MDH Speaks: “Shining a Light on Phantom Organisms” by Mel Anacker (13:34)

Anna Strain: “Thank you, Emily and Ray, our two speakers so far from Infectious Disease Lab. Our third and final speaker from Infectious Diseases will be up next and then we'll a switch. Mel Anacker is up next with her presentation, ‘Shining a Light on Phantom Organisms; How Routine Public Health Testing Helps Identify Unexpected Pathogens.’

“Mel Anacker has always been interested in science. Even from a young age her teachers thought she would end up as a Research Scientist as a career. So far, she's achieved that. She's also following in the footsteps of her grandfather, who studied tick borne disease during his career as a microbiologist.

“Let’s welcome Mel!”

[applause]

Mel Anacker: “Hello, everyone. I am Dr. Anacker and I am a Research Scientist at the Minnesota Department of Health’s Public Health Laboratory. I'm here today to share some stories about how we made unexpected discoveries in the Public Health Laboratory and how these discoveries impact our ability to help people.

“My story starts in Montana, where I studied the organism that causes Lyme disease to earn my Ph.D. in microbiology and biochemistry. This organism is carried by black legged ticks found in Minnesota, but oddly enough, not in Montana where I was studying them. So it's really funny that I found myself moving from a state that had no Lyme disease ticks to a state that is full of them. Back in 2013, I finished graduate school and was looking for my next adventure in science. I applied to a program that places you in a host lab to help develop tests to complete a research project and learn more about public health. Coming from a college research environment where the focus is deep research into specific details of a single topic, jumping into public health was a completely different experience. Here, my previously predictable days of performing planned experiments were replaced with an ebb and flow of situations that popped up and had to be responded to. Surprise outbreaks, emergence of new organisms or unexpected samples; you have to be ready to respond to any of these on a daily basis. A job in public health means that I never know entirely what to expect each day when I come into work. COVID has obviously been the biggest and most well-known surprise so far, but I'm here to share some of the less well-known surprises that I have been involved with in my job at the Public Health Laboratory.

Mel Anacker (con't): “As a child, I was always fascinated by organisms that could cause diseases. I also wanted to help people and thought about becoming a medical doctor for a while. But then I realized that there are other ways to help people in science, which ended up leading me to my work in the Public Health Laboratory. And public health is all about dealing with new and unexpected germs that cause disease. Sometimes these germs are already out there, and we just don't know it because we do not have ways to detect them. This is where I came in. I wanted to work on germs that are becoming resistant to medicine, called antibiotics, that we use to treat people who are really sick. We refer to this these organisms as ‘antibiotic resistant,’ and you may have heard of them as ‘superbugs.’ Those of us that are scientists call them ‘bacteria.’ We have been in an arms race with bacteria since the dawn of time.

“Here we have a normal bacteria that is causing illness. When we take antibiotics, they will kill the bacterium and the person that is taking the antibiotics will feel better. However, if this bacteria changes itself, then it will become resistant and the antibiotics will no longer be effective. There are many different ways a bacterium can stop itself from being killed by antibiotics. One way is to break apart that antibiotic. This is the main resistance mechanism that I study in the lab. Today I'm going to share a couple of stories about how I discovered some antibiotic resistant organisms in Minnesota.

“The first discovery occurred when I had just started as a fellow. I was tasked with evaluating new tests to detect antibiotic resistant bacteria, specifically those that are resistant to antibiotics called ‘carbapenems.’ And I'm going to be using the term carbapenem a lot, so just remember that one. These antibiotics are reserved for people who have an infection that are unable to be treated by anything else. Other antibiotics that we have don't work on the organisms that are infecting these people. But resistance to antibiotics is developing at an alarming rate. Testing bacteria from sick people allows us to find these resistant bacteria so we can stop them before they become a big problem.

“Back in 2013, I was evaluating a new test called the CarbaNP Test because at the time we were only able to detect a very few specific resistance mechanisms with our regular testing options. The CarbaNP test, on the other hand, is not as specific and will detect resistance mechanisms regardless of the type. And for those of us that are looking for new resistance mechanisms, this is a big boon because you have to discover them somewhere. It works by having antibiotics in one set of tubes and no antibiotic in another set of tubes to compare color changes. So here you see the blue dots are representing antibiotics. In this case, it is a carbapenem antibiotic. You put resistant bugs into one of each of these kind of tubes, and then you wait. If the bacterium has a carbapenem resistance mechanism that breaks down that antibiotic. So it breaks apart our little blue shapes here. It will turn the media from red to yellow. Yellow means positive. The media will turn orange if the bacterium does not have a resistance mechanism. So that is a negative result. The red tubes on the side of each of these are used to compare the color changes at the end of the test. Most resistant bacteria break down the antibiotic within 30 minutes, but we wait for 2 hours just to make sure that we do not miss anything.

Mel Anacker (con't): “One day I was playing around in the lab with some bacteria that we had received that week. I stuck some organism into the tubes of CarbaNP test and went about my day. However, when I glanced back a few hours later, I noticed the tube with antibiotic that was previously orange had turned bright yellow. This was a really weird result because all the other organisms that I had been studying for the past few weeks with this test had either turned to the media orange, indicating a negative result, or turned the media bright yellow within 30 minutes. Here's a picture of an actual CarbaNP test so you can see the nice colors up here. So I repeated this test to make sure I hadn't done anything wrong, and then I repeated it a third time just to be sure. This result repeated both times. What was going on? I called the submitting hospital lab and talked to a laboratorian there, I said, ‘Hey, I got this really weird result with one of the bacteria that you sent us this week.’ He said, ‘Huh? We also tested that bacteria with the CarbaNP test. We got kind of a funny result, but it overall looked negative, which was unusual.’ To which I replied, ‘Well, that's interesting. Could it be because I added beads to the test tubes?’ He said, ‘Well, maybe. You know, we're bringing on a test to look at more specific mechanisms of carbapenem resistant. We could test the bacteria and just see what result we get.’ So he did. And you know what? The bacterium had a very rare resistance mechanism that had been making people sick in other parts of the world, but not in Minnesota, at least until now.

“Suddenly things had become very interesting. If I had not been running that test on that particular day, on that particular organism, it would have gone undetected and it could have made others sick before being caught. Shortly after that, we made testing for this resistant mechanism into a regular occurrence, and we have been finding it in some organisms periodically ever since. Our new tool was really helpful in this case. I may not have become a medical doctor, but my work was helping others treat infected people and was finding bacteria and preventing them from spreading to others and making them sick.

“The second instance of unexpected discovery of carbapenem resistant bacteria happened several years later in 2017. At the time, we had strong testing in place for those carbapenem resistance mechanisms and we were dipping our toes into something called whole genome sequencing of bacteria. Whole genome sequencing gives us the ability to look at a complete blueprint of what makes bacterium up. Different bacteria have different blueprints, and we're curious about two things with whole genome sequencing information. The first is, do organisms have the same antibiotic resistance mechanism? You can see on the slide here that we have three different bacterial cells and one of them, the antibiotic resistance mechanism is shown in red and blue dots. So you can see that A and C have the same resistant mechanism, whereas A and B are different resistance mechanisms. The second thing that we are looking at is, once we know if we have bacteria with the same resistance mechanism, are they related to one another? You can see here that A and B are the same color and they're related to each other, whereas A and C are not. So they all have the same resistance mechanism and C are not related to each other.

Mel Anacker (con't): “In summer 2017, we got a strange result for a bacterium using our normal testing options. So we sent it for a whole genome sequencing. When the results came back, we discovered the bacterium had a variant of a rare resistance mechanism that had just been reported for the first time ever, very recently. If you remember earlier, I mentioned that we will not be able to detect things that we don't have tests for. We had received other carbapenem resistant bacteria of this type in the past, but they did not test positive for a resistance mechanism using the tests we had available to us at the time. So I went back to our collection. For your reference, we have freezers and freezers full of all kinds of different bacteria going back 20 years and more. I tested others of this type, sure enough, this bacteria had been in Minnesota since at least 2011. It's been out there in the community spreading around, and we had no way of identifying it until we brought the right test on board. We were all really shocked by this.

“Here you see a map of Minnesota showing places where people infected by this bacterium live. Each isolate was collected between 2009 and early 2019, and we have had additional cases since these data were put together. Each red marker represents the isolation of one of these carbapenem resistant bacteria. You can see they're really spread out across the state here. Patients with these bacteria had no history of being in a hospital or traveling to places where other carbapenem resistant mechanisms come from, which told us that this resistant bacteria was different from the one seen in other states and other countries. It's behaving completely different from what we've known so far. However, when we looked at our sequencing data, we discovered that the bacteria did not appear to be related to one another, even though they all had the same resistance mechanism, which is really weird.

“This bacteria is more common in Minnesota, and as we learned later, as we've had more of these organisms come in the whole Midwestern region than elsewhere in the United States, there seems to be some link with agriculture, but we don't know enough yet to make any definitive conclusions about that. The one of the patients of the cases had a pet pig, so maybe there's a link there.

“There's always more to learn. And that is something that keeps this job really interesting. As I mentioned earlier, I've always been fascinated by bacteria and now I get to spend my days studying them. I did not become a medical doctor, but I still get to wear a lab coat every day. My job as a Research Scientist at the Public Health Lab means that I get to constantly learn about new bacteria making people sick. And I know to always be looking for the next emerging threat by finding ways to improve our test methods. Because whether we like it or not, they're probably already out there and just waiting for us to find them.

“Antibiotic resistance is a really big problem everywhere in the world, and it's getting worse all the time as bacteria find new ways to change to resist them. But we have a lot of brilliant people out there working to fight back. Who knows? Maybe some of you in the audience will be part of this solution.

“Thank you for letting me share some of my stories with you today.”

[applause]