When Science Finds a Way

Season 4, Episode 8

Is hope on the horizon for treating drug-resistant TB?

Show notes

Episode description:

Tuberculosis has been with us so long that traces appear in mummies. But today, the challenge is different: how do we respond to TB that's resistant to modern drugs?

Professor Salome Charalambous tells Alisha Wainwright about the challenges of treating the half-million people with drug-resistant TB, and Professor Nazir Ismail explains how it gets harder in countries where resources are scarce.

But there may be hope on the horizon. Salome gives a glimpse of the new tests and treatments already saving lives, and we hear from Enalkachew Fekadu, a drug-resistant TB survivor who now advocates for others with the disease.

Transcript

[00:00:00] **Salome Charalombous:** You can't just treat a person with that disease as if it's like you just got a bug that you're treating. You're treating a person who has a whole lot of other things going on with them, and you've gotta understand how those work together.

[00:00:16] **Alisha Wainwright:** Welcome to When Science Finds A Way, a podcast about the science changing the world. I'm Alicia Wainwright, and on this series I'm talking to the global experts who are making a difference, as well as the people who have inspired and contributed to their work.

This episode is about ending the world's deadliest infectious disease: tuberculosis or TB. TB is contagious and airborne. In 2024, 10 million people were diagnosed with TB and it caused over a million deaths. TB is preventable and curable with the right treatment, but this is complicated by the emergence of drug-resistant strains of the disease. These strains are not susceptible to the usual frontline treatment and require special diagnostic tests and drug regimens. And this is a challenge because the TB burden falls disproportionately on settings and populations in which these resources may not be easily accessible.

Joining me to discuss TB is Professor Salome Charalombous, Group Chief Health Officer at the Aurum Institute in South Africa. Salome has been in this field for years, and the organization is involved in research, clinical trials, policy, and frontline health services for infectious disease in the country. Salome describes the scale of the challenge of drug-resistant TB and the funding gap for prevention, diagnosis, treatment and care. But there's also hope here, with so much progress that's already been made and some breakthroughs on the horizon.

So let's give a general definition of tuberculosis. What is it and how does it spread?

[00:02:01] **Salome Charalombous:** So TB is caused by the germ we call mycobacterium tuberculosis, and it really is spread when people breathe in droplets that have got TB in them. Basically what happens to a lot of us that live in a country with higher rates of TB, including myself and especially healthcare workers, is that we breathe in these droplets very young, so as children. And what happens is that the TB goes into your body and it actually forms a, what we call a ghon focus, which is a little like a nodule in your lung. And then later on in life, when your immune system is suppressed or you're under stress, or sometimes when you get reinfected by another TB bacillus, you can then develop what we call TB disease.

And so that we call that active TB. And active TB, usually people have a cough. and the other classic symptoms are night sweats or sweating at night and weight loss. But it can be that you can also be completely asymptomatic. So that's a new thing that we found out recently, is that someone can have TB disease and at the beginning be asymptomatic, in other words, doesn't have those classic symptoms of TB, but actually have it. So that also causes us some problems sometimes in diagnosing TB in those people. But those are the classic symptoms: cough, weight loss, and night sweats.

[00:03:34] **Alisha Wainwright:** I think when I was preparing for this episode, I hadn't fully understood that many people carry TB with them and are asymptomatic. That was new information to me. I was aware that TB was a slow moving disease, sometimes it took people a long time to either recover from it or succumb to it, but I hadn't considered that you could be carrying this germ with you in a nodule in your lungs for maybe even decades before you found yourself having active TB.

[00:04:09] **Salome Charalombous:** In some ways it makes it a very interesting disease to study because there's so many different facets to it and so many difficulties that we face with identifying TB, treating TB. This is the disease that's been around that's been found in mummies. So it's been around for 2000 years and yet we still haven't been able to control it, and some of it is because of some of these characteristics.

[00:04:37] **Alisha Wainwright:** What are the regions and demographics or other groups that are particularly vulnerable to tuberculosis?

[00:04:46] **Salome Charalombous:** So unfortunately, TB is most prevalent in the poorest countries of the world, and we know that, of the 30 highest burden countries in the world, 67% of TB occurs in 30 countries. And you know, Sub-Saharan Africa and Southeast Asia are really the parts of the world where TB is most common. So people who are poor live in lower socioeconomic groups have a higher risk for TB. But there are other reasons that a person can also get TB. One of them is having also something that affects your immune system, like HIV, like human immunodeficiency virus, or even other other diseases that affect the immune system. If you're on cancer treatment, for instance, you are at higher risk for TB.

Also TB occurs very commonly in congregate settings, what we call congregate settings. So people who live close together. So for instance, that's why mines are particularly a place where people get TB but also other congregate settings like army barracks, prisons. And interestingly enough, TB is actually more common in men than in women. So the typical congregate settings are the ones where there are mainly men.

So those are, you know, some of the high risk factors for TB. But anybody can get TB, it doesn't have boundaries, you know? So yes, it is more common in people who are poorer,

but anybody can actually get TB. and it's also a really big problem amongst healthcare workers because we are exposed to TB when we are working with people and we have a high risk for TB as well.

[00:06:36] **Alisha Wainwright:** Because so many people are walking around asymptomatic and they might not even know it, how are we diagnosing tb?

[00:06:43] **Salome Charalombous:** So that's a very interesting question because the diagnosis of TB is quite difficult. So again, up until about 10 years ago, the way that we diagnosed TB was the same as in the 1950s. So we were using a microscope and diagnosing TB on sputum under a microscope.

And luckily there have been new diagnostic tests that have now come out that are better than that. And they have been rolled out in most parts of the world, but it's been quite an expensive test. And we're still finding that only about 60% of all people who are diagnosed with TB are being diagnosed with the right test.

And part of the reason is because of the cost of the tests and the difficulties with getting those tests into the poorer countries, which are the countries that have TB. But more recently and very recently, we are actually expecting WHO to come out with a guideline for it, a brand new test that has just been found that has been a lot cheaper than the previous test.

And we are hoping that will improve the diagnosis. And how we diagnose TB is through sputum, so people cough and then that sputum. So it sounds horrible. That gets tested for tb.

[00:08:04] **Alisha Wainwright:** Got it. So it's not just spit, it's almost like phlegm. Is that kind of the better way to say that?

[00:08:08] **Salome Charalombous:** Right. We call it sputum, but yes, it's phlegm basically.

But this new test that has just come out is actually using a lot of the technology that came out of COVID and it's actually using a mouth swab. So do you remember when we used to have the nasal swabs from COVID? It's actually using a swab and it's able to do the test in clinic. So it doesn't require a laboratory infrastructure for the test.

And so everyone's very excited about this, but, like I say, WHO hasn't actually even released the guideline yet around that. But everyone's getting very excited. And, the test is being produced and lots of plans are underway to actually start rolling out that test in many different countries.

[00:08:55] **Alisha Wainwright:** So currently, how is TB typically treated?

[00:08:59] **Salome Charalombous:** Unfortunately, a regimen that has up to four drugs and is taken for as long as six months and has many side effects. So we don't have the best treatment for TB and much of that is because there was a period where TB rates were dropping drastically in the whole world.

And then unfortunately, when HIV arrived, there was a resurgence of TB. And so then with this resurgence, there's been a lot of work now to try and find new drugs and, but the emphasis has really been on drugs, for those people who are resistant to what we call the first line drugs, which is the first lot of drugs.

[00:09:43] **Alisha Wainwright:** And these are pills?

[00:09:44] **Salome Charalombous:** Yes. These are pills. And a daily medication for six months. And many of the drugs that we use unfortunately do have side effects. So people will often tell you about, you know, that they really feel very ill while taking TB treatment because of the many side effects of TB treatment.

So it's really something where we are hoping for newer and better regimens and we are wanting to see that happen. There are lots of trials that have been done, some to reduce the regimen from a six month regimen to a four month regimen. And, there has been a successful trial actually done on this.But unfortunately for many reasons the new regimen hasn't yet taken off. So most people are still getting the six months regimen of TB treatment.

[00:10:38] **Alisha Wainwright:** The emergence of drug-resistant strains has complicated the diagnosis and treatment of tuberculosis. So to get a personal perspective on this, we spoke to Endalkachew Fekadu, or Endy.

In 2004, Endy was a student in Addis Ababa, Ethiopia when he was diagnosed with TB. But when first line treatment didn't work, it was the start of a years-long journey to diagnose and treat drug-resistant TB. Endy survived and now works as a pharmacist and advocate for TB treatment. We'll hear how things have improved since those days 20 years ago, but some of the underlying issues still remain

[00:11:21] **Endalkachew Fekadu:** In those times, it was very difficult to, you know, identify, whether is it resistant or not.

So I was even forced to terminate my school. Because physically I was not that capable enough to continue my study. So in the meantime, there was some senior internist or physicians, so they told us to do some – we call it a culture and sensitivity test, in one of the national laboratories.

In most of those health professionals, they're not prone to order or prescribe such kind of test because it's not common, not even accessible. But, they gave me an opportunity just to, give my sputum to do a culture and sensitivity test. And I waited for maybe four to six months for the result.

Eventually it end up becoming, you know, actually resistant to the first line anti-TB medication. I was lucky enough to meet one of, you know, senior internists. He gave me the prescription. He told me, “I don't know from where you can get this medicine.” So they are very expensive. Many people were dying, actually, including doctors, because this unaffordable – ten thousand, thirty thousand, fifty thousand. It was literally unaffordable. So many people were – even though they are diagnosed with resistant DR-TB, since it's no way to mobilize those kind of resources to buy just medicine – it's like a death sentence for many.

I grew up in a child support organization called Compassion International and through my sponsor, through my mom, she's from the US, and she bought those medicine. So that is how I got those medicine.

In those times, the medication even more severe than the disease itself. There are a number of side effects. You know, your brain, you know, your nerve, everything can be affected with those medicine. I can't move my limbs, you know, my hands and everything, you know. But also there are a lot of the gastric irritation. I can't eat anything. There is a sleep loss and there are some issue with the hair.

Some maybe can change your hair to gray or something like that.

For mine, I had to take the medicine for 23 months and, fortunately after I started those second line treatments, immediately after six months, there is some kind of progress in terms of, you know, the bacilla, the bacteria. In the nine and twelve months in between, I was actually smeared negative. You know, I became smear negative.

That's a big news for many, for my family, for my doctors. That was like, you know, my second chance in terms of, you know, fighting TB. I had to contribute something. That is how I end up with, you know, advocating for TB, you know, for treatment of TB. And I started my advocacy commitment, just after those experience.

[00:14:53] **Alisha Wainwright:** Oof. I already know the story, but hearing it, I can't help but feel emotional on so many levels because TB, on its own, is a horrible disease. To be given news that you have an essentially incurable version of it, because the cost to cure you is inaccessible, then having a compassionate person from another country who has known you your whole life, pay for those drugs, fly across the world and give you a second chance at life that takes you almost two years to heal. And then now he's healthy and he's an advocate. And I think about that complete 180, 360 story, and I'm so touched and also alarmed by how many people probably did not have that same experience.

[00:15:54] **Salome Charalombous:** Oh, for sure. For sure. And, you know, there are so many of these stories and it's always so sad to hear them. And you know, I am just pleased that we now no longer treat TB for 23 months. Hopefully most people only need to take treatment for around six months. Even those with, drug-resistant TB. And the side effects are improving.

[00:16:22] **Alisha Wainwright:** So tell me a little bit more about the current regimen for drug resistant tuberculosis.

[00:16:28] **Salome Charalombous:** Yeah, so the new regimen that we are using now for drug resistant tuberculosis is called BPaL. It's a great regimen because it's only made up of four drugs. In the past, people used to actually be on up to seven drugs. And the B stands for bedaquiline.

So the other drugs are pretamonid, linezolid, and then levofloxacin. So that makes up BPaL. And the good thing about BPaL is that it's an all-oral regimen, which means there aren't any injectables involved. You know, it's an all oral regimen that is safe and it's now given for six

months instead of previously, whether the regimens were given for nine and 12 and much more, so that is the new regimen that people have been using. It came in about two, three years ago and it's really revolutionized drug-resistant TB treatment.

[00:17:22] **Alisha Wainwright:** So to continue the conversation about drug resistance – Endy had a specific type of drug-resistant TB 20 years ago, and yes, we've accomplished quite a bit and had a few setbacks along the way since then. But are there different types of drug resistance for tuberculosis, or is there just one kind?

[00:17:43] **Salome Charalombous:** Yes. So what we do is, the most common form of TB we call drug-sensitive tb. And that is in most cases the most common form. You know, in South Africa where I live, 95% of TB cases are drug-sensitive TB. And that means that they would then be able to be treated with what we call the first line of treatment, which is the first four drugs that we use. Once someone is tested for TB, we try to make sure that they also get tested for drug-resistance and in most cases, as I said, they would have drug-sensitive TB.

But then another common type of resistance is rifampicin resistant TB, which means they then are resistant to the main drug that is in the first line regimen, which is rifampicin. Once somebody is actually resistant to more than rifampicin, they're called multi-drug-resistant TB. But if someone is resistant to rifampicin and other drugs, then the choices start to become less.

And then eventually we can get to what we call extensively drug-resistant TB, which is when you are resistant to the big guns like bedaquiline and another drug, which is called moxifloxacin, or the quinolone. So that then makes it very difficult to treat the person because basically many of the drugs that we use, won't work in that person. We have to actually find the other drugs and try different combinations of drugs and so on. So that's the different types of TB that one gets.

[00:19:23] **Alisha Wainwright:** If you have extensively drug-resistant TB, what's the likelihood of a positive outcome?

[00:19:30] **Salome Charalombous:** Well, luckily, I mean, we are still seeing positive outcomes in those people. You know, I think that it is a very difficult treatment. And we have in our country, South Africa, we actually have a committee. So in those cases, the doctors will actually refer to the committee, give all the information on the person, and then the committee will help the clinician, you know, at the hospital to decide what kind of drugs to put the person on and then monitor.

You know, it's not a great thing as you can imagine. And, you know, in many cases it would actually require that the person spends quite a bit of time in hospital. Because then the treatment's actually an injection. Some of the treatments are like an injection, like a daily injection.

So, those cause more problems. But, as I said before, 95% of people have the drug-sensitive TB. About 5% have the rifampicin-resistant TB, and then the extensively drug-resistant TB becomes a much smaller proportion, I think it's around probably 0.5% of all TB. But if you have it, then it's a big problem, obviously.

[00:20:57] **Alisha Wainwright:** So as Salome describes, some progress has been made since Endy was diagnosed with drug-resistant TB all those years ago, but globally, it still

presents a big challenge. According to the World Health Organization, the majority of people diagnosed with drug-resistant forms of TB are still on treatment regimens that take 18 months or longer to complete.

And like with any disease that develops drug resistance, the problem is always evolving. To get a broader perspective on the situation around the world, we spoke to Professor Nazi Ismail. He's the Head of Clinical Microbiology and Infectious Disease at Wits University in South Africa. He told us more about the positive steps in recent years as well as problems that lie ahead.

[00:21:46] **Nazir Ismail:** So, globally the total number of drug-resistant TB is close to half a million people, which is about 5% of the global burden. Obviously the challenge there is that we only detect, or probably detect globally, about half of those. So the other half are totally missed. So we just need to appreciate that.

But it's supremely transformed in the past decade and a half, with new Rapid Molecular Diagnostics, which provide rapid results for TB and drug resistance. We're even talking of already, South Africa has already started implementing a next generation sequencing for diagnosing drug-resistant tb.

But in terms of success rates – so for MDR-TB we're like 50%. With the introduction of bedaquiline, that was climbing more towards 60, 70%. But with a new regimen, at least, the evidence is still accumulating, but it's probably, definitely above 80%. So I think it's been a quite amazing journey over the past decade.

But that's not to say that we don't have problems ahead. The scary thing for the current BPaL regimen, particularly for bedaquiline, which is sort of the cornerstone of this current regimen and many other alternative regimens that are being recommended by WHO. Now, they all include bedaquiline as the core drug.

But the concerning thing has been the evidence that we had shown initially in South Africa with bedaquiline resistance already approaching 3 to 4%, at the early stages. And now emerging evidence in the Western Cape in South Africa and in Mozambique with resistance rates now reaching 10% or more.

And the key thing there is, this is a very new drug. It's not even 10 years in use, and we are already sitting at 10% resistance. So that is the concern that, with the scale up, I mean, it's been a revolution, so there's a huge interest and excitement in implementing these new drugs. You know, it's been proven historically and nothing's gonna change again, is that, as I said, the more we use it, we are more likely to lose those drugs in time.

[00:24:19] **Alisha Wainwright:** How much do we know about the emerging resistance to newer drug regimens and what are the gaps in our knowledge?

[00:24:28] **Salome Charalombous:** So we are lucky enough that there is surveillance that goes on and, in many countries, everybody who is first diagnosed with drug-resistant TB has additional testing done to make sure that they are not resistant to other drugs.

I think where the big problem comes in is making that first diagnosis, as also mentioned by Dr. Ismail, that of people with drug-resistant TB, only half are actually picked up in the world,

and that's where our biggest gap is. And then part of that is because of all the problems with diagnosing that we've already mentioned. And so you have to diagnose TB to be able to then go forward and diagnose drug-resistant TB.

[00:25:17] **Alisha Wainwright:** But what are some of the key interventions or policies that could stop the spread of drug-resistant TB?

[00:25:26] **Salome Charalombous:** The first is increasing testing. And so there have been many strategies where what we've tried to do is identify who is at risk and then test regardless of symptoms. We call that targeted universal testing. So testing people regardless of whether they have symptoms because they have a risk factor. So being a minor or being in a prison is a risk factor for TB. So testing, more testing, more people for TB is important. Testing with the right test that can actually diagnose resistance is very important and that's what we've also discussed. And then, you know, putting people on the right treatment. So if you test with the right test that then identifies that there is resistance, then you can put the person on the right treatment that will then prevent further resistance because, you know, a person who is on the wrong treatment, is still coughing and still spreading, and spreading the resistant bug.

In addition, we also know that TB is actually preventable and there's treatment that one can take to actually prevent TB. And that is, also, something that we have been working on over the years to try and improve that treatment to make it easier for people to take something that can actually help them to prevent TB.

And that is, at the moment, the standard is a once-weekly treatment for prevention of TB that you take for a period of three months. But we also are working quite hard at trying to find even easier options, like one month treatment or a single treatment that, you know, that you can just take one treatment and that will then prevent you from getting TB for a period of time.

There's a lot that's also going into place for that. And of course, vaccines. There is also a lot of excitement around vaccines that are being tested at the moment to try and prevent TB, and that will be the ultimate, you know, for a new vaccine to become available that we can then give to everybody who is at risk of TB and introduce those rates completely down.

[00:27:49] **Alisha Wainwright:** So what's the current state of research into vaccines for TB?

[00:27:55] **Salome Charalombous:** Okay, so there are currently two main trials that are going on that are in what we call phase three stage. And so those phase three trials have been done actually quite rapidly because there's been a lot of urgency in the community to say we need to get these trials done. And they are now in the follow-up phase. A lot of the people that were that have been enrolled in those trials have already taken the vaccines, and we are waiting to get the results. And by the beginning of next year, some of these trials will start being reported. And the community, the TB community at the moment, we're working very hard working with governments to ready them and prepare governments for if the vaccine does come out to be effective. People are really, you know, optimistic that the new vaccines are going to show a benefit because the phase two trials did show benefit and so we think there's a good chance. But of course we can't be sure until the results come out fully and we are aware, so that is something that we are looking forward to.

[00:29:11] **Alisha Wainwright:** I'm thinking sometimes that, you know, all these years of research, sometimes it's just half the battle, because then you actually have to logistically get the drug, of course, to the people who need it, educate the people who need it, give it to them, and then hopefully, and once you get it en masse, you can see the, positive benefits. So it's, yes, so much effort and work and, still you're just one step forward in the long, road ahead to, you know, inoculating an entire community.

[00:29:42] **Salome Charalombous:** Yes, but you have to, you have to have those steps. You know, if we don't do the phase three trial, we won't have a vaccine at all. So we have to do that. We have to go through these steps and then eventually get to the point where we will be now talking about, all the people who don't want to take the vaccine and why and how to fix that and, you know, and so on. But, you know, hopefully, trying as much as possible to make sure that the countries are as ready as they can be, when we do get a vaccine so that it can actually be a smooth rollout and as many people as possible can receive the vaccine and then be protected. So we are hoping that's going to be the case.

[00:30:30] **Alisha Wainwright:** There's one issue underpinning this whole conversation: the challenges of fighting TB on the ground in under-resourced settings. The burden of this disease falls disproportionately on countries in the global south, and recent foreign aid cuts have made headlines, but they also make real problems and difficult choices for people working on the ground.

So is the progress against TB at risk? And how do you deal with infectious disease while there's also a funding gap? And in this situation, what is the role of researchers and scientists? These are the questions that came up in our conversations with Endy and Nazir, and here are some of their thoughts.

[00:31:13] **Endalkachew Fekadu:** Recent development, especially for the last two years, we have seen, we have witnessed, there was a tremendous progress in terms of fighting TB, but for the last maybe two years, like for example, last March or February 2025 especially, the intervention from the American government, from the Trump administration really impacted a lot, you know, impacted a lot of people.

So the determination of those USAID , the contribution of USAID is really in months, not only for Ethiopia, for many global initiative including Global Fund, UNITE and everyone. So those funding cuts really halt our progress in TB because you know, there is a considerable amount of resources that have been cut from this initiative. TB had funding gap even before two years.

There are considerable funding gaps, but now is much worse. You know, we are losing everything, you know, we're losing everything. We don't even have a chance to maintain the progress. So there must be a solution, there must be a way to fight back and to actually to cover the gaps, you know, we have to fill the gap.

[00:32:44] **Nazir Ismail:** No country in the world, whether it's an upper income country or low income country, there's never enough money. Even our household budget, there's always something that you want that you can't afford, right? That's a reality of life. And I think we have a social responsibility in health as well to make sure that every dollar spent is effective.

That is sometimes not easy to solve. Sometimes the whole issue around integration and you know, primary healthcare kind of services or prevention, is areas where we should be

spending our money as well. So I think there's definitely efficiencies, but also I think one thing that we kind of forget about is the long-term consequences. The challenge with drug-resistant TB is that it knows no border, it's airborne, and if we don't nail it down rapidly, the long-term consequences could be something that affects not low income countries, but could transfer into upper income countries as well.

[00:33:50] **Alisha Wainwright:** I mean, everyone could always use more money, especially in the research space. I'm just wondering if, for you and your work, you have experience with funding gaps or if any recent, you know, reductions in USAID have – if you've experienced that in your own work.

[00:34:11] **Salome Charalombous:** Of course, very much. In our organization we had a USAID grant that was providing services to communities.

We had spent a year to get the grant up and running and it required that we would have a memorandum of understanding with the provinces that we're gonna be working in, of course, makes sense. You know, they want to understand what you're going to be doing, how are you going to provide the services when you find somebody who has TB, how are you going to then refer to the public health system, and so on. We'd spend a lot of time setting up memorandums of understanding. We'd spend a lot of time getting teams in place. Then we'd had to, we'd also purchased big vehicles and so on because what we were doing was we were doing community screening for TB using big chest x-ray trucks and so on.

And so that all took quite a long time to get in place. And we were running for about six months when the funding was cut and that was just devastating. You know, like we were just feeling like we're starting to make inroads in these communities. We are identifying people that have TB. We were putting people on preventive treatment to stop TB in people who were at high risk. And then that was just stopped. And people were obviously extremely devastated. You know, they couldn't do their jobs. They didn't know whether they would have work going forward, whether they didn't know whether they had a job. And unfortunately that ended up with us having to cancel their contracts and stop.

That was the end of it, that 26th of January, that was the end of it. And so yeah, we were all so devastated, the trucks came back to the office. They're just lying there. And, you know, and everything, all the preparation was for nothing. And then the biggest problem, and on top of all of that is that a lot of the data management systems were also at that time being paid for by the US government. We don't even have a way of measuring what the impact of the cuts are. Because in many cases those systems just shut down. And so that's really hard because I don't think every anyone will ever find out, exactly the impact of these.

[00:36:53] **Alisha Wainwright:** What are some of the challenges of fighting infectious disease in settings where, you know, resources are limited?

[00:37:03] **Salome Charalombous:** I mean, I think that it starts from the person that is ill. And the whole thing is that when there are limited resources, it's quite difficult for people to even just access care. So even to just make it to a clinic, you know, if there isn't money for transportation, for instance, or if there isn't money, if there is a copayment required or treatment payment required, which in many countries that is the case, people just don't even access care. But once they get to a clinic, if there's not enough nurses and healthcare workers, and they have to sit in a queue for an entire day and are unable to to earn money while they're in the queue or even to have someone, you know, look after their children while they're in the queue, that's another big problem. And then, you know, once you're in the

healthcare setting, you have the problems of, what kind of tests are available to those healthcare workers if they do a test that requires something to be sent to a laboratory, for instance, are there resources to get that test to a laboratory to be tested? Are there resources to get the result back to the healthcare worker? Once the healthcare worker has a result, you know, and say the result is negative, have they got access to other tests to try and understand what is actually going on with this person? And if it's positive, have they got the treatment available?

So has the country got that treatment, in some cases the country hasn't even purchased a treatment because it's too expensive. Or if they have purchased a treatment, have they actually got it to the place where the person is? Because every time, if someone has started on TB treatment, for instance, sometimes people actually expect the person for the first two weeks to go every single day back to the clinic to take medication. You know, that's called directly observed treatment. And you know, I think for a long time that is how, that was the mainstay of how people gave TB treatment, for instance.

But now everyone has understood that just creates even more barriers for the person who's on treatment. I mean, there's so many challenges and you know, I think that a lot of the programs and the global health community have understood that there are these challenges and, you know, the only way to get past some of these challenges is by supporting and supporting all the ways that we've spoken about, you know, providing diagnostic tests at the household instead of at clinics. Making those diagnostic tests available, making treatment available, making provision of adherence support available to people, getting treatment to people instead of having them come every month to come get the medication.

All of those things are things that we take for granted. But, you know, in resource-poor settings, those things are not available. And, that's why the funding that we were getting, and we are still getting from many countries, but not so much anymore from the US, was so important and helping to fight some of these infectious diseases.

[00:40:29] **Alisha Wainwright:** You know, my next question was to ask about the role that scientists and researchers can play here, but I feel like you really answered that – the role that a researcher and scientist can play is to understand the limitations and barriers for patients and create the opportunities and pathways to get through those obstacles.

So rather than just living in your silo where you're creating drugs and things, you're actually looking and understanding what your patient might need or some of the limitations and barriers that might prevent them from being able to get treatment and tailor your treatments so that someone might be able to receive it and actually have an effective outcome.

[00:41:13] **Salome Charalombous:** I agree. I mean, I think that, you know, taking a person and looking at the person holistically and trying to understand what are the barriers that person has is really important. You know, in the past, I think often, us as doctors, we would often just treat whatever was wrong. But, you know, you can't just do that.

You can't just treat a person with that disease as if it's like you just got a bug that you're treating, you know. You're treating a person who has a whole lot of other things going on with them, and you've gotta understand how those work together. But I think that the other role that scientists can play is that of advocacy.

You know, I think that if it's only by educating, making people aware and advocating for what's required, that resources have come, and that's how resources came in the first place, and the only way that we can be part of the solution, part of making sure that those resources are coming back.

[00:42:21] **Alisha Wainwright:** I am so impressed just by what you've been able to accomplish, how far research, diagnostic testing and treatment has progressed in the last 20 years. And I'm excited to see where it goes, and I hope that we will continue to see a decrease in the numbers of TB and also, you know, limit the amount of drug resistance that is occurring. This was such an educating conversation. I really, thank you for your time, Salome.

[00:42:49] **Salome Charalombous:** Thank you Alisha. And we will end TB. We will, yes. Eventually. Thanks.

[00:42:56] **Alisha Wainwright:** It was important to end on a positive note like that from Salome. We talked a lot about the challenges and threats that remain with drug-resistant TB and the problems of funding gaps. But I think it's important not to lose hope. As harrowing as Endy's story was, it's also a powerful reminder of the improvements in diagnosis and treatment in the years since. And after all, Endy himself beat the disease and now shares his story as an advocate. It's a sign of the progress that's been made and what can be achieved if we keep up the efforts to end TB.

Thanks for listening to this episode of When Science Finds A Way. Thanks also to Professor Salome Charalombous, Endalkachew Fekadu, and Professor Nazir Ismail. If you enjoyed this episode, make sure to follow us wherever you get your podcasts, and subscribe on YouTube.

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