

Sustainability Leaders podcast

Episode 27: Preventing The Antimicrobial Resistance Health Crisis

Dame Sally Davies: The fast pandemic, I talk about a lobster in boiling water of COVID-19, and it's making a lot of noise, and it's waking everyone up to the threat that can come when healthcare goes wrong. Meanwhile, there's this slow, creeping pandemic of resistance by the bugs and microbes to their treatments, whether it's TB, malaria, HIV, fungi or indeed bacteria when it's antibiotics that the resistance has developed to.

Michael Torrance: Welcome to "Sustainability Leaders." I'm Michael Torrance, Chief Sustainability Officer with BMO Financial Group. On this show, we will talk with leading sustainability practitioners from the corporate, investor, academic and NGO communities to explore how this rapidly evolving field of sustainability is impacting global investment, business practices and our world.

Legal Disclaimer: The views expressed here are those of the participants and not those of Bank of Montreal, its affiliates or subsidiaries.

Alice Evans: Welcome to the "BMO Sustainability Leaders Podcast." My name is Alice Evans, and I'm one of the two co-heads of our Responsible Investment Team at BMO GAM. At BMO GAM, we have a team of analysts with expertise on different social, environmental and governance issues, and we research those issues that have most relevance to the companies that our clients invest in, and our team leads BMO GAM's Engagement Program, entering into dialog with those companies on those key issues to request and encourage improved management of those issues. Public health is a key theme of interest to us as responsible investors, and today we're going to zone in within that topic on the subject of antibiotic or more broadly antimicrobial resistance, AMR for short, which is really nothing short of an evolving public health crisis that doesn't get really as much airtime as it probably should, and to explore this topic, we're extremely delighted to welcome into our virtual studio today Dame Sally Davies, the UK's special envoy on antimicrobial resistance, and before taking on this role, Dame Sally was Chief Medical Officer for England and Chief Medical Advisor to the UK government from March of 2011 until late last year. This is a post somewhat equivalent to the Surgeon General in the US, and it's a key position of influence in setting priorities for public health policy in the UK. The 18th of November marks the start of Antimicrobial Awareness Week here. It's a topic that doesn't get the headlines of climate change, and most people would probably only be I think peripherally aware of what it means, but we really passionately believe it's a topic that deserves to be more front of mind. I think most of us and our listeners have likely been fortunate to grow up in a world where we've taken antibiotics for granted, and I think it's a level of trust and comfort that we've enjoyed in the background to all of our encounters with healthcare, but I think for most of human history, life has been less certain, and just introducing it for me personally, it's a topic that I feel very strongly about, and it took me being in the hospital with my then 3-year-old son who was desperately ill with pneumonia out of nowhere for it really to hit home how dependent we are on and how vulnerable we are without effective antibiotics, but it's the nature of bacteria to tend to develop resistance to the agents that we develop to use against

them, and ever since the discovery of penicillin really, which was of course a transportational milestone in human health, we've managed to stay one step ahead of that evolving resistance, but I think many people are not aware that we are losing vital ground in the race. And so, Dame Sally, you issued really a call to arms on the topic of antimicrobial resistance during your tenure as Chief Medical Officer. It is a topic that can sometimes I think turn people off by being too technical or too intangible. Can you tell us, how do you explain AMR? Why has it become such a pressing issue? Can you paint us a picture of what the future might hold if we don't get to grips with it?

Dame Sally Davies: Thank you, Alice, and thank you, BMO, for being at the cutting edge. Well, just imagine as Fleming was discovering penicillin, there was a 6-year-old in Maryland in the United States, and she cut her face, and a few days later she was struggling to breathe because she'd got such swelling round her mouth and her throat that it was difficult to breathe, and they feared for her life, but actually she was one of the first patients to get penicillin, and within a week she was better. She was out of hospital. Your own story paints the picture beautifully, but think about the 60,000 newborn babies that die every year in India from sepsis, from uncontrolled infection, either because they can't get the antibiotics or because the antibiotics don't work. So when I was a young doctor, we had a plentiful supply of antibiotics, and when the natural resistance happened because it is a natural occurrence, the microbiologists would say to me, "Don't worry, Sally. Just swap the patient to this other drug." The problem is that we've been swapping patients to other drugs, and the bugs have been coming resistant to these newer drugs. Meanwhile, actually because we pay peanuts really for new antibiotics really as well as the old ones, we've got a very empty pipeline. No new clinical class of antibiotics has come into general practice and use since the late 1980s. That is a tragic story for a failure of the R and D system, and so what I think we're seeing at the moment is the fast pandemic. I talk about a lobster in boiling water of COVID-19, and it's making a lot of noise, and it's waking everybody up to the threat that can come when healthcare goes wrong. Meanwhile, there's this slow, creeping pandemic of resistance by the bugs and microbes to their treatments, whether it's TB, malaria, HIV, fungi or indeed bacteria when it's antibiotics that the resistance has developed to. Interestingly, earlier this year, World Health Organization published a list of their most serious health threats for the 2020s. A pandemic with a virus was one, and another was antimicrobial resistance, and I don't want us to go back to the Armageddon that was pre-antibiotics. They underpin all of modern medicine. When I had a caesarean section, I was protected with antibiotics. Joint replacements, transplants, cancer treatments, diabetic patients: Most of, well, all of modern medicine actually relies on effective antibiotics and anti-infectives, and the bugs are beginning to win this race, and yet we haven't sorted the pipeline, and people aren't taking it seriously enough.

Alice Evans: I think in the UK at least, we are becoming more aware of being encouraged to use antibiotics more sparingly than of less indiscriminately when we get sick, which is of course part of the problem, that overuse in healthcare, but even the overuse in healthcare isn't the only issue contributing to the problem, is it? We live in an ecosystem.

Dame Sally Davies: No, sadly you're right, but over 40 percent of the UK's total antibiotic use is in humans, chickens and pigs, and globally more than 70 percent of antibiotics goes into animals and fish, shellfish production as well as in crop-spraying. We have been making strides in this country. Between 2014 and 2017, our general practitioners reduced their use by 7.3 percent, so we are getting the message out there in this country. Meanwhile, our pig manufacturers have reduced their

use ... our chicken ... I don't know what the word is. Growers is not the right word, but the people who ...

Alice Evans: Farmers?

Dame Sally Davies: Yeah, thank you, our chicken farmers have reduced their use of antibiotics dramatically, more than 80 percent, so in this country we're making progress, but there's still a long way to go. We'd like more here, but across the world. Meanwhile, the environment is involved as well, so in making drugs, as they are made, the effluent from factories pours out into the streams, rivers, surface water, and then eventually reaches oceans and that sort of thing, and that's bad for us. Meanwhile, it's just amazing that over 70 percent of antibiotics are peed or pooped out by animals, so that means humans, food chain animals and fish, so that contaminates. A recent study from York University showed that of the 700 rivers they looked at, most of them had antibiotic residue. The Thames does, the Danube does, the Iowa River does, so it's not just low-income countries that have a problem with contamination that can increase the risk of resistance developing or of infection with resistant organisms and consequent problems. It's all of us that need to attend to what we're doing and how we do it.

Alice Evans: So as you say actually a lot of progress is being made on management of antibiotic use in countries like the UK. How are the more developing countries starting to address it?

Dame Sally Davies: Well, I'm very worried about this because it is a development issue. At the moment, more people die of lack of access than resistance, but that's going to change in the not too far future, and modern medicine and strong health systems underpin economies and development, so we need to help countries get this right. In 2016, the world agreed that every country would prepare a One Health National Action Plan. I think 132 countries now have plans. Another 50 or more are in development, but it's easy to write a plan. It's another thing to find the money and then make it happen, so everyone is trying to work on it, but it's hard work, and it's very difficult, and we need much more awareness in the professionals and in the public, and as countries develop, they inevitably need to use appropriately more antibiotics, so we also need to bring more antibiotics through, new ones, so that as the old ones become ... The bacteria and fungi, et cetera, get resistance, there's something else to move to, and we're not winning like that, but we are seeing countries making big efforts. I'll give you a couple of examples. India is consulting on an innovative piece of legislation to limit the concentration of antibiotic pollution. We need other countries to support them and introduce similar legislation. China saying that it will take out all antibiotics from animal feed before the end of the year and banning...

Alice Evans: Wow.

Dame Sally Davies: Yeah. There are ... One has to congratulate these countries that are making big steps, and most of them are making them because they recognize the importance, but that means we've got to keep talking about it and finding the data and showing them. Others are shifting their behaviors because of either investors or consumers, so you <Indistinct> you have a role. We have a role.

Alice Evans: So we are of course already in the midst of a public health crisis. I think COVID-19 exploding around the world has given us probably a wake-up call about the potential societal and economic impact of a public health crisis, but I expect it's having an effect on the issue of antimicrobial resistance itself and probably impacting the action that is being taken to address it. I

don't know if it's impeding it or accelerating it. Sally, do you have ... What do you see as the impact of the current pandemic?

Dame Sally Davies: The early data that we're hearing is that far more antibiotics are being prescribed nationally because doctors are worried about their patients, but actually inappropriately because although only about 8 percent of patients in one study had secondary bacterial or fungal coinfection, 72 percent of the patients were given antibiotics and antifungals, so we know that they're likely to be overused, and that does give us a worry, but isn't it interesting? Here we are in the middle of this sad and tragic pandemic, and everyone is waking up to the fact that, "Ah, so global health threats impact health, life, livelihoods and the whole fabric of our social structures." They're also seeing that prevention is a lot cheaper than cure, and that you, as my mother used to say when I was a kid, "A stitch in time saves nine." You're better taking action before there are problems, and we're seeing unprecedented global cooperation for COVID across industries, sectors, governments and a shared vision, and that gives me hope maybe we can do that with AMR. It's the first pandemic we've been facing in the digital age, so can we use technology and data to overcome COVID, but also much more in surveillance and in rapid diagnostics for AMR? I would argue that COVID is the lobster dropped in the boiling water pot making a big noise, but AMR is the lobster in cold water slowly heating up, but the impact is going to be even greater. This is a creeping, long-term pandemic, so if we can't make progress now with COVID happening and demonstrating the issues, then it will be tragic for all of us.

Alice Evans: Here's hoping that we can and that even though it's opening eyes to the urgency of the issue and that we need to take a long-term approach, I hope that the economic and logistical challenges that we're facing with the current crisis doesn't obscure that. I think it's clear this is a multifaceted problem, and we can't solve it quickly or once and for all time. It's going to be an ongoing process and involve collaboration of lots of different sectors and people. We've declared an investor year of action on AMR this year in 2020, and I was wondering, why do you think it's important for investors to be giving attention to this issue? What can we do?

Dame Sally Davies: Thank you. I absolutely agree. If this is a problem for all of us for all kinds, then we all have to sort it out, and I think that we've tried a lot from the public sector and through research to understand things, but if you look at how the big changes happen, they're through investor push and consumer pull, and this global threat is like every other. It doesn't respect our borders. If we're going to deliver the sustainable development goals, we've got to have sustainable solutions to our world's biggest challenges, and that's vital to investors because we need effective infrastructure, and we need to protect our shared environment while boosting productivity, and I would argue that our strategies can be made so that we can go forward. We've seen the impact of COVID-19. If investments are directed so as to promote sustainability, whether agriculture, water or healthcare, then investors will gain in the long-term, and antimicrobial resistance not only undermines our ability to treat humans and animal infections, but actually to invest in healthcare or environmental systems, it's going to impact investors, so that's why they need to think now about mitigating risks and making sure that we are all secure going forwards. We've seen the global purchasing habits move away from livestock farms on antibiotics, consumer power behind those. Imagine what we could do if we really put pressure on fast food chains and other food chains to up the standards of food production. In the US, they've got a really great scorecard that helps consumers understand different company policies on antibiotic use in fast food restaurants. It's absolutely changed behaviors, which has changed how those companies behave, which helps us all

over the world. We really need that level of transparency here in the UK and across the rest of the world, and investors help us get ahead of the game, but you can also help us by investing in sustainably sourced goods. We've got the power to make change, and investors can back sustainable practices. The World Economic Forum is doing its great reset. How do we move global economies forward to future-proof their investments and the economies? So what I really need people to do is, as investors and as people, but let's start with investors, integrate AMR into your ESG and your investment decisions. You play a vital role. You can leverage change, and I'm sure it's going to benefit your portfolios and the livelihoods of many, so it really needs doing, and as an individual, wash your hands, be careful and make sure that if the doctor says you don't need antibiotics, you don't argue. You've probably got a virus that antibiotics won't cure.

Alice Evans: Sally, thank you so much. Thank you for sharing your knowledge and your passion on this topic.

Dame Sally Davies: Thank you.

Alice Evans: As investors at BMO GAM, we have taken up the challenge on this topic, and we've been engaging in dialog with companies involved with and exposed to the issue of antimicrobial resistance from pharma to restaurant groups and up the chain to food producers. We as investors are raising awareness. We're emphasizing the importance of the topic to us and trying to better understand where the barriers to action lie, needed trying to use what influence we may have as investors to press for progress, and in these conversations, we've seen really a wide range of responses and degree of willingness and strategic importance given to getting to grips with this issue. Within these conversations, GlaxoSmithKline is a company that we've seen at the forefront of pharma industry action, and for the second part of this conversation, I'd like to introduce our lead analyst on the topic at BMO GAM, Catherine McCabe, for a discussion with James Anderson from Glaxo about their approach. Catherine?

Catherine McCabe: Thank you, Alice. Yes, my name is Catherine McCabe, and I'm an analyst in the Responsible Investment Team covering public health issues, and I've been leading engagement on AMR since the beginning of last year, and we're delighted to be joined by James Anderson, who's the head of AMR within GSK's Comms and Government Affairs function. He leads work to enable the pharma industry to work with partners around the world so that they can continue to produce antibiotics and vaccines, and, James, it would be great if you could explain how you became involved so closely with work on AMR.

James Anderson: Thanks very much, Catherine, and I'm really pleased to be here talking to you. I first came across AMR, antimicrobial resistance, over 10 years ago, and I was fascinated with the challenge that we face as a global society, which is that with most medicines, company invest and then sell them to make a profit, and the better the medicine is, the more of the medicine that gets sold, and the more profit the company gets. That system works well, I would argue, to generate innovation in most areas, but in antibiotics it doesn't work because when you produce a new antibiotic, it should be used very carefully, and that means often in very small volumes to only treat those patients that can't be treated with anything else, and that's because that the more that an antibiotic gets used, so if it's the new one and it gets used a lot, then bacteria will develop resistance to that new one as well. So the model for medicine development for companies like GSK to invest into our pipeline, our R and D works well, but it really doesn't work in the case of antibiotics, so that was a big problem because antibiotics do underpin so many aspects of healthcare, and that was

what attracted me to really try and see if we could solve this one. Clearly over the last few years since then, with a lot of thanks to Dame Sally and others who've led the way around the world to make the changes that are necessary, we have seen real progress, and I look forward to talking about that as we move through the conversation.

Catherine McCabe: Yes, thank you, James. I think it's absolutely true that antibiotics are very unusual in the sense that usually a pharma company would expect to be paid more if more of a particular drug is sold, but in the case of antibiotics, you're absolutely right to say that we need to conserve their effectiveness, and that comes down to responsible use, and GSK has really been a very vocal proponent of new commercial models to try and help reinvigorate antibiotic R and D as we've seen so many of GSK's peers exit from this space, so we really need to create a more sustainable antibiotic pipeline, and it would be helpful if you could share your thoughts on this.

James Anderson: So I think that's exactly right. The current model doesn't work, and yet we need to invest into this very challenging scientific area. We need expert researchers who specialize in studying bacteria and developing antibiotics, and we have to keep this investment going because bacteria continue to evolve and continue to develop resistance to all the current antibiotics that we have, so we will always need new antibiotics in the pipeline. Now, GSK has continued to invest into its antibiotics R and D for very many years. In fact, we've been active in antibiotics since about the Second World War, where we provided significant quantities of penicillin into the war effort, but in recent years, you're right, many other companies have decided for economic reasons to stop. Now, GSK has taken a flexible and innovative approach. We've developed a series of partnerships which include funding from external sources, and that has really helped us sustain our investment continuously over the recent decades. Like many companies, we've had several failed assets, several failed antibiotics that have been in development, but then something has happened and they've not reached patients at the end of the development pathway, but we do now have one that is currently in phase three, so that's the final stage of development and looking pretty promising. The other thing to think about is why it's so hard is that what we need are genuinely new antibiotics, not just ones that are incrementally different, and that's because they are likely to avoid resistance development for a longer period of time, not guaranteed but on average, because the bacteria will not be used in any way to these new antibiotics, so that increases the challenges as well. Now, the good thing is, there is a fair bit of public money going into the early stages of research, which has built out a robust pipeline for early stage assets, but then there's a gap, and that's because the commercial model doesn't work, as we've said before. GSK and other companies over the summer launched the AMR action fund, which is intended to specifically fill that gap for a period of time and deliver two to four of these desperately needed novel, highly novel antibiotics to patients over the next decade, but even with that, that won't be enough to really attract and sustain the investment that we need over the long term into the future. In order to do that, we do need to correct the market dynamics so that really companies that are successful with their investments get a financial return on those investments, so the challenge again comes back to what I said at the beginning, that we need a model that rewards company based on a different value measure for the antibiotic they produce rather than simply the price times the number of packs of medicine that are sold. We've seen a couple of what I think are really promising examples of this starting to happen, both of which involve a type of subscription model, and you can imagine the Netflix type of subscription model where on some months, you may not watch any Netflix at all, whereas in other months you may spend a lot of time watching Netflix, but you pay the same amount each month, and that's the key principle that is being employed both, first of all of in the UK by a pilot that is run

in the UK by NICE and the NHS as well as supported by the government, and also in the US there's a proposal that's really following along very similar lines. We think that could make a very significant difference to the economics involved here, and we're actively involved and hopeful that this will be a concrete step of progress.

Catherine McCabe: Yes, I think that's really interesting, and I think you've conveyed how many positive developments there have only very recently been, and we really hope that all of these different initiatives will help to make sure that their pipeline is sustainable, as you say. There was quite a lot of funding going into early stage antibiotic R and D, but in the latter stages, which tend to be the most challenging stages, they were simply not receiving enough funding, and having the collaboration between different pharmaceutical companies and not-for-profits will hopefully help to create a much more robust picture and bring more antibiotics, which are so urgently needed, to market. And also on the commercial side of things, I think obviously the initiatives you spoke about are still in the pilot stage, but it just goes to show that we have to have innovative thinking to try and solve the economic conundrum that we currently have, and it's great that the UK has been at the forefront of trying to think creatively about such a difficult problem. If we take a step back and think about the antibiotics which are currently available, Dame Sally helpfully articulated to us how there are many different factors driving AMR, including antibiotic residues in wastewater, and it would be interesting to hear your thoughts on how GSK is taking action to mitigate the environmental risks and potentially the public health risks associated with antibiotic manufacturing.

James Anderson: So that is another important area for GSK and for the industry more broadly. Clearly anytime antibiotics get in contact with bacteria, those bacteria start to evolve and develop resistance potentially. Antibiotics reach bacteria in the environment from a number of different roots. Farmers often use antibiotics on their crops or on their animals. As patients or animals that are treated with antibiotics excrete those antibiotics, they also reach the environment, but there is a certain fraction, relatively small but important, that does get released into the environment as a result of antibiotic manufacturing. Clearly that is something that we can and should control very rigorously, and indeed GSK has been taking a very proactive approach to this, so the first thing we needed to do is to develop some very sensitive tests to understand how much antibiotics, if any, were leaking out of our factories. Then we needed to take steps to make sure that that stopped, and indeed this has been the process that we've been going through over the last few years, and I'm pleased to say that we're really near the end of that journey, and then the third key thing is to make sure that our supply chain, so the suppliers of some of the chemicals that go into our medicines, also have those same rigorous sets of standards involved, so we are now very actively working across our supply chain in order to make sure those standards are fully applied. I think the last thing I'd say here is that the industry has come together to form an AMR alliance which has set a set of common standards to how this manufacturing should be done. Now, that covers about 40 percent of the total antibiotics that are produced around the world. That means obviously there's the rest, the other 60 percent which come from companies, often smaller ones, often localized that haven't signed up to hitting these very tight targets, so one of the things we think is important is that the larger procurers of antibiotics such as the NHS actually start to distinguish between antibiotics that have been made responsibly from those that haven't. We think that will really encourage those remaining companies to step up their efforts to reach the high standards that all the Alliance companies are as well.

Catherine McCabe: I was very interested indeed to read about the AMR Alliance's work, and I think what's key with what GSK has done, as James explained, is to really take ownership of not only its own sites manufacturing antibiotics, but also the sites of its suppliers, so when you have both sides of the equation adhering to their limits which have been agreed, then hopefully you can really mitigate the risks associated with manufacturing antibiotics, and I'd just like to talk about now, once antibiotics are actually in circulation for people to use, once they're on the shelf, stewardship is absolutely key, and it's something we've touched on in this conversation, and we use the term "stewardship" to describe effectively measures to prevent the overuse and misuse of antibiotics, and it would be great if you could shed some light on how GSK monitors resistance patterns to antibiotics, and how can you use the data gathered to help ensure that timely action is taken to combat AMR?

James Anderson: I think that's right. There's a package of actions that the system needs to take in order to make sure antibiotics are used carefully, and that system absolutely needs to include healthcare professionals, pharma companies and all the other stakeholders who are involved, so what GSK does really is two things. First of all, we do conduct a pretty broad-reaching surveillance program, which means we take samples of bacteria from hospitals and from patients around the world and then analyze them to understand the patterns of resistance that may or may not exist, and the second thing we do is, we work through our sales reps and our medical teams again all around the world to help explain and educate doctors about, first of all, what the resistance patterns may look like in their local region, but secondly, how our products should and should not be used in different types of patients. Clearly a lot of antibiotics are used for patients with respiratory infections, which often are coughs and colds, and oftentimes those are actually caused by viruses, not bacteria. Distinguishing between the two is very tricky, but being clear, as clear as we can to help doctors make that distinction we see as a very important aspect of our overall programs.

Catherine McCabe: Obviously looking to the future, we need better conservation of our existing antibiotics as well as a pipeline of new antibiotics, and certainly what I hadn't realized before preparing to engage pharmaceuticals on AMR is how challenging it is from a scientific perspective, and this is something we touched on at the beginning of our conversation, to actually find new antibiotics. I think we're almost lulled into a sense of false security on this because antibiotics are so commonly used, it's difficult to bear in mind actually that there are enormous challenges and actually breaking through bacteria's defenses and finding substances which are toxic to bacteria but not toxic to humans, and it'd be helpful to hear your views on where you see the most progress being made in antibiotic innovation.

James Anderson: I think the first thing to talk about is actually how amazing bacteria are. They've been around for billions of years. They have evolved to be able to exist to live in the harshest environments on the planet, whether that's in the Arctic, whether it's in volcanic vents under the ocean as well as, of course, on humans and every other species that exist, so the other fact I always think is amazing is that the human body consists of about the same number of bacterial cells as it does of human cells, and of course there are many, many, many different types of bacteria, some of which are helpful to us and some of which are harmful or some of which can be harmful if they get into the wrong places. They also, if that wasn't enough, they also create ... They've got various defense mechanisms that they use to avoid the harmful effects to them of chemicals like antibiotics, so all that's to say, bacteria are pretty amazing. They're a tough threat to manage, and that's part of

the reason why it is very tricky to come up with chemicals that are strong enough to overcome all of those challenges, but as you say, don't harm the patient. Now, a number of different new approaches are being pursued that range from new, often genetically defined targets within bacteria that can lead to new chemicals, so new types of antibiotics with a different function, different way that they work inside the bacterial cell. There are also what we call larger molecules, so things like monoclonal antibodies that are also being used against COVID, of course, of moment, which would offer a different type of therapeutic approach, but the one I think is quite fascinating is what are called bacteriophages. These are a specific type of virus that only kill bacteria, and they often are very selective which bacteria they kill as well, so there have been efforts, not yet sufficient in my opinion but growing, to identify those bacteriophage, develop them up in the right quantities and be able to deliver them to patients as a completely new mechanism to kill the bacteria that are infecting those patients. I should say it's not completely new because in a few countries, in particular Russia, they have been using this type of approach for a while, but it has never been developed in the rigorous way that we would expect it to be done before it can be used widely in Western countries.

Catherine McCabe: That's very interesting, James. Thank you for giving us an overview of the key areas of progress. It just goes to show we really shouldn't underestimate bacteria, and that we are less human than we thought. I think this is such an exciting space to watch, and we'll obviously see a great deal of exciting progress hopefully over the medium and long term. I think the final point we wanted to discuss with you is obviously, hopefully we see new antibiotics coming into the market, but we absolutely have to acknowledge that we need to reduce our dependence on antibiotics in the first place, and there are various ways we can do that, and one key piece in the puzzle is vaccines, and you may not already know this, but GSK is one of the world's largest vaccine companies, and it would be interesting if you could explain how vaccines can actually help to prevent antibiotic use as well as saving millions of lives across the world.

James Anderson: That's exactly right. Vaccines do already play a very significant role in this and have the potential to do even more in the future. So by protecting people from becoming infected in the first place, of course there's a direct reduction in the use of antibiotics that are needed for those patients. If you don't get infected, you're not going to need a treatment, so that applies to vaccines for bacterial infections such as strep pneumoniae. There are also vaccines that prevent against other types of disease, including viral diseases, flu for example, that by avoiding those diseases, often antibiotics are used incorrectly to treat patients with flu, for example, so by reducing the number of those patients or reducing them going to see the doctor, you also reduce the amount of antibiotics that get used, thereby helping slow resistance. There's some really exciting development in this area because as the vaccine technology has been advancing, and again as we've seen with COVID currently, some of the new technology approaches really open up the possibilities to create vaccines to more of these targets, particularly on the bacterial side, but very much on the virus side as well, and that could increase the proportion of infections that we can potentially protect people against in healthcare systems. So an example of that would be often people who go into hospital for a surgical procedure will be given antibiotics prophylactically ... that means in advance. They don't have an infection, but it's to make sure they don't get an infection, but what would be better really is if we had a vaccine that could be given to those people instead. Then we wouldn't need to use the antibiotics for them. They'd be protected by the vaccine. They wouldn't get the infection, and yet we would save ... We would avoid the use of antibiotics, so vaccines already play a massive role around the world in protecting people from these infections in reducing the amount of antibiotics that do

get used, but there is certainly more that can be done there, and GSK is very actively working on our pipeline with some very exciting new vaccines that we hope will be given to patients in the near term.

Catherine McCabe: That's great to hear, and I think it's absolutely true obviously if we can tackle both viruses and bacteria using vaccines, then we'll have fewer people going to the doctor, because unfortunately at the moment, and I'm sure we're all familiar with this, when you go to the doctor, say, with a cough, it's very unusual to be given a test to work out whether your cough is being caused by bacterial infection or a viral infection, and reducing antibiotic use to treat viral infections is absolutely key, and so vaccines play a vital role there, and we'll also see the developments in the diagnostics space on this front. So I think that's all we have time for today, unfortunately. I know we've covered a lot of ground, but, James, it's been absolutely wonderful to hear your insights on all of the different aspects of combating AMR that we've covered and to hear the work GSK is doing on this front, and we really hope that you can continue to be a leader on your work on AMR.

James Anderson: Great talking to you too, Catherine, and again, thanks very much for inviting us onto this podcast.

Catherine McCabe: Thank you.

Alice Evans: Thanks so much, James, and thanks, Catherine. I've really enjoyed this conversation, and I think there's a lot of work to do, but a lot is being done, and I'm really excited that we're going to get somewhere with this really important issue.

Michael Torrance: Thanks for listening to "Sustainability Leaders." This podcast is presented by BMO Financial Group. To access all the resources we discussed in today's episode and to see our other podcasts, visit us at bmo.com/sustainabilityleaders. You can listen and subscribe free to our show on Apple Podcasts or your favorite podcast provider, and we'll greatly appreciate a rating and review and any feedback that you might have. Our show and resources are produced with support from BMO's marketing team and Puddle Creative. Until next time, I'm Michael Torrance. Have a great week.

Legal disclaimer: The views expressed here are those of the participants and not those of Bank of Montreal, its affiliates or subsidiaries. This is not intended to serve as a complete analysis of every material fact regarding any company, industry, strategy or security. This presentation may contain forward-looking statements. Investors are cautioned not to place undue reliance on such statements as actual results could vary. This presentation is for general information purposes only and does not constitute investment, legal or tax advice, and is not intended as an endorsement of any specific investment product or service. Individual investors should consult with an investment, tax and/or legal professional about their personal situation. Past performance is not indicative of future results.