

**Announcer:** Welcome to the “Science is the Best Medicine” podcast with your host Dr. Abhinav Sharma, exploring the pressing scientific and healthcare issues of our time.

**Dr. Abhinav Sharma:** Superbugs—we hear about them in the news. Organisms that seem to be resistant to every medicine that doctors have. They’re seemingly cropping up everywhere, especially in hospitals. But what exactly are superbugs, and how do they affect our day-to-day lives? How can we contract these bugs? Are we going to see epidemics like those in Hollywood movies? Finally, what exactly is it that we can do about these superbugs? Today we sit down with Ephraim Tsalik, MD, PhD, an infectious disease specialist and researcher here at Duke University.

**Dr. Ephraim Tsalik:** Let's get into it.

**Abhinav:** So, Ephraim, tell us a little bit about your journey until this point and how you came to be an infectious disease doctor.

**Dr. Ephraim Tsalik:** Sure, so I probably had a little bit of an atypical journey. I was a little bit of a wandering soul of sorts. Going back to a fairly early age, I was always interested in science and research in particular and I guess it was the idea that there are questions and there are mechanisms to try and answer them, and you can design experiments you can go into a library, you can read, there are things you can do to try and find answers to the unknown, and that sort of general interest led me towards medicine and to research in particular.

I went into my college education at Rutgers with a very strong interest in research. From there I went to Columbia and did an M.D. Ph.D. program that really allowed me to really hone my research skills. And then while I was there, the focus of my research was on neurobiology very far removed from infectious diseases and so I guess again it was a little bit of a wandering course in terms of how I got to where I am. But following my training I was fortunate enough to come down to Duke to do my clinical training in internal medicine. And during those three years, I just found a lot of things that I was interested in but was really trying to find that one that that I could commit to and identify as the area in which I would pursue my research interests for the long term.

And so, I really struggled with that because again there were a lot of things that I found interesting but ultimately it was really a series of conversations with the Faculty in Infectious Diseases at Duke that made me realize that that particular environment and the people in the division really stood out as being totally invested in my own development and success. And so more than anything else I felt like it was the right environment to be in. And that's ultimately how I ended up in infectious diseases and have been really ecstatic with my experiences there so far.

**Abhinav:** Ephraim, can you tell us a little bit about what antibiotic resistance means and is this really that big of an issue?

**Dr. Ephraim Tsalik:** So, antibiotic resistance is a situation where you might have a bacteria that you could have chosen for example, penicillin to treat it. And at one point in time that would be an effective treatment. But over time the bacteria evolve, and part of that evolution is done in the face of antibiotic use. And what that allows the bacteria to do is to become resistant. They'd acquire mutations in their genetic code such that the next time they're exposed to penicillin, they continue to grow in the face of it. And that is resistance at its very basic principle.

Now the good thing is that we have a lot of antibiotics and so if it happens to just be resistant to penicillin that's not a big deal, there are others you can choose. But what happens when that bacteria has become resistant to every antibiotic that we have? And that is now becoming a reality that is

now the case. There are individuals dying from infections for which we have no treatment whatsoever because it has become resistant to everything.

**Abhinav:** So, that sounds horrific and it sounds like a plot of some sort of Hollywood thriller essentially.

**Dr. Ephraim Tsalik:** I'm sure it's in the making.

**Abhinav:** I'm sure it's in the making right now. And so, these bugs or these bacteria that have become resistant to everything. Is this what's referred to as a superbug when you hear that in the media and when people talk about a superbug? Is that what they mean these bacteria that are essentially resistant to every antibiotic available?

**Dr. Ephraim Tsalik:** That's exactly right. So, a superbug is a term loved by the media that suggests that it's a bacteria that has become resistant to most antibiotics.

**Abhinav:** And in the United States and globally, have superbugs really exploded in terms of an epidemic? Are there outbreaks of this happening or is this confined to a few centers or a few individuals?

**Dr. Ephraim Tsalik:** So, the growth and the presence of those superbugs is again something that's changing over time as bacteria evolve, the frequency with which we're seeing these superbugs is increasing. So, what at one point in time might have been a sporadic case here and there is becoming epidemic in certain parts of the world, and with global travel being what it is, it is inevitable and we are already starting to see this in United States, that there are more of these superbugs present in this country.

**Abhinav:** All right so you mentioned global travel. So, this is the part that worries me a little bit; I travel a lot for work and I'm in airports very frequently, and inevitably I'll sit down somewhere and the person sitting next to me is hacking and coughing. Can superbugs be transmitted through these highly dense areas such as airports when a lot of people are coming together? Or is this something that evolves out of being in a hospital for a long time or being in a health care institution?

**Dr. Ephraim Tsalik:** The spread of these superbugs is generally unlikely through casual contact. What often happens is that people become colonized with these. And that's a word we use to describe bacteria, again that are part of your microbiome, things that are in and on your body and that often happens in a hospital context, people who are spending a lot of time in the hospital, which could be family members or staff or the patients themselves, can acquire these and they might be on that person's skin, or in their digestive tract and not cause any problems at all until some point in time when they do develop a real infection. Moreover, the fact that they're carrying these bacteria but not necessarily having symptoms does increase the likelihood or the risk that they might transmit it to others down the line. But it's generally not a casual contact sort of a phenomenon like you touch the door handle in the bathroom and now you're a goner. It's not quite that bad.

**Abhinav:** Well that's very reassuring. And I think maybe Hollywood has put this concept in our mind that you can have an epidemic spread through airports. Is that a likely scenario in the future that you can have either a virus or bacteria, whether it's a superbug or not be transmitted or disseminated through an airport or other settings.

**Dr. Ephraim Tsalik:** With respect to those different types of infections, it is generally unlikely with bacteria because they are harder to transmit. And in order for someone to become sick, they usually have to be exposed to a fair number of that bacteria. But viruses are a bit easier to spread.

They can be spread through sneezing, coughing, if somebody then wipes their nose or rubs their eyes and then touches a surface, that surface will carry the virus for a period of time. And so, those can be transmitted in airplanes where the air just simply circulates around and around, are known for spreading colds. I think I remember in the context of the SARS epidemic, that they were tracking cases based on who was sitting next to whom on an airplane. So, that is a possibility. More so with viruses than bacteria.

**Abhinav:** OK. And I recall going through airports and seeing people wearing those masks. Does that do anything at all? Should we all be masking it up as we go through the airport?

**Dr. Ephraim Tsalik:** I probably wouldn't quite go that far. People are certainly welcome to take on those personal protective measures. But, in my own anecdotal experience, I can't ever recall getting sick just being in an airport. I pretty much always trace it to my kids.

**Abhinav:** Well that is very, very reassuring I must say. But now just a quick question about these superbugs. Are there strategies that healthcare providers or even individuals can do in order to minimize the development of these superbugs and to follow up as well? Does over-prescription of antibiotics lead to the development of more of these bugs?

**Dr. Ephraim Tsalik:** Absolutely. So, we've been talking about antibiotic use and using them in appropriate and, unfortunately, inappropriate situations, and so more appropriate use of antibiotics, in other words using them when they're needed and not using them when they're not needed, is one of those steps that every individual can take.

And so, if a patient comes to their doctor and says I'm not feeling well and the doctor recommends an antibiotic, it's completely appropriate—and I would say encouraged—for the patient to turn back to their doctor and say, “Hey doc, is this really something I need?”

A lot of doctors prescribe antibiotics just in case. A lot of them prescribe antibiotics because they think that's what the patient is hoping for, or is looking for. And so, turn it back on your doctor and say, "Is this really something I need?" And if they say, “Yes,” then you know that's something you need. And if they say, “You know what, probably not,” then it's completely appropriate to then put that antibiotic aside, maybe put it in your pocket in case things get worse and not better. But that would be one of those simple measures that everybody can do in order to try and improve on the problem.

**Abhinav:** So that's really interesting. With regards, though, to differentiating between a viral infection, which may not need antibiotics and can resolve the time, versus a bacterial infection that typically does need antibiotics—I recall just from my own clinical experience that it can often be tricky to distinguish between the two of them in the clinical setting, when you have a patient coming in and complaining of these symptoms. So, at the bedside, when you have a patient sitting in front of you, how can you tell if this is someone who needs an antibiotic prescription? Or, if this is someone who needs a prescription for some rest and relaxation?

**Dr. Ephraim Tsalik:** So, you're right Abhinav, it is difficult because if you think about every symptom that people might report with either a viral infection or a bacterial infection, you can see it in either. So, if it's sore throat, there are bacteria that causes sore throat. There are viruses that cause sore throat. If it's a fever, there are bacteria that do that and there are viruses that do that. If it's green phlegm, there are bacteria that do that, and there are viruses that do that.

And so, for any one of those symptoms it's impossible to know what it is. And so, what doctors do is they look at the combination of all of the symptoms. There are some combinations that tend to

speaking more to a viral infection and some combinations that tend to speak more to a bacterial infection. Knowing whether or not you've been exposed to somebody with similar symptoms might argue in favor of one or the other. And then there's testing that the doctors can do in order to really figure that part out.

**Abhinav:** What kind of testing are you referring to in this circumstance. It depends a lot on where you are if you're in a primary care office, your doctor might do a rapid strep test to look for strep throat. They might do a rapid flu test to look for influenza. But beyond that, most doctors' offices don't have too many tests available to them in order to distinguish. And those two tests that I mention only look at two things. There are dozens of things that can make somebody sick. In an E.R. or a hospital environment, there are other tests that are available that can give you a much broader sense of what the virus or bacteria is that could be causing you to be sick. And most of those tests focus on trying to find the pathogen, trying to find the bug, under the assumption that if we find it if we find something, then that must be what's making you sick.

So, that actually leads right to my next question, because as you've mentioned it can be very tricky to distinguish someone from having a bacterial versus a viral infection because of the similarities in the symptoms. You recently published some research in [Science Translational Medicine](#) that can help shed some light on the issue of identifying viral infections from bacterial infections. Can you tell us a little bit about your research and your findings?

**Dr. Ephraim Tsalik:** I'd love to. So, the idea behind our research is that whenever we as living organisms interact with our environment, that environment interacts with us just the same, and we react to it. So, if you are exposed to cigarette smoke, your body reacts to it. One of the ways that it reacts to it is by turning on certain genes and turning off certain genes in specific patterns. We call those patterns signatures.

And so, what we did is we started off with a few hundred patients where we looked back at their records and looked at all of the information we had, and identified a group that had a confirmed viral infection, and another group that had a confirmed bacterial infection, and then a third group that was sick but ended up not having an infection at all. And then we looked at and how all of their different genes, 20,000+ genes were being turned on and off in every one of those individuals. And we then defined those signatures. We asked, what is it that's common among all of the people with a bacterial infection, but that sets them apart from all of the other groups that we looked at? And the same thing for viruses, what's common among people with a viral infection that sets them apart? And we use those signatures to identify and develop a test that you could then apply to an individual subject, an individual patient, and ask what their gene expression profile, what their signature is closest to. Does their signature match that of someone with a bacterial infection, or a viral infection, both or neither? So that's the approach that we took.

**Abhinav:** And this is a simple blood test that people can get in the clinic right now. So, if I have a cough or a cold, can I come to you and say, "Ephraim, I've got some symptoms, can you check my blood and see what my signature is looking like, and then prescribe me antibiotics if you feel that I have a bacterial infection." Is it ready for primetime right now?

**Dr. Ephraim Tsalik:** We're not ready for primetime yet, but that's exactly how it would work. You would come in, you would give a sample of blood. We are aiming to have the test results available in an hour. So, it is the sort of thing that you could get done in just about any clinical environment. And we're working with technology companies and diagnostics companies to develop that test. And the good news is, we're making great progress.

**Abhinav:** On today's episode, we heard from Dr. Ephraim Tsalik about what exactly superbugs are,

and how we can minimize the risk of developing superbugs.

It seems to me that as the use of antibiotics increases, we are going to be hearing more and more stories about these bugs, but it's a bit reassuring to know that unlike viruses, these superbugs don't necessarily cause epidemics like we would see in the movies. I'm constantly faced with the threat of superbugs when I go on my clinical rotations in the wards and in clinic.

But it's also good to know that with basic procedures such as hand hygiene, wearing gloves and gowns where appropriate, and encouraging patients and visitors to wash their hands, and to maintain proper safety procedures, that we can really minimize the spread of these superbugs. For now, it seems that appropriate use of antibiotics, avoiding treating viral infections with antibiotics, are some of the easiest things that we can do to prevent these bugs from developing. Thanks to all of those who made today's episode possible.

I'm your host Abhinav Sharma and I hope you've enjoyed today's dose of Science is the Best Medicine podcast.

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