

Highly Pathogenic Avian Influenza A(H5N1) Virus Outbreak in New England Seals, United States

[Announcer] This program is presented by the Centers for Disease Control and Prevention.

[Sarah Gregory] Hello, I'm Sarah Gregory, and today I'm talking with Dr. Wendy Puryear, a virologist at The Cummings School of Veterinary Medicine at Tufts University. We'll be discussing the spillover of highly pathogenic avian influenza A(H5N1) into New England seals in the northeastern United States.

Welcome, Dr. Puryear.

[Wendy Puryear] Hi. It's great to be here.

[Sarah Gregory] How is avian flu H5N1 different from other flu viruses?

[Wendy Puryear] So first, it's probably worth starting off with a really brief rundown of influenza since it can definitely get a bit confusing. So there are a lot of different forms of influenza A virus or what's often called 'avian flu', and it's defined by two proteins on the outer surface of the virus—there's hemagglutinin (or 'H') and neuraminidase (or 'N'). And we know that there are 144 different combinations of H and N that can occur, of which H5N1 is one of them.

So there are all of these combinations that can and have been found in what's considered the natural reservoir (or wild birds), and this is primarily water fowl, gulls, shore birds. And in most cases, the virus stays in birds and causes little to no disease. But sometimes the virus can spill over into other types of birds or species. And in this case, the H5N1 that we're talking about today, made its way back into domestic poultry (actually, way back in 1996) and it continued to evolve into a form that's very deadly to poultry, and that evolved and made its way actually back out to wild migratory birds. And over the past few years, it has really disseminated around the globe, and that's what we pick up on with this paper that we're going to discuss.

So the thing that's particularly unique and concerning about this form of H5N1 is that it is causing a large amount of mortality in a diverse range of wild birds. And that's something we actually haven't seen previously. So it's making its way also into wild mammals and causing mortality there as well.

[Sarah Gregory] When you say, "It makes its way into wild birds and mammals", mortality, obviously, is dying. But what other problems is it causing?

[Wendy Puryear] So there are really three main avenues of concern when we talk about this transmission event, and it really comes down to thinking about wildlife, thinking about domestic animals, and thinking about human health. So for wildlife, it's having a huge impact and really hitting some wild bird species quite hard, particularly sea birds, shore birds, some vultures and raptors. Some of these are endangered species, like the California condor is now showing pretty high levels of influenza H5N1 infection. And some of these are species that are already facing really large threats from other things, like climate change. So this is yet another blow.

And then, if we talk about domestic poultry, worldwide the current estimate is that there have been half a billion (billion with a 'B', which is hard to wrap my head around that number), half a billion poultry that have been infected or depopulated because of H5N1. And that is just a staggering number to process, and of course has a huge economic and food security impact. And

then finally, if we think about human health, thankfully this virus so far has shown very limited capacity to infect people. But it has occurred. There have been some deaths, though it has been quite rare. But that's something that we're watching really closely since a hallmark of influenza is its ability to constantly evolve.

[Sarah Gregory] And you mentioned the staggering number of half a million poultry and food security. That's really important because poultry is a main food source globally, right?

[Wendy Puryear] Yeah, exactly. So that's been one of the really large impacts that have received a lot of attention (rightfully so), but of course there's also the large impact that is occurring for wildlife as well right now.

[Sarah Gregory] Right. And so, going to your study, you studied 132 stranded seals, and they were tested. Why and what prompted the testing?

[Wendy Puryear] So our group has actually been doing surveillance on seals for over 10 years now, as well as wild birds. And all told, we've really tested thousands of seals over the past decade or more. In part, this is because there have been outbreaks of influenza in seals going all the way back to the 70s. So we've been trying to understand the role that seals and other wild mammals may play in the bigger picture of disease ecology. And also, in part because there's been concern, really, all along that H5N1 (the one that we're currently seeing and discussing) may eventually move into seals from wild birds since they share a habitat. So ongoing testing was already underway, but that really ramped up when we started to see a sharp increase in the number of stranded seals (stranded and dying seals) along the coast of Maine during June of 2022.

[Sarah Gregory] And what kind of seals are these?

[Wendy Puryear] So the seals that tested positive for H5N1 in Maine were primarily harbor seals, and then there were a smaller number of gray seals. And we also looked at harp seals. So those are really the three main species that we have in this region. None of the harps tested positive, but we did see the H5N1 in both the harbor and the gray.

[Sarah Gregory] Explain a little bit more about why you did this sample testing just in the northeast.

[Wendy Puryear] There's a few reasons that we've been doing this ongoing surveillance here for so long. So for one, the Gulf of Maine has been one of the primary regions where influenza has been detected in seals, going back 50 years now. It's an area where we have seen this sort of thing. Not necessarily with die-offs, like we saw last year, but we've seen influenza go into the species in this region. This region is also a place where seals are recolonizing after being hunted to near extinction in the region. In addition to the numbers of seals increasing, waters are warming and migratory patterns of both seals and birds are shifting, and multiple species of seal and bird overlap. There are all of these very dynamic events that are occurring. So this really is a region that's particularly primed for looking at the movement of virus (such as H5N1) in wildlife.

[Sarah Gregory] Okay. So you've mentioned Maine and up around there, but what other states have you possibly tested in and what were the dates you did this recently?

[Wendy Puryear] A lot of the surveillance that we've done in seals over the years has been in the Gulf of Maine—so, largely in Massachusetts, New Hampshire, Maine. But we have tested all the way down along the Atlantic coast. Although it has primarily been in the northeast, we certainly

have samples that come in from Delaware, from Virginia, from North Carolina. So we have been monitoring to see if the virus is making its way into seals and other regions of the Atlantic, beyond just looking at the Gulf of Maine. You were asking about the timing about this particular sampling was, and what's reported in the paper is focusing on January to August of 2022.

[Sarah Gregory] And those samples you collected farther down the coast...no sign of H5N1 in those?

[Wendy Puryear] There has not been. So far, it has only been in...even just in Maine. We haven't even detected anything in Massachusetts, kind of on the lower end of the Gulf of Maine. So it has been in the state of Maine itself we've picked up the H5N1.

[Sarah Gregory] Maybe some kind of hope there? I don't know.

How were the samples collected?

[Wendy Puryear] So we partnered with NOAA and multiple groups throughout the stranding network—so, people who are responding to stranded and deceased seals. They collect a suite of swabs from the animal, sometimes tissue if the animal is being necropsied or sometimes blood samples when it's possible, and then those are sent to us here at the Tufts Runstadler Lab.

[Sarah Gregory] And how was the analyzing done?

[Wendy Puryear] So it's actually very similar to what we've all become very familiar with, whether we like it or not, with testing for COVID. So the sample undergoes a process where we extract out the genetic material, and then we do a PCR. So the PCR reaction is looking specifically, at first, just for influenza in general. So if you recall, I mentioned there are all those different forms of influenza that circulate. If we detect that there is influenza, then we do a follow-up PCR to specifically look at whether or not it's H5 influenza. And then, once we find that, we send it along to the USDA's National Veterinary Services Laboratory for conformational testing, and we also send a sample to our partners at the School of Medicine at Mount Sinai to do genetic sequencing of those samples.

[Sarah Gregory] So going back to your paper, you talk about outbreaks. When was the first outbreak wave and what was found in the seals?

[Wendy Puryear] So in addition to doing surveillance with seals that is ongoing, we did start to ramp up the amount of surveillance that we were doing in wild birds as we saw H5N1 land in North America in late 2021. So we had been testing wild birds throughout Maine and Massachusetts, and we first saw the big wave of H5N1 (here in our region, anyway) in the spring of 2022. And that was in a lot of different birds, but mostly it was in raptors and in gulls that we were seeing in that first wave. And at that point, there was nothing that was showing up in seals.

[Sarah Gregory] When was the second wave then, and what was found?

[Wendy Puryear] So after that initial wave, things quieted for a short period of time, and then we saw a small spike in H5N1 that was really mostly in terns in the early summer. But the next real wave of a sizeable manner came in in the summer. So we really started to see it pick up again in multiple bird species in June, July, and August of 2022. And that's when we had it showing up in lots of different birds, and then we started to detect it in the seals as well during that same timeframe of that second wave.

[Sarah Gregory] And where were these waves found? Was this all in the Maine area you were talking about? Were they both from the same place?

[Wendy Puryear] Yeah, so this is all through the Gulf of Maine. So both of these regional waves were in birds that we were detecting H5N1 in these populations throughout the Gulf of Maine—so, Massachusetts and New Hampshire and Maine itself. And our focus was primarily on those states in terms of birds, but that is the only area that we were detecting it in seals, although we were testing for seals all the way down the coast.

[Sarah Gregory] Do we know or suspect what the route of transmission is for all of this?

[Wendy Puryear] There are some hints that it's still kind of out there to really be determined. So we know from our data by being able to look at the sequences that we were able to pull off of the seals and comparing that to the birds in the same regions in the same timeframe, we know there were at least two unique transmission events from birds to seals. Now, once it's in seals (once it's in mammals), influenza in mammals is primarily a respiratory disease, so it can enter through the nose, the mouth, or the eyes. And this can occur through direct exposure...you know, if you think of how we traditionally think of passing influenza to one another, you sneeze on somebody or something on your hand and then you wipe your eye. So there could be a direct exposure, or it could be exposure through contaminated sources—so, feces on the beach or contaminated water that shed from the birds, or sediment in the sand, or even the seal coming into contact with, say, a bird carcass.

[Sarah Gregory] I'm trying to sort of wrap my brain around this. So the seal coughs on another seal and they spread it? Or the bird poops on the landscape and the seal snorts some of it? Clarify a little here.

[Wendy Puryear] Yeah, I mean it could be any of those, right? So if it's a scenario—and we can talk about this a little bit more later—but if it's a scenario that it's passing between seals, whether it's seals that we're talking or a different mammal, if it's passing between animals, then it can be a situation where they are literally sneezing on each other or breathing it into each other's faces. So that could be happening. But from that transmission event going from a bird to a seal, it could also be a direct interaction that's happening. So it could be—and we see this out in the field—we'll see that a seal will go and roll around on a carcass of a bird.

So if that bird is oozing virus, then there is a chance that that is going to get into the seal. There could be...what's probably happening in these transmissions is that, just based on other similar situations where we've seen with influenza transmission to seals in the past, there could more likely be an indirect transmission where the virus is being shed from a bird and being shed in its feces, and it's staying in an infectious form outside of the bird in the feces, whether it's there in a little puddle of water or it's there on the beach. And then the seal comes through and either rolls around in it inadvertently or inhales it as it's dragging its body over that pile of bird poop. So that's another way that it could make its way from a bird to a seal.

[Sarah Gregory] Well, you mentioned that seals can transmit it to each other. Is that correct? You want to clarify that a little bit?

[Wendy Puryear] Yeah. This is...it's something that's really just not clear yet. It's still inconclusive. And really, there just simply isn't enough sequence data to make an absolute determination of who exactly is giving it to who and how the virus is moving through the ecosystem. We do know that for other forms of influenza—and so, again, we've mentioned there

are all these different variants and subtypes of influenza that exist, and there have been cases of influenza in seals in the past—so we do know that it is possible for seals to spread influenza amongst themselves. But for this particular H5N1 variant that is currently circulating and that caused the outbreak in the seals in 2022, there's simply not enough data to say for sure if it is spreading between the seals themselves or if each of those cases was an individual case of going from a bird to a seal.

[Sarah Gregory] Oh, I see. Okay.

Well, we've talked about probable or maybe or likely ways it's spread. Are there any routes that are not likely to be?

[Wendy Puryear] Possibly. And a lot of this is really still, in the grand scheme of things, the early days of trying to figure out precisely how it is moving through the ecosystem and between living species. It is possible...but it is possible that each seal is getting infected directly from a sick bird, and that is going from a bird to a seal, and a bird to a seal, and a bird to a seal. And there are a lot of scattered cases of other wild mammals—we're seeing a lot in fox and coyote and skunk (lots of other mammals). But there's a lot of cases with terrestrial mammals that seem pretty well-defined that the H5N1 virus is going from that bird to that mammal through a predator-prey relationship, alright? So a fox is eating an infected bird.

There are some instances in seals where you can observe that a seal will eat a bird. That happens. But especially when we're talking about harbor seals, they are a smaller seal, and that is not something that you see very often. It's certainly not a common occurrence that they eat birds, so the probability that they are ingesting a sick bird in a predator-prey relationship is hypothetically possible, but it's pretty unlikely that that's how the transmission is occurring, at least as a full explanation.

[Sarah Gregory] So far, in the seals, it's not gone past Maine. Okay.

So what are some of the potential bad effects of this virus spreading farther along the coast among more seals?

[Wendy Puryear] In addition to the impact that it can have directly on the health of the seal population, it could also impact fueling transmission into other wildlife species as well. So if you think about a seal as a large animal, and if that animal is infected with H5N1 that is capable of transmitting to other birds that are scavenging on it or a beach coyote or any other animal that comes into contact with that carcass, that provides the opportunity to further this virus through the ecosystem. So there is the consequences that are there in terms of wildlife.

But in addition to that, the more time that H5N1 spends in a mammalian host, the more chance there is for it to adapt and become better able to replicate and transmit in mammals. And this can be through a steady, ongoing evolution of the virus or it can be through larger changes that can happen if the virus is able to reassort with another form of influenza that is also circulating in wildlife.

[Sarah Gregory] I'm really here in how it hasn't spread farther since it's so active in birds all over the place. What's happening with this? Why is it limited to Maine still, and what will cause it to spread farther down the coast and do you think it will become seal to seal?

[Wendy Puryear] Those are all such excellent questions. So why it was only in Maine is still unclear, but it's worth clarifying though that there were cases that occurred just a little further

north in Canada. I don't know that there's official publications that document that yet, but there certainly were cases in gray seals and harbor seals in the North Atlantic and Canada as well. But it didn't go further down the coast. And a few speculations here is that it could have to do with the overlap of species and the interactions that are happening between species. So in the Gulf of Maine in the summertime, you're going to see more of, particularly coming into the early part of the year, animals are congregating together there and you've got the pupping season, and then you come into the molting season and then we come into the fall with getting ready for the breeding season.

So you've got area where the seals are going to congregate as they go through these activities throughout the year. And depending on where exactly they are congregating in those denser numbers, if they're also in a same area where there's a species where, let's say, maybe it's an eider, or we saw pretty clear evidence (as clear as one can get) of virus that was circulating in the terns (H5N1) going into the seals. So if they happen to be on a same rocky outcropping or beach where there is a bird population that has a high amount of virus at that same time, then that might be kind of the perfect storm that's creating the opportunity for it to spill over in that region as opposed to a very similar region a little further down the beach (a little further down the coast), but maybe doesn't have that same exact dynamic.

[Sarah Gregory] Okay. Given that, how great a concern is this flu virus? I mean, obviously half a billion poultry is pretty terrible. Will it die out naturally or is the prognosis really pretty dire?

[Wendy Puryear] So I think it's likely here to stay in at least some capacity. So it's so widespread around the globe at this point, even in regions where we previously haven't seen high-path influenza or H5N1 viruses similar to this go, such as South America. It's in so many different species. It's at a pretty high prevalence. I think it's here to stay. But I do expect that the severity will decrease over time. And in fact, we've already started to see that there are some signs of species that are recovering from H5N1. There are recent reports out of gannets that have seemed to recover or are showing signs of being able to recover from H5N1. And then there's some asymptomatic species, such as ducks, seem to get it and not necessarily have the high level of mortality that you see in other species. But I think we'll kind of get to a point where it's less severe in wildlife. But how long that's going to take and what that's going to look like is still to be seen.

[Sarah Gregory] Okay. Well barring natural immunity eventually, can this spread be stopped or at least managed in wildlife in any other way?

[Wendy Puryear] Yeah so, unfortunately, there's really not a whole lot that can be done at this point in terms of stopping the spread of this particular outbreak in wildlife, again, given that it's such a large and broad scale of impacted species, really, around the globe. The primary ways we can try to mitigate is really by being extra diligent with biosecurity, really limiting interactions between wildlife and domestic animals (wildlife and us) and doing the best we can to limit the additional stressors that we impose on wildlife—so, the ways that our actions impact where and how different species interact with each other, and the other things that are impacting the health of those species. Those are all kind of bigger picture things that can help to try to curb the spread of these sorts of illnesses.

[Sarah Gregory] Maybe this is sort of the same question, but do you have any specific action steps that can be taken in mind?

[Wendy Puryear] Yes. I mean, really, biosecurity is the incredibly important component here. So it's making sure that we limit the ways virus can spread between and within species through really robust biosecurity practices. For example, it's critical that wild birds are kept separate from domestic birds and other domestic animals. And this comes up even if you don't have a backyard poultry farm, but you have a dog that you walk along on the beach or on trails where there might be a bird carcass that was infected with H5N1. So really trying to limit those sorts of opportunities for that transmission link to occur between wildlife and domestic.

And then, really on a broader level, there's some really big picture ways that we've contributed to these sorts of emerging diseases. And it comes down to things like our centralization of agriculture—massive farms, crowding of animals, the way the breeding, movement, and processing of animals is structured. All of these factors contribute to the ways that virus is able to spread. So if we truly want to impact these sorts of viruses—maybe not H5N1 that's currently causing the outbreak, but the next one on the horizon—if we truly want to try to impact these things, we really need to take a serious look at things like how we do our food production and think about trying to recalibrate those a little bit.

[Sarah Gregory] So you've been monitoring all of this for a lot of years now. What's the use of monitoring if we're just sort of observing and there's no real way to step in?

[Wendy Puryear] Right. If there's not much we can do, then why pay attention to it? And that's a great question, and it is important for a couple of reasons. One is that it's critical for us to understand how the virus is adapting and evolving so we can efficiently prepare ourselves with best candidate vaccines and treatments so that we don't have a scenario like COVID, where we're really caught off guard with something new just suddenly landing on our doorstep. That's one of the reasons it's important to pay close attention, but also so that we can understand the factors that impact how virus is moving through the ecosystem, and the places that we (our species)...the places where we might be inadvertently contributing to the ability of virus to evolve and move, like some of the things I was mentioning about our food production practices. There are things that we can hopefully learn about the ways we can make better or worse the spread of these sorts of things.

[Sarah Gregory] And you mentioned people being protected. Where do people fit into all of this at this point? Can someone get this from seals or wild birds or any other animals?

[Wendy Puryear] So far, there has been very little human infection, thankfully. There has been no evidence of human-to-human transmission or any other mammal-to-human transmission. Cases have occurred that have been traced to poultry. So there has been some infections that have happened in people. But it's all been traced so far to having a direct interaction with infected poultry. We do know, though, that it can infect people and we know that it's continuously undergoing adaptations. So it's important that we continue to be vigilant, even though it's currently considered to be low risk for human health.

[Sarah Gregory] And you mentioned pandemic. First of all, isn't there a vaccine for H5N1 for people now?

[Wendy Puryear] Yeah, kind of. So we have a flu vaccine, but it is very specifically tailored to whatever is circulating for seasonal flu. And just to kind of go back a little bit to the really big picture, when we're talking about all those different forms of influenza, the ones that circulate in people are referred to as 'H1N1' and 'H3N2'—those are the human seasonal forms. So H5N1 isn't

one that our immune systems have regularly seen. So that's not what our vaccine is currently directed against.

But, with that said—this is what I was mentioning about the importance of monitoring what's happening—we know that this is out there, and we know that this is a concern. So the CDC actually maintains a seed stock of candidate vaccine viruses. So it's not enough certainly to vaccinate the world or even the US, but it is a seed stock from which, in theory, we should be able to rapidly scale up if we get to the point where it seems like that need is arriving.

[Sarah Gregory] You indicated that you thought this might eventually die out instead of getting much worse, but could this be our next pandemic?

[Wendy Puryear] We can't say for sure, but this is one that has been on the radar as a virus of concern long before COVID came along. The reason is, in large part, because even though the number of people that have been infected has been relatively low, fatality has been high. So if you take all of H5N1 infections in people going back 20 years since this first started to emerge in kind of its earlier form of the virus that we're currently seeing...take all 20 years, there have been just shy of 900 cases around the entire globe of H5N1 infection in people. But the fatality in those has been just over 50%. So that's why it has been something that has been paid very close attention to. At this point though, it's not transmitting between people. Infections are rare, and we do at least know what we would need to do to get a vaccine in place. The hope is that the prognosis would be good if it were to start to crop up into people more than what we're seeing right now.

[Sarah Gregory] Last year in my very small garden (I live in the southeast), it was like an aviary. I had so many birds—at least six cardinal families and lots and lots of other birds (different varieties). This year, I have one cardinal couple and almost no other birds. Every few days, I might see a single other bird. Is this a coincidence or are songbirds being that noticeably depopulated? Or is it just some weird, random thing?

[Wendy Puryear] That brings up a really interesting point, that for whatever reason, it's not incredibly clear why there's this distinction. But songbirds, generally speaking, whether we're talking about H5N1 or other forms of influenza, songbirds really do not end up having much for influenza, and that's been the case for this outbreak as well. H5N1...it is being picked up in the occasional songbird here and there, but it hasn't been really impacting them very much at all, with the one exception, actually, are crows. And I will fess up here that I did not realize until this outbreak that a crow is considered a songbird. But it is, and crows have been impacted quite a bit by H5N1.

And so...but with all that said, there are plenty of other things globally that are impacting songbird populations—really heavy impacts from climate change and other things outside of viral infections. At least right now, H5N1 doesn't seem to be on the long list of things that are causing problems for songbirds.

[Sarah Gregory] Well, whatever is causing it, I find it very depressing.

Tell us about where you work and your job and your main area of interest.

[Wendy Puryear] Yes, so I'm a scientist at The Cummings School of Veterinary Medicine at Tufts University, and I'm interested broadly in viruses and focusing primarily my interest in viruses and wildlife. And I'm really interested in understanding kind of all of the stuff that we've been talking about and understanding how interactions between and within species—especially

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in the context of environmental stressors and climate change—impact the overall transmission and evolution of viral.

[Sarah Gregory] Well, thank you so much for taking the time to talk with me today, Dr. Puryear.

[Wendy Puryear] Yeah, absolutely. Thank you so much for having me.

[Sarah Gregory] And thanks for joining me out there. You can read the April 2023 article, Highly Pathogenic Avian Influenza A(H5N1) Virus Outbreak in New England Seals, United States, online at [cdc.gov/eid](https://www.cdc.gov/eid).

I'm Sarah Gregory for *Emerging Infectious Diseases*.

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