Transcript

00:00:01 Nicole Marshall

It's the holiday season, a time when people gather with friends and family to enjoy each other's company and share tasty meals. But for two unfortunate people, the 2010 winter holidays were a little less joyous.

00:00:14 Nicole Marshall

That December, they were gifted with stomach cramps, a fever, and vomiting.

00:00:20 Nicole Marshall

Eventually, we will come to find that these individuals were infected with Escherichia coli or E coli O157H7.

00:00:29 Nicole Marshall

Just like other pathogens, E coli can affect anyone. And just like other pathogens, it can cross borders and end up in our homes or restaurants and anywhere else where food is kept, made, and eaten.

00:00:43 Nicole Marshall

In 2011, an outbreak of E coli O157:H7 swept across multiple states, and with it, a new suspect was linked.

00:00:53 Nicole Marshall

We'll follow along as investigators piece together clues that point to a new carrier for this pathogen. We'll also learn about key partnerships that help them crack the case.

00:01:03 Nicole Marshall

We'll hear from members of the outbreak team who were on the ground during the investigation, including Josh Rounds and Dr. Kirk Smith, with the Minnesota Integrated Food Safety Center of Excellence, and hear about their experiences as well as the lessons they learned. Join us as we walk through a historic outbreak and its implications for future public health work.

00:01:24 Nicole Marshall

I'm your host, Nicole Marshall, with the Washington Integrated Food Safety Center of Excellence. This is Foodborne.

00:01:34 Nicole Marshall

Now, before we dig into the investigation, let's put these bacteria under the microscope.

00:01:40 Nicole Marshall

E coli is a type of bacteria that naturally exists in our gut.

00:01:45 Nicole Marshall

It helps maintain the balance of other bacteria in our body, but there are different strains or types of E coli. Some of them are pathogenic, meaning they can cause illness. E coli O157:H7, or E coli as we'll just call it, is a particularly harmful strain, and it can cause severe foodborne illness.

00:02:04 Nicole Marshall

Now you might be thinking E coli. That name sounds familiar.

00:02:08 Nicole Marshall

That might be because this wasn't the first time E coli 157 made headlines.

00:02:13 Nicole Marshall

In 1993, another outbreak of this strain was associated with a well-known fast food chain. It resulted in hospitalizations, deaths, and years of litigation as a result of the 1993 outbreak. Infection with E coli O157:H7 became what's known as a notifiable disease, a notifiable disease means that when someone tests positive for an especially severe or contagious infection, healthcare providers must report that case to state or local public health officials.

00:02:44 Nicole Marshall

When the officials are aware of these cases, they can then potentially identify an outbreak and prevent others from getting sick. Some other notifiable diseases you may have heard of are Hepatitis C, Listeriosis, and even Measles.

00:02:58 Nicole Marshall

So what makes E coli so dangerous? Some individuals, such as young children and older adults, are at higher risk for more severe illness, and E coli O157 infection can sometimes lead to a rare but serious condition called Hemolytic Uremic Syndrome, or HUS. HUS is a serious disease that can affect kidney function, even resulting in kidney failure, which can be fatal.

00:03:27 Nicole Marshall

In early 2011, the Minnesota Department of Health, which we'll just refer to as Minnesota, learned of two E coli cases who had become ill.

00:03:35 Nicole Marshall

By February 2011, Minnesota received two samples from the patients to test in their lab. They compared the two samples to see if they were connected by using a lab technique called Pulse Field Gel Electrophoresis, or PFGE.

00:03:50 Nicole Marshall

As a refresher from the last episode, PFGE is a laboratory technique that separates pieces of DNA using an electrical current. Once separated, these pieces of DNA form a PFGE pattern, also called a DNA fingerprint, for humans. Unless you're an identical twin, your DNA is slightly different from every other human.

00:04:10 Nicole Marshall

Similarly, for bacteria, different strains of bacteria also have different DNA from one another. One DNA fingerprint is unique to one strain of bacteria.

00:04:17 Nicole Marshall

When investigating an outbreak of foodborne illness and defining who should be included in the outbreak, epidemiologists use a series of steps to identify three key factors of disease, person, place, and time. This helps epidemiologists describe an outbreak and identify additional cases that meet what's called their outbreak definition.

00:04:38 Nicole Marshall

Since the two matching DNA fingerprints had not previously been seen in Minnesota, public health officials suspected that this was a cluster with a common source. In other words, all the cases were probably linked to one specific food. Now, an investigation was needed to identify what the source was and any additional cases.

00:04:59 Nicole Marshall

On February 7th, the official investigation began.

00:05:03 Nicole Marshall

The first task was to identify if any other cases had a matching PFGE pattern to the two cases. In Minnesota, investigators did this using PulseNet, a national lab network that contains DNA, fingerprints, or PFGE patterns of bacteria sampled from sick patients.

00:05:20 Nicole Marshall

This is an extremely useful tool to identify related cases in other regions or states more efficiently, which can speed up investigations.

00:05:29 Nicole Marshall

Josh Rounds was the lead EPI investigator at the Minnesota Department of Health during this outbreak. Here we will hear directly from Josh about the early stages of the outbreak.

00:05:38 Josh Rounds

Our public health lab let us know about two Minnesota E coli O157:H7 case isolates that had indistinguishable PFGE patterns, and so this is back before whole genome sequencing.

00:05:51 Josh Rounds

And, you know, one of the first things we did was, oh, you know, have we seen this PFGE pattern before? How common is it? And we had actually never seen it before in Minnesota. And then kind of the next question is, is it anywhere else in the US? And so a PulseNet search revealed that there were four additional case isolates from two other states. So three in Wisconsin and one in Michigan.

00:06:11 Josh Rounds

And that was kind of the first inkling this could represent an outbreak.

00:06:16 Nicole Marshall

Next, investigators began interviews with cases to narrow down potential food items that could have caused the infections.

00:06:23 Nicole Marshall

Since this was a multi-state cluster, each state actually conducted its own interviews using its own process, and then investigators came back together to share what they found.

00:06:34 Nicole Marshall

One tool that investigators can use during an outbreak investigation is an epidemic or epi curve to show when each patient became ill, when they were tested, or when they started experiencing symptoms.

00:06:45 Nicole Marshall

Epi curves are a tool that visually shows the course of an outbreak, starting with the first known cases and ending with the last known case. They look like most graphs you might see in a math or science class. It has an X axis, which has the date a patient first experienced symptoms, and a Y axis, which is the number of cases that occurred on a given day.

00:07:05 Nicole Marshall

This can tell epidemiologists a lot of information about an outbreak, such as how spread out the cases are, when the cases could have been exposed, and even point to clues about the type of outbreak that's occurring. In this cluster, cases were spread out across multiple weeks. This is an important clue as it suggests that the contaminated food item had a longer shelf life and is continuing to make people sick over a long period of time, so the shape of the curve actually gives you a clue as to what you might be looking for.

00:07:33 Nicole Marshall

Now we'll turn it back over to Josh to hear more about what they were seeing on the ground when reaching out to patients.

00:07:39 Josh Rounds

So by about the fourth day of the investigation, so this was February tenth, we had re-interviewed our case in Minnesota, and actually, our second case had gotten that letter and decided, hey, I will talk to you. So he called us back, and we got his exposure information. And then I think Wisconsin had been able to re-interview their cases. Michigan hadn't quite yet, but had pretty good information from their initial interview.

00:08:07 Josh Rounds

And, you know, we kind of got back together, and we had five out of our six cases reporting ground beef. But again, trying to get those real specific details, it turned out two of those cases only beef exposures were from private kill beef from different local farms, we're like, oh, this doesn't seem like it's the same, you know, ground beef that all the cases are eating. And then we also had four out of six cases reported consuming lettuce, but kind of again, those specifics didn't seem to line up exactly. Two of the cases just had pre-packaged lettuce, and two ate iceberg lettuce.

00:08:37 Josh Rounds

So it seemed like those kinds of different lettuces that they were being exposed to, and then finally, by this point, now we had five out of our six cases consuming in-shell nuts, and all five of those reported in-shell hazelnuts.

00:08:51 Josh Rounds

And also interestingly, four out of five purchased them from bulk bins at grocery stores, so it really kind of seemed like, oh, it's the same type of nuts. It's in-shell hazelnuts from bulk bins at grocery stores. This is kind of an unusual exposure too, we really want to kind of look at this more closely and kind of those specific details really helped us focus on the in-shell, Hazel nuts, and kind of rule out more the lettuce and the beef.

00:09:20 Nicole Marshall

The most surprising finding was that five of the cases had consumed nuts on average; only about 30% of adults in the US consumed nuts or mixed nuts in a week. We know that from what's called food net population surveys. In contrast, over 80% of the cases in this outbreak had reported eating mixed nuts. That's a big difference.

00:09:41 Nicole Marshall

And not only is that a big difference, it's actually a statistically significant difference. Using this type of comparison involves relying on what's called a binomial probability model. In statistics, you may have encountered this type of model when talking about coin flips or free throws.

00:09:56 Nicole Marshall

In epidemiology, we ask the question if the likelihood of each case eating a given food is no different from that of the average person in the population. How often would we find by chance alone that our outbreak cases would have eaten this food? We can compare the rate of those in our outbreak or cluster eating a specific food to the likelihood of consumption, or background rate of consumption, to determine if there is a significant difference by using the binomial test.

00:10:22 Nicole Marshall

This outbreak was one of the first instances that the binomial probability model had been employed to solve an outbreak.

00:10:28 Nicole Marshall

This signaled to investigators that it was worth taking a closer look, even if nuts weren't considered a common source of E coli O157, since so many sick patients had reported consuming them. Kirk Smith was the supervisor of the Foodborne, Vectorborne, and Zoonotic Diseases unit at the Minnesota Department of Health during this outbreak.

00:10:45 Kirk Smith

The demographic profile is very striking, and hadn't really seen it before, and didn't know what it meant. All of the cases were 55 years or older, except for one teenage boy.

00:10:59 Kirk Smith

And five of the first six were were male, so again, kind of the older male demographics.

00:11:06 Kirk Smith

And the nuts just became increasingly interesting as time went on. When we thought about it. I mean, the demographics didn't predict what it was going to be. But then when you start seeing a hypothesis emerge like hazelnuts, and then you look at the demographics, you thinking like, oh, yeah, that actually could make a lot of sense.

00:11:27 Nicole Marshall

When interviewed, cases were also asked which specific type of food they consumed in each food group and where they purchased each food item.

00:11:35 Nicole Marshall

Investigators can use this information to narrow their search and figure out where the contaminated product originated from.

00:11:42 Nicole Marshall

Since this was a multi-state investigation, this became a bit trickier. Instead of 1, store investigators were looking at multiple. However, they could still try to track down a common distributor that sold the product to each store.

00:11:57 Nicole Marshall

For this reason, ground beef was looking less and less like the source. Two cases had reported purchasing local ground beef from private suppliers. Remember, all cases were infected with the same strain of E coli, so it was unlikely that the ground beef from two separate private suppliers could have had the same exact strain as the ground beef from other retailers.

00:12:18 Nicole Marshall

That turned investigators' attention back to mixed nuts. When asked what specific type of nut patients had consumed, investigators were surprised, all patients reported eating hazelnuts, a food that has never been connected to E coli outbreaks in the past.

00:12:34 Nicole Marshall

Even so, the evidence against hazelnuts was stacking up.

00:12:38 Nicole Marshall

So what are the next steps? You're probably thinking? Ask the patients for the hazelnuts and test them for E coli, right? Well, in an ideal world, yes, that would be the next step

00:12:48 Nicole Marshall

However, investigations don't always go according to plan, and the investigators in this case experienced that firsthand. None of the patients had any hazelnuts left to test.

00:12:58 Nicole Marshall

Adding to that, many of the patients had purchased the nuts from bulk bins at grocery stores, so specific brands couldn't be identified either. Without sufficient evidence to confidently name hazelnuts as the culprit, investigators had to build their case with another tool, a traceback investigation.

00:13:18 Nicole Marshall

A traceback investigation is a process used to identify the distribution and production chain of a product that is suspected of being a potential source of foodborne illness outbreak. On February 11th, multiple public health, environmental, health, and agricultural partners from Minnesota, Wisconsin, and Michigan discussed the next steps in the investigation and decided that Minnesota and Wisconsin would lead the traceback investigation of in-shell mixed nuts. You may be wondering why they started with mixed nuts since all patients had specifically reported eating hazelnuts.

00:13:46 Nicole Marshall

But since some patients reported eating hazelnuts purchased from bulk bins sold with other types of nuts, investigators didn't want to rule out the possibility that another type of nut had been contaminated. However, re-interviews of each case by health departments revealed that in-shell hazelnuts were the only food items consumed by every single case.

00:14:06 Nicole Marshall

However, the fact that many hazelnuts were purchased in either bulk bins or part of a mix meant that many brands were not immediately identifiable. The lack of information on the brands, but the exceptionally higher than expected rate of consumption of hazelnuts, meant that investigators would need to find a quick but creative way to test this hypothesis and implement a public health intervention.

00:14:28 Nicole Marshall

Starting with grocery stores, patients reported purchasing the nuts from investigators, collected records related to shipping and receiving label information, packaging type, packaging size, lot codes, and production dates.

00:14:40 Nicole Marshall

They also collected information about how the product was shipped and how the store handled the product once it arrived at the store. Although not used in this case, epidemiologists can also use information such as loyalty memberships and credit card numbers to aid in traceback investigations.

00:14:56 Nicole Marshall

So, what did the Minnesota Department of Health and Department of Agriculture find when they conducted their traceback investigation?

00:15:02 Josh Rounds

We've never seen O157 with hazelnuts before. For sure, I don't know if there had been even O157 in nuts previously, so it's kind of a novel vehicle potentially. We'd like to know more specifically, are these in-shell hazelnuts coming from the same source?

00:15:20 Josh Rounds

And that's kind of where the traceback investigation can come in. Additionally, these are from bulk bins, so there's not like a brand, like this is brand A in-shell hazelnuts. No, it's just like a bulk bin at the grocery store. Different grocery chains are being involved, too. So we really needed that traceback investigation. And when we are trying to do one of those, we work closely with our Department of Agriculture colleagues. And in this case, you know, we had to work with agriculture colleagues in multiple states.

00:15:46 Josh Rounds

We're able to go out to the grocery store where the case was purchased, those in-shell hazelnuts.

00:15:53 Josh Rounds

Gather the records from them and then kind of follow those in-shell hazelnuts back through the food distribution system to see it. Do these converge back on one distributor or grower? That's kind of powerful evidence that, you know, these seem to be the same in-shell hazelnuts that all the cases are consuming, and that that did end up happening.

00:16:11 Nicole Marshall

By February 24th, all sources led back to one distributor, a family-owned business based in Los Angeles, CA. Investigators told this distributor what they found, and on March 4th, the distributor issued a voluntary recall of all hazelnuts and mixed nuts products that were distributed between November 2nd and December 22nd of 2010. Minnesota and Wisconsin also released press releases on that same day to inform the public about what was happening and what to do if they had products in their homes that were being recalled.

00:16:43 Nicole Marshall

So, was it hazelnuts had a new E coli vehicle been identified

00:16:48 Nicole Marshall

Let's back up.

00:16:49 Nicole Marshall

During the investigation, a few new pieces of information came to light that helped answer these questions. First, this 6th patient, who had previously stated that they didn't consume hazelnuts, called back after they realized that they had in fact eaten hazelnuts before becoming sick. So that was another point towards hazelnuts. Second, an additional case was identified. In the most surprising information, they still had Hazel nuts that could be tested for E coli.

00:17:16 Nicole Marshall

The samples were sent to the lab, and on March 7th, they tested positive for E coli O157H7, and the PFGE pattern from the hazelnut sample was identical to that of the samples from the sick patients. But the investigators made their announcement and issued a recall on March 4th, a few days before the lab tested the hazelnuts.

00:17:36 Nicole Marshall

Why?

00:17:37 Nicole Marshall

The investigators felt that they had sufficient evidence, even without the hazelnut lab results, to issue a recall. Hazelnuts have a longer shelf life, and there was an ongoing risk to the public if they had waited; more individuals could have become ill. This is always a trickier part of an investigation. Epidemiologists have to weigh the evidence they have, pointing to a food item as a source against the risk to the public. Is there enough evidence to warrant issuing a recall? What if it isn't actually that food? What if we wait too long and more people become sick?

00:18:08 Nicole Marshall

Although there aren't easy answers to these questions, decisions aren't left up to one single person. There's an outbreak team that's comprised of representatives and experts from multiple entities.

00:18:18 Nicole Marshall

Such as the FDA, CDC, state and local health departments, and environmental health staff. They work together to weigh their options and come to a consensus based on what they believe will harm the fewest and benefit the most.

00:18:33 Nicole Marshall

Here is Josh again explaining how Minnesota and their partners made the decision to recall the product.

00:18:38 Josh Rounds

We kind of call it the threshold of confidence that, like we're, we're confident this is causing the outbreak, this the outbreak vehicle. And you know, that can vary from investigation to investigation. What pieces of information do you have that allow you to kind of reach that level of confidence that you need to put in place some sort of public health action?

00:18:56 Josh Rounds

In this case, when we reached that was when we got that traceback information that all these are all tracing back to a common distributor. That really tells us, even though we've never seen E coli 157 from nuts before, and specifically hazelnuts, this really is the outbreak vehicle. We have all of our cases at this point and ended up with a third case that also reported in-shell hazelnuts in Minnesota.

00:19:22 Josh Rounds

Had seven cases all reporting this really rare, unusual exposure with this rare PFGE pattern, and they're tracing back to the common distributor.

00:19:32 Nicole Marshall

And how did the hazelnuts become contaminated? Unfortunately, we still don't know. Although investigators did identify one common distributor for all of the stores that hazelnuts were purchased from, this distributor did not grow and pack the nuts.

00:19:44 Kirk Smith

That distributor had such inadequate internal records that they couldn't pinpoint it to a certain packer. So it probably was one packer that gave them like 98% or 99% of the hazelnuts that they shipped out to this region, but they couldn't say that with certainty. And then that packer had also inadequate records and said, well, anywhere from 20 to 60 farms could have contributed to this shipment or these shipments.

00:20:19 Kirk Smith

But again, it just really showed with the problem with the lack of internal traceability, which has been seen in lots of other outbreaks, and it's certainly a focus of the Food Safety Modernization Act.

00:20:29 Nicole Marshall

Despite investigators' best efforts, they could not definitively pindown which packaging company the contaminated hazelnuts originated from due to some paperwork issues, and therefore, they could not determine the environmental cause of the contamination. However, it was suspected that a 40,000 LB shipment received by the distributor in question on November 4th, 2010, likely contaminated the hazelnuts.

00:20:53 Josh Rounds

But in this packer, they had just switched the process when the nuts come into the packer, they have kind of a bath that they go through to get, you know, more gross contamination, dirt off of them. It's not meant to, you know, clean any bacterial contamination off. But they had just switched the solution in that from like a chlorine-based solution to a citric acid-based solution.

00:21:13 Josh Rounds

So maybe our suspicion is like, oh, maybe there was an issue with this new process that they were trying to do, where now you have a bath that isn't killing off any bacterial contamination that's in there. Now, the bath itself could become contaminated with O157.

00:21:29 Josh Rounds

And now you're having this amplification impact of, you know, a few nuts come in contaminated with E coli O157. But now all the nuts going through the bath are getting contaminated, and you have, you know, a much bigger problem than maybe initially was happening.

00:21:44 Nicole Marshall

In the end, there were a total of eight cases across Wisconsin, Michigan, and Minnesota.

00:21:50 Nicole Marshall

Their eighth case was identified after the recall was issued.

00:21:52 Nicole Marshall

Fortunately, all eight recovered from their illness, and there were no cases of HUS.

00:21:59 Josh Rounds

So those kinds of close relationships on the EPI and you know, the agriculture side really helped make this outbreak investigation successful. I don't think any individual state would have probably solved this outbreak, and definitely not as fast, just using their own cases. You know, we just had small numbers in each case, and we really needed to combine our efforts across those states for the hypothesis generation and then also that traceback investigation to be able to implicate it. So kind of having those close relationships that were already existing, where we felt comfortable just calling up or emailing each other, and quickly getting on a conference call together to pursue the investigation was really helpful.

00:22:40 Nicole Marshall

The collaboration between different state and national entities and the epidemiologists, environmental health specialists, and laboratory staff helped ensure that the investigation was a success. Without these partnerships, the investigation may not have been as successful, and the food source could have been missed, potentially leading to more illnesses.

00:22:57 Nicole Marshall

Even with how quickly the investigation identified the source of the outbreak and issued a recall, the investigation highlighted the importance of proper record-keeping with the food industry. Food production doesn't just happen in one place where food is grown, washed, packaged, and assembled before arriving in our grocery stores; it can all happen at different places.

00:23:16 Nicole Marshall

Knowing the farm-to-fork path of how food is distributed is essential in foodborne outbreak investigations. And missing or incomplete paperwork only makes it much harder to prevent additional cases. We can't know how to fix the problem if we don't know where the problem is.

00:23:33 Nicole Marshall

Now we'll hear some final thoughts from Kirk on how this outbreak contributed to future outbreak responses.

00:23:38 Kirk Smith

So this was the time within a two or three-year period, I would sa,y where we as a foodborne disease outbreak investigation community in this country really started getting away from these community case control studies since there's so much work and since they needed to be kind of verified with other investigation findings anyway.

00:23:58 Kirk Smith

Why not just skip all that work and do the binomial probability model or a case-case comparison method, which Wisconsin and we also did kind of comparing our 157 outbreak cases to Salmonella cases that were occurring at the same time, which also yielded significance.

00:24:22 Kirk Smith

So why not just do those quicker methods to kind of solidify or advance your hypothesis, and then get on with the business of actually confirming the vehicle through things like traceback

00:24:33 Kirk Smith

So this also was about the time period where informational traceback were starting to be used a lot in outbreak investigations. Traditionally, tracebacks would only be done after a vehicle is implicated by more formal methods or by laboratory testing of the product.

00:24:54 Kirk Smith

But again, we started using them as part of the epidemiologic investigation to help confirm the vehicle in the first place, and so that was another noteworthy thing about this particular outbreak investigation was kind of this combination of generate a hypothesis, you advance it or solidify it using a binomial probability model or a case-case comparison. And then you confirm it when you find everybody's exposures trace back to a common source.

00:25:26 Nicole Marshall

Thank you for joining us on our journey through the E coli O157:H7 hazelnut outbreak of 2011. We would like to thank our partners, Josh Rounds and Kirk Smith from the Minnesota Food Safety Center of Excellence, for sharing their expertise with us. Special thanks to the International Outbreak Museum for their partnership this season. I'm your host, Nicole Marshall.

00:25:46 Nicole Marshall

Foodborne is created and produced by Piper Brase and Nicole Marshall. Our producer and sound designer is Kevin DeVoss. This episode was researched and written by Sarah Garcia with support from Erica Ellis. Foodborne is brought to you by the Washington Integrated Food Safety Center of Excellence, which is a collaboration between the University of Washington, the Washington State Department of Health, and the Northwest Center for Public Health Practice

00:26:10 Nicole Marshall

For more information about the sources used in this episode, check out our show notes or visit foodsafety.uw.edu/foodborne.