkers in the blood from that far away in these healthy kids.

Camila
When looking at these teenagers, Mary's team found an increase in monocytes, a type of innate immune cell that fights and destroys pathogens. While they don't fully understand the association between monocyte levels and exposure to air pollution, it's concerning because increased numbers of monocytes can be markers of heart disease.

Mary

And so, it makes us wonder, these kids being exposed to these fires, are we predisposing them for future chronic health problems? You know, we don't know, but we do see changes in their blood.

Camila
Okay, so now we understand the kinds of physiological changes Mary and her team were looking for after wildfire smoke exposure. But, to answer the question of whether these children will be predisposed to future chronic health problems, you have to do the same tests over time - over a *long* period of time. Otherwise, you wouldn't really know if you were seeing transient changes or actual biomarkers for long term diagnoses, right?

Mary

We do have repeat time measures. It's really hard to follow a cohort long, long term - which is what's needed, really, for looking at the wildfire smoke exposure - because you don't *know* who's going to be exposed, you know, until it happens. Um, which is one reason we also have been focusing our research on firefighters because obviously they're like the extreme situation and so we've been studying both active and retired firefighters, knowing that what changes we see in the blood with them, we could potentially expect something on a lesser extreme for the general population when we have these large scale catastrophic wildfires.

Camila
Okay, but to clarify, there *is* a difference between someone who is directly impacted by a wildfire - like an evacuee or firefighter- and someone who was just *exposed* to one, like me.

Mary

So we've never dealt with people who are directly impacted by the wildfire. It's more the smoke exposure, which, you know, now we've learned smoke can blow thousands of miles. When the Camp Fire hit, we realized, oh, we should be collecting samples and we did, but we didn't have a good baseline. And so in the fall of 2019, we collected baseline data on lots of subjects, predicting that at some point there's gonna be a wildfire and then we would have a post-exposure blood draw. We waited. And lo and behold, in August, you know, September of 2020, the Bay Area was hit really hard with the wildfires. And we were able to collect follow-up blood on a segment of the participants.

Camila

Taking a baseline *after* an event has already occurred doesn't sound intuitive, though. What if there were lingering effects from the previous exposure?

Mary

Yeah. I mean, that's a good question, but it's gonna be hard, in this area, now, to find subjects that weren't exposed. So, their exposure to the Camp Fire smoke would've been, at that point, two years. But yeah, that's why it's so important to compare within individuals, so we know, at least relative to the fire that's *about* to occur, what their baseline immune system looked like.

Cicle Gerano

Mary

We don't have a good idea yet whether or not changes that we see in the immune system with an exposure to a fire is going to be maintained long term. We, we just actually don't know. We also don't know if being exposed to continual poor air quality, if those people become kind of tolerant to smoke exposure or whether those people look the same as someone who typically is exposed to good air quality now exposed to a smoke event.

Camila

So, maybe not ideal, but like Mary said, finding people who haven't been exposed to wildfire smoke is quite the challenge in and of itself. And while I've personally never been affected by wildfires, because the smoke can travel enormous distances, I've been exposed to wildfire smoke every single wildfire season in California.

In the 2020 wildfire season, when Mary's team collected the follow-up exposure samples, the August Complex fire was the largest ever fire in California's history. You might remember seeing photos of apocalyptic landscapes from that time, like that iconic Golden Gate Bridge obscured by orange smoke, set against a fire-red sky. That's becoming more and more common. There are articles every year about smoke from California wildfires being visible in Kansas, even in Europe.

So, Mary collects her baseline blood samples at a time that is removed from the previous wildfire smoke exposure. Now, she can collect follow-up samples from people who are exposed to this second wildfire…but, as if the fires aren't enough of an issue, something else is going on in 2020 that complicates things…just a little bit.

Mary

It was obviously severely impacted by the fact that COVID was going on and now people are restricted and not able to come in as much. But we did have a group of 15 people that we got baseline and post-exposure on, and we're about to publish some of those results.

And we did see increases in several markers in the blood, which indicate that, even for the general population - they typically spend most of their day inside working, and, we know which ones wore masks and things like that - we still demonstrate that certainly the smoke did have an impact.

Camila

Okay, speaking of COVID - since it's a respiratory disease, do you know if exposure to wildfire smoke affects symptoms or your likelihood of catching it?

Mary

A group out of Harvard found that if you're exposed to smoke, the rates of *getting* COVID went up, but in addition, the rates of *dying* from COVID went up. And these effects were seen up to four weeks after the smoke exposure. And that's the only study I know of that has really looked at the intersection of COVID and wildfire in that way, but it supports other studies that have been done that have shown an association with COVID and air pollution.

And biologically, it makes sense because we know that when you inhale particulate matter, the macrophage, which is an immune cell that's lining the base of your lung, it will go and try to digest the particulate matter. And it makes the immune cell less optimal. So now when you're hit with COVID, you could think it of as your immune system being distracted in some way.

Camila

Your nose and respiratory tract are lined with mucous and tiny, fine hairs called cilia that filter out and trap particulate matter - things like PM10. So that would include things like dust, soot, and all the crap that leafblowers kick up. You cough or sneeze out PM10, or you swallow and digest it. Or, it gets gobbled up by macrophages, like Mary mentioned, which are important innate immune cells that live all over the body. From there, filtered air passes into our lungs to deliver fresh oxygen to the bloodstream.

But PM2.5, the pollutant that is monitored by air pollution indexes, is a whole other story…but why? What makes it so different from PM10?

Mary

So particulate matter, the composition of it depends on what's being burned. So PM 2.5 from, let's say, a factory is gonna look different than PM 2.5 generated by a car and it's gonna look different from PM 2.5 generated from a wildfire, which is different from a wildfire burning through a town and burning synthetic materials and plastics and all kinds of things you would find in your home or in structures where you wouldn't naturally find them in the wilderness. And then also there's things like heavy metals, which can kind of tag along and hitchhike on the particulate matter.

And then when you talk about smoke, there's also things like gasses. So carbon monoxide, nitrogen dioxide, there's, organic compounds that haven't fully burned, they're partially combustible and there's others that maybe have chlorine involved, so, like a chlorinated organic compound. These different compounds are toxic to varying degrees and, depending on what it is, can be related to increases in cancer, or it can be simply an irritant to the lining of the lungs, of the airways.

The composition does vary and that's what makes some of the research difficult because you're not always comparing apples to apples. And in addition, when particulate matter ages, it becomes more toxic, because you get the production of free radicals, and that would be, you know, more toxic to the body itself.

Camila

I can't believe I breathe all of that during the wildfire season. If my body is already dealing with all of this, it's really no wonder that I might be more susceptible to a respiratory illness like COVID-19.

Mary

So, the association makes sense. There was another study that looked at a community that was exposed to wildfires, and then they looked at the influenza rate a few months later in the fall. And what they found is, the exposure of the smoke increased the rates of influenza. And so it's not COVID, specifically, that's associated with wildfire exposure, it's *any* type of pathogen that your body needs to fight. You know, if we look, we would probably see an association, so influenza, MERS, and SARS, all of those viruses have been associated with pollution levels. So it just, it kind of goes hand in hand with the whole concept of, 'pollution is bad for your immune system'.

Camila

With Mary's research, and work by similar groups around the country, we have a better understanding of how wildfire smoke negatively affects our physiology. But, we still don't really *know* what the long-term effects of exposure to smoke are, and that's scary because of how frequent and expansive wildfires are now.

And that's something we have to talk about, too. Wildfires are a *natural* occurrence, but climate change has caused an increase in both the frequency and the level of destruction in recent years. While we figure out how to slow down (and ideally stop) climate change, we also have to contend with increased exposures to wildfire smoke and how that will affect people in wildfire-prone areas.

Cicle Gerano

Camila
As a lifelong resident of CA, I feel that there *has* been an increase in wildfires over time. So I looked up how much the frequency of wildfires in the US has actually changed in my lifetime. Here's what I found: according to Resources Magazine - between 1991 and 2020, the annual area burned in fires has increased by about 192,000 acres - or the size of New York City - per year across the *entire* United States.

On the west coast, where fires burn more land compared to on the east coast, the annual average area burned in large forest fires has grown by about 1200% between the 1970's and the 2000's. With such drastic changes in wildfire activity, it's *absolutely impossible* to attribute this all to chance. In fact, increases in fire season lengths closely follow changes in our climate. So, how intimately related are climate change and wildfire season?

Mary
So we know that climate change causes extreme weather events, one of which is wildfires. And the wildfires have increased for a lot of reasons, but obviously because it's hotter and drier. But as we get an increase in those wildfires, now wildfires are putting in a substantial amount of pollution into the air. And so it's kind of become a vicious cycle. So, I mean, I think it's important to realize that, right now, climate change is considered the greatest human health threat of our time. And that's *because* climate change has so many, both direct and indirect impacts, which end up impacting our health.

Camila
Yeah, okay. So, I can fully understand that if you were to tell me that you got hit by a car, your health is impacted. But it *is* harder to imagine how something seemingly intangible like climate change can *directly* affect someone's health.

Mary
There's other ways that the increase in heat impacts our health, such as the heat itself causes pollen to become more allergenic and climate change has also been associated with a lengthening of the pollen season. So if you have individuals with hay fever, they're gonna be experiencing more of it and more intensely, and that can also be a trigger for asthmatics.

Camila

Hay fever is an inflammation in the nose that occurs in response to your immune system overreacting to allergens in the air. According to the CDC, around 18 million Americans are affected by hay fever. Unlike other fevers, which are usually caused by a buildup of pathogens in the body over time, hay fever does not, in fact, cause a fever. Instead, those afflicted will develop itchy eyes, runny noses, sneeze attacks and all of that fun stuff *immediately* after exposure to allergens. So if you're a victim of hay fever, you may be a victim of rising temperatures. But even if you're not prone to the adverse effects of allergy season, that doesn't mean you're totally safe.

Mary

There's a lot of downstream, indirect impacts, too. When you have a wildfire of a large area, it can impact the water quality and the runoff, so, you know, that can impact human health. There's just kind of like a, a rippling effect of all the problems that climate change is having with our health.

[crosstalk] There's a paper by Marshall Burke, he's at Stanford. They estimate that the smoke itself is contributing now 20, it was 25%, to the rise in the pollution. So it's, it's a significant problem.

Camila

Burke and his co-authors found that wildfires account for this rise in air pollution. They even mentioned that in some western regions, wildfires account for up to *half* of the pollution! There's really no escaping it. So, what do we even *do*?? What are the practical solutions to all of this?

Mary

People talk about the wildlife-urban interface. You know, we're building homes in places that are fire-prone. So that's one of many problems where we have had this mentality that burning is bad. And the way that the landscape used to be handled would be, the Indians would do basically prescribed burning. In the 1850s, with the settlers in the west, all that burning was stopped. And now there's kind of been a lack of maintenance of the forest. And so, prescribed burning can be highly restricted, but that might be increasing our risk of, and severity of, wildfires when they do occur.

Camila

Prescribed burning are planned fires that maintain the health of a forest and are set to prevent a wildfire. So, basically, a group of experts will get together and plan to burn a defined area of the forest around areas and times that won't pose a threat to the public. They plan the place of the fire, how big they want it to be and what sort of stuff will be burned, like debris, leaves, tree limbs. All really good examples of highly organized chaos. But that's sort of out of the hands of individuals, so what's something that the average person can do?

Mary

It's a multifaceted problem, unfortunately <laughs>. Um, with regards to our health, I think it's important if people start being aware of their indoor air quality. You can't assume that you have good air quality, just because you're inside. Sometimes it's just as poor depending on your ventilation and the age of your home and things like that. And so I think that's an important consideration that maybe hasn't been promoted as much.

Because there's no systematic way to know what the indoor air quality is of a school or school system, but studies are showing that you get a decrease in test scores when the air quality is bad. So I think just knowledge of air quality would help and it might spur people to be more proactive with whatever needs to be done to make sure that, especially kids, are in good air quality.

Camila

Wow! Okay, so bad air quality - makes sense that it's bad for allergies, but I guess I never really thought about test taking! I mean, I got an air filter right before the fire season last year and I usually just crank it up whenever I smell smoke. It definitely works, but is that enough?

Mary

People assume they can smell the smoke and you can't really go by that <laughs>. You know, there could be high levels of pollution. I mean, certainly you *can* smell smoke, but you can't necessarily determine your indoor air quality by using that method, so…Yeah, filters are a good thing, but then, you know, there's a lot of populations that don't have the ability to do that, or the knowledge, so I think it's a large problem. I'm not gonna be able to give you any easy solutions at all. <laugh>

Camila

That's…pretty depressing, isn't it? So, we're stuck in this vicious loop of climate change and wildfires perpetuating and worsening each other. On top of that, wildfire smoke is harmful to our immune systems, travels thousands of miles so you can't even escape its effects, and there's no surefire way of making sure that your environment has good air quality, even if you *do* have the resources to do things like filter the air in your home. You know, what does this mean for us?

Cicle Gerano

Well, the most important thing, like Mary said, is to recognize climate change for the existential threat that it is, and to take action where we can. Yes, corporations and governments are largely responsible for creating and upholding harmful policies that worsen climate change, but that doesn't mean that individuals *can't* make a difference. With that in mind, what are practices that we can adopt? What are policies that we can advocate for and support?

We can make sure that the people around us don't dismiss the effects of climate change as a far-off thing, because it's here and affecting *all* of us *now*. Climate change isn't restricted by geopolitical boundaries, and we should fight for policies that aren't, either.

Palms Down - Blue Dot Sessions

Camila

This episode was written and produced by me, Camila Benitez, and Cindy Liu, with help from Devika Nair and the team at Carry the One Radio. A big thank you to Dr Mary Prunicki for taking the time to speak with us, and to you for listening!

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Thanks for listening, and as always, stay curious!

Post-credits

Cindy

So our last couple questions are, uh, what do you hate the most about your work and what do you love the most about your work?

Mary

Hmm <laugh> uh, um, well, I'll go with what I love the most first. Um, I really enjoy doing something that I feel like can make a difference. You know, hopefully, some of the findings will be quickly disseminated to the public or to lawmakers so that they can better understand the impact the fires and the air pollution are having on our health. You know, it's easy to be pretty passionate about something that impacts kids since I have my own. You know, air quality is something that impacts everybody. For what I hate about my job? Um…

Cindy

If it helps, we hear a lot of people say they hate the grant writing.

Mary

Uh, I actually don't mind it so much. I hate Endnote. I shouldn't say that, I guess. And references are difficult, but, uh, um, I guess it would be, um, I don't know. This is terrible, isn't it? Um, maybe…

Cindy

No no no, that's great! You don't have to. <laugh>

Mary

<laughing> I can't really come up with anything right now. Um, yeah, sorry. No, I like my job. I like, like my job and I like the people I work with, so I'm kind of out of….I don't know! I can't help you with that one.

Cindy

I think that's the best situation you could possibly be in, that you can't think of a single negative thing.

Mary

Yeah, I'm, yeah, I'm fortunate in that, in that regard.