JPMorgan Healthcare Conference

Company Participants

- Chad M. Robins, Co
- Peter Lee, Unknown

Other Participants

- Tycho W. Peterson, Senior Analyst, JP Morgan Chase & Co, Research Division
- Unidentified Participant, Analyst, Unknown

Presentation

Tycho W. Peterson {BIO 4279327 <GO>}

Okay. I think we're going to go ahead and kick it off. Thank you, everybody, for coming. I'm Tycho Peterson from the life sciences team at JPMorgan. Today, we have a very interesting panel. We have Chad Robins from Adaptive Biotechnologies, one of the founders; and Peter Lee from Microsoft.

Questions And Answers

Q - Tycho W. Peterson {BIO 4279327 <GO>}

I think to kick it off, maybe I'll just ask each of you to give a little bit of an introduction. Maybe, Chad, talk a little bit about Adaptive, the role the company plays and why sequencing in the immune system is important?

A - Chad M. Robins {BIO 17183354 <GO>}

Sure. And Tycho, thank you for having us, we appreciate it. Adaptive characterizes cells of the adaptive immune system at a very precise and exquisite level. You have these attacker cells, which are pathogens that come into the body. And then you have the defender cells of your immune system. The primary defender cells are T cells and B cells. And their job, it is to bind to kill and then remember these foreign perturbations that come into your body. And what's unique about these immune system cells is that their DNA actually rearranges. And what we're able to do is we're able to use next-generation sequencing technologies to characterize and read this DNA at a very exquisite level. And now the goal and the vision of Adaptive is to translate the precision and scale of the immune system to diagnose and treat disease. We have a first commercial product in blood cancer. It's called clonoSEQ. And that's for measuring minimal residual disease or to be able to predict relapse or whether or not that cancer is gone after a treatment. And we have a pipeline of diagnostics related to this concept of whether your immune system is competent or

not. And I'll save the discussions on the partnership and the antigen mAb after Peter does his introductions.

A - Peter Lee {BIO 1416324 <GO>}

Great. And let me add my thanks, it's really great to be here. And I'm just thrilled to be in this great partnership with Adaptive Biotechnologies. I'm Peter Lee. And I'm a Corporate Vice President at Microsoft. And I run an organization that was created by Satya Nadella and Harry Shum shortly after Satya took over as the CEO. Internally, it's called NExT. And our organization has deep ties and reach into Microsoft Research. And we can be viewed as kind of internal venture fund that is supposed to spark new projects and empower teams through a disciplined investment process to grow into new product engineering teams and new lines of business for Microsoft. So that's essentially our mission. Our focus areas traditionally have been in silicon futures, particularly silicon strategy and technologies for the data center, for the cloud and also in AI machine learning. And not too long ago, Satya Nadella asked us to take on health care strategy for Microsoft. And so we've been on the hunt for the smallest set of partners where we can really go deep on research and development and really make a difference in the world and bring new product and business ideas to the fore. Then so Adaptive Biotechnologies is really very, very much top of mind and just an incredibly thrilling and important partnership for us.

Q - Tycho W. Peterson {BIO 4279327 <GO>}

Do you want to talk a little bit about how the partnership came about? Obviously, you're both based in Seattle. But maybe what's the history and what led you to Adaptive in your search.

A - Peter Lee {BIO 1416324 <GO>}

Do you want to start?

A - Chad M. Robins {BIO 17183354 <GO>}

Sure. Sure, I can get started with that. So I should say this has been a long-term vision for Adaptive. We spun out of the Fred Hutchinson Cancer Research Center in 2009. I founded the company with my brother, Harlan Robins. And he has -- had a long-term vision that you could use the immune system to diagnose disease, perhaps as a universal diagnostic for many, many years. Although it took us probably close to a decade to develop all the chemistries and technologies and informatics that led us to believe that this was possible. And so over the course of the last two years, we put the final piece together, which we'll explain in more detail in a minute, that links up those immune receptors to the pathogens that they bind to and getting that functionality of your immune system receptors. And so that led us to say, hey, we can start filling out this map of your entire human adaptive immune system, or what we call the immunome. And we can start filling it out with chemistry. But what we realized is that it would take some very, very sophisticated machine learning and cloud compute power to truly get at this problem and to be able to impact patient care. So we set out and we started talking to a variety of different partners in the big data, large market cap, machine learning experts. And I think some of the assumptions that we went into in our discussions were change based on the partners

that we wound up talking to. And Microsoft had this just deep commitment to doing this, to really putting resources in. I'm not just talking about the financial resources in terms of investment, I'm talking about the resource commitment from an FTE perspective. And they had the capabilities, it was the team. There was an incredible synergy between members of the team at all levels. Starting with Peter and I, who happen to have season tickets, a couple of seats away from each other at the Seahawks, to the scientist level, from the technology level to even at the board level. There is all these connection points. And this kind of massive commitment to say we're in this -- we're not only in this right now, we're in this for the long term. We want to make this the cornerstone. Peter convinced me. And I had many discussions with the executive leadership team, his team at Microsoft, that this was going to be the cornerstone of Microsoft genomics efforts because they could differentiate their strategy based on going after a very tractable problem, which is the differentiating around immunomics and sequencing the adaptive immune system. So this deal has been in the works for several months. And I think we couldn't -- I echo Peter's comment, we couldn't be more trilled to have Microsoft as a partner.

A - Peter Lee {BIO 1416324 <GO>}

Yes. We got a lot done during halftime at the Seahawks game. When you think about, from the perspective of Microsoft, what reason do we have to be in the world of health care? It's just a huge, vast ocean. In fact, I joked that when Satya Nadella asked us to take this on, I felt like he threw us in the middle of the Pacific Ocean and ask us to find land. I mean, where do you go? And so you quickly -- from Microsoft, you quickly start to focus on, well, where will the cloud and where will AI matter. And that starts to take in the discussion about possible precision medicine futures and now the fundamental technologies. And that quickly gets you into the genomics space and omics space. And so of course, there are big players there already. And so it doesn't fully kind of rationalize our reason to be in this space. And so we started to ask the question, well, where could we really kind of go deep and be best-in-class and really gain some confidence in this space. And that got us into a broad-ranging discussion. But one thing that rose to the top was, all of the interesting scientific and commercial work going on, generally speaking, in and around the immune system. We actually had, through Microsoft Research, some interactions with Harlan Robins and other scientists at Adaptive biotechnologies and at the Fred Hutch. Our relationship with the Fred Hutch gave us more insights. And one thing led to another. And we were consistently led to Adaptive Biotechnologies as being the leader in this space. And so as we started to interact, we just arrived at this, just to this incredibly beautiful -- from our perspective, incredibly beautiful -- scary big. But incredibly beautiful machine learning problem that if really directed in a focused way with a lot of engineering finance and engineering excellence, it could really solve some important problems. And it just really went from there. It was then left to Chad and me to get creative on the deal structure. And as Chad mentioned, it took a few months but we got it done.

Q - Tycho W. Peterson {BIO 4279327 <GO>}

And maybe let's look ahead a little bit and think what's your vision for the collaboration. What do you think it ultimately could mean for patients at the end of the day?

A - Chad M. Robins {BIO 17183354 <GO>}

So let me give you the longer-term vision. And then let's back it up into tangible near-term milestones because I think it's important to separate the 2. The longer-term vision is that based on a blood test and based on understanding your immune receptors and the antigens that they're binding to that we can diagnose multiple diseases at one time. If you think -- I think about the immune system as -- or this project, there's an x-ray for the immune system or a molecular stethoscope. We will get there eventually. That's not currently how the agency, how the FDA and how the payer community work. So in the shorter term, we want to break this up into going after what we call low-hanging fruit, unmet medical needs, diseases that are extremely hard to diagnose that are either slow, invasive. They're done more by a rule-out test. Let's take multiple sclerosis, where you're doing 50 tests to determine what you don't have and then settling on a disease diagnosis of what you do have. This is more of a rule-in test, where you know at a molecular level. If you have that immune receptor or combination of immune receptors, because those immune receptors are specific to the antigen that they bind to and because that antigen is specific to that disease, we know that we can potentially diagnose that disease. So if you think about areas, hard-to-diagnose auto immune disease and certain chronic pathogens perhaps. And I'm using this more as examples because we're coming up with a prioritization matrix of the disease states that we want to diagnose first. But if you think of things like Lyme disease, even in the cancer space, if you look at the high-risk populations, we would narrow that down. We wouldn't say, hey, let's go after general screen first. We would more say, let's target BRCA-positive, 40-year-old-plus women for ovarian cancer, whereas a diagnosis at Stage 4 is fatal. But if we were able to diagnose that at an earlier stage, there's kind of a massive patient benefit. So yes, that's really kind of how we think about it. We also think, though, that if you look at some of these screens of biological systems, such as the x-ray or the MRI, they weren't initially indicated as a screen of a system, they're indicated for a specific use. So we believe. And we look forward to working with our partner, Microsoft. And working with the agency, working with the payer community education, to kind of over time, as we layer in diagnostic after diagnostic after diagnostic that, ultimately, we can get this to be a screen for the entire system. Actually, I'll leave it at that, I've got a couple of more comments. But...

A - Peter Lee {BIO 1416324 <GO>}

Well maybe I can just add to your question about how does this partnership work. There are 2 -- at least 2 components, important ones there. One is how are we working together to develop the technology, advance the science and develop the technology. And the other part is, what is the business arrangement that we have. And those are 2 very important things that we've had to put a lot of thought into. On the technology side, roughly speaking, you can think of 3 components. One is data and, ideally, label training data and, super ideally, a hell of a lot of it. And that's really important. And what is extremely impressive about Adaptive Biotechnologies is that they have large amounts of labeled and unlabeled data but also the ability in a really high throughput way to generate more labeled data, super important. Second is algorithms for machine learning. That's something that we're very proud of, our capabilities and our contributions. If you go to half the Silicon Valley startups trying to do any kind of imaging, by and large, they'll be running REsNet 50, which came directly out of our labs. And we have much, much more sophistication in a cloud

scale to bring to bear on that. Then ideally, if we put these 2 things together, we get models, machine learning models, that give you the basic AI intelligence. And so we have just almost a perfect working relationship where there's data, there's algorithms and then turning those models into diagnostic tools and technologies as it goes back to Adaptive Biotechnologies. I think that's a very, very nice and comfortable and clean setup. Then on the business side, we're trying everything we can to just keep this as clear and simple with respect to intellectual property, with respect to go-to-market, with respect to Adaptive's future business prospects and success, try to keep things as clean and clear as we can. Then that just liberates our engineering and development teams to be unencumbered by any complications, just focus and get the work done.

Q - Tycho W. Peterson {BIO 4279327 <GO>}

I think one of the advantages, I think, of your assay technology is the ability to look at retrospective data sets. Is that something you leverage here in this partnership?

A - Chad M. Robins {BIO 17183354 <GO>}

Absolutely. One of the things -- we've designed our assay to be able to characterize retrospective samples. I think that's a huge advantage for us as we develop the training set data. We can do that at scale. And we can do it quickly. So the technical term, if you look at how samples are stored and especially in the cancer setting and formalin fixation, FFPE sample, we -- the assay does work on FFPE. We don't need fresh samples, we use DNA as an analyte. So there's many, many different reasons why we can move rapidly to develop really massive quantities of data that Peter and team can then apply their machine learning algorithms to, to hopefully get us to an answer quicker.

Q - Tycho W. Peterson {BIO 4279327 <GO>}

How do we think about time lines here? And as we think about maybe some initial milestones and then, ultimately, commercialization around some of the initial disease states, how far out is that? Is that a couple of years?

A - Chad M. Robins {BIO 17183354 <GO>}

I look at the first set of diagnostics being kind of the 3 to four years' time line. I think this concept of a universal diagnostic and working with the agency and the payer community is probably more a decade out. But I think one other comment on why Microsoft is really a great partner for us is they have a commitment to shipping product as do we. We've already commercialized their first diagnostic. We have other diagnostics in the pipeline related to immune competence. And we were very keen on not having this be some mega moonshot that says, hey, maybe 10 years later, we're going to have something. We believe that it's a tractable problem and that we can make significant headway in several disease diagnostics in the short term. And short term being a 3; to 4-year time horizon.

A - Peter Lee {BIO 1416324 <GO>}

And in terms of shipping product, there may be 2 comments to make there. One is the scale of the machine learning problem that we're talking about is literally web

scale. And that's a fairly daunting prospect. It's not unknown to us. Our team has done a huge amount of machine learning foundational work that is actually present in the Bing search engine, for example. So we're confident about our ability there. But we are also cognizant of the fact that to get to that level of scale, you have to start from the first day addressing and ensuring the level of kind of engineering precision and excellence. You can't bolt that on later. And just in terms of innovation process, just speaking out purely as a manager, the nice thing about that is then that guarantees, from the first day, that you are thinking in terms of product and shipping quality. Super important. The other thing to say is, remember for me and Microsoft, this is part of our cloud and AI imperative and it's also part of trying to think about what is our role broadly in the genomics space. And so these sorts of activities really give us also a broader kind of reason to be exploring things. It has led us to other partnerships and investments. And so we also entered into an agreement with G&A and Nexus, for example, including an investment. And we can already see that, that partnership also leads to more and more kind of sparking of innovative ideas. So in a way, it's almost perfect for us. If you think about my organization, there is the sort of awe-inspiring moonshot of this universal blood test. It's just super inspiring, attracts talent like crazy, at the same time, what we see as a prospect of a steady stream of intermediate products coming out of the pipe. Just very few times in my career have I been in a situation that has had that combination quite like this.

Q - Tycho W. Peterson {BIO 4279327 <GO>}

Maybe you could touch on the regulatory and reimbursement side of things. You alluded to that earlier. It's an evolving landscape. We had a panel earlier this week on a dual pathway. We've seen Foundation and Exact go through that successfully. I'm just curious, when do you start to think about payer engagement and how you think about the regulatory side of things, too?

A - Chad M. Robins {BIO 17183354 <GO>}

Sure. You can't start, either regulatory or payer engagement, early enough. I'll say that. And I do have to say the diagnostics industry has been challenging because of the fact that there is no universal payer coverage. You've got the government payer coverage, Medicare, Medicaid. And then you go kind of one by one on the private payer side and there's tech assessment bodies, et cetera. It's a very complex web to navigate. That being said, we're encouraged, I think, the dual-track pathway, with the next-generation sequencing, natural coverage decision that you're referring to for Medicare. And really the mentality around how the FDA is thinking about problems is, in the last year, kind of with the new -- with Scott Gottlieb at the helm, has been incredibly, I think, impressive. We're also seeing on the payer side as well a willingness to engage in dialogue earlier than has been previously. So it will take a lot. This concept is -- I think there's 2 components that are challenging about the concept. One, we alluded to earlier of having kind of this screen of a biological system but at a molecular level. That's a challenging concept. I also think -- but at the end of the day, your -- the immune system is a beautiful system to be able to do that. And so I think -- again, I think it's the early engagement. And we're encouraged.

A - Peter Lee {BIO 1416324 <GO>}

We're counting on you guys, too.

A - Chad M. Robins {BIO 17183354 <GO>}

A lot of challenges.

Q - Tycho W. Peterson {BIO 4279327 <GO>}

How about as we think about kind of the practical implications from a patient perspective, data interpretation, what is the treatment paradigm ultimately look like for patients if they're getting diagnosed earlier on? How do you think about that side of it, early diagnosis? And potentially, there may not be an established treatment paradigm for some of these areas.

A - Chad M. Robins {BIO 17183354 <GO>}

Yes. I think that's a great question. And I guess more simply put is what are you going to do with the information if you have it. And I think there are certain disease states, high-risk disease states, where there's a clear unmet medical need. And there is a clear kind of translation of that information into actionability. And so clearly, if you diagnose certain cancers earlier, you can take that information and cut out the tumor, start treatment earlier. I think clearly, in certain autoimmune disorders, if you had that information earlier, you could get on the right treatment. And this all goes to this concept of precision and personalized medicine to say let's get the right treatment for the right patient at the right time. There are certain areas that are fraught with kind of political considerations and questions. And frankly, I think perhaps you stay away from them at first until there is -- information for the sake of worrying people, I'm not sure is the place to start. That's -- unless there's a treatment that you can do something about it, I think we start in those areas first where there's kind of a clear clinical utility, clear actionability. Then as things develop, as new medicines develop, we can talk about layering on the additional diagnostics.

A - Peter Lee {BIO 1416324 <GO>}

Yes. Just a little bit on a tangent. I've actually -- one conversation that Chad and I have had several times pertains to the research and development program and what things are we going to target first and what is the rationale for doing that. And so there are -- if you talk to the machine learning folks, there are certain criteria and certain way of thinking about it, same thing comes out of the biology side. But there is also a third component, which is the business side and the need to be creative and inventive and cognizant of the regulatory landscape on that. And so you sort of want a framework where you're taking into account all 3 of those things in order to frame the decision process about what are our targets, in what priority or order and how do we focus our teams that way. And that's an ongoing discussion that, I think, is going to give us a lot of insight. One thing also, when you're at a conference like this one, I'm sure it's much more for you than for me. But even I get an earful from stakeholders who have their own suggestions and thoughts about where we should be, how we should be targeting our things early on. Then so all of that is sort of input. And I think we'll have an interesting time trying to decide basically what is the priority list.

Q - Tycho W. Peterson {BIO 4279327 <GO>}

Can you talk a little bit about the type of data you're going to be collecting? I think you're also collecting phenotypic data, outcomes data. How do we think about the data side of it?

A - Peter Lee {BIO 1416324 <GO>}

Right. So there's -- there are already some very interesting data sets that Adaptive has access to in terms of antigens, in terms of blood bank samples, blood bank samples correlated with specific disease states. And then that technology to take naive samples, inoculate them and, in that way, generate remarkably high rates of new label data sets. And so I think of those things as a combination of both labeled and unlabeled training data or corpuses. Now one thing that I've been instructed to do is not assume too much knowledge of machine learning. And so to put it very simply, machine learning, the way that we're conceiving of it, which is a deep learning paradigm, has 2 phases: the training phase and then an inference or execution phase. And the data assets that Adaptive has and is able to create give us a gold mine for that first training phase. And so what we're able to do even with the unlabeled data sets is start to do automated feature extraction at large scale. That will be informative and drive up the accuracy of other inferences for whatever diagnostic applications we come to. And so the kind of data privilege that we have in our hands here is just very, very, very important for the whole program, at least on machine learning side. One other thing I wanted to say. And this has more to do with culture and agility. Being Microsoft, we do get into a lot of partnerships with grand plans to extract insights from data. And probably, many of the organizations represented in this room do this also. Generally speaking, after the decision is made to go with those things, it gets to be a frustration in the delays to overcome the technological, regulatory and strategic hurdles and actually get the data into the hands of data scientists and machine learning researchers. The thing that I found so exciting here is, literally, within 2 hours after signing the partnership agreement, Adaptive had significant data sets in the hands of our machine learning researchers. And I think within 2 hours after that, we had some pretty deep questions back to Adaptive. And so just that level of agility, again, just reinforce the reality of the significant data assets that we have to work with.

Q - Tycho W. Peterson {BIO 4279327 <GO>}

How about from a patient consent perspective? I mean, do you need patients to kind of opt in to the development path here? We had a panel yesterday with 23andMe, they talked about the high level of patient engagement they have as they've kind of gone down their own path on drug development. What level of consent do you have for payers in this -- patients in this process?

A - Chad M. Robins {BIO 17183354 <GO>}

Well there's 2 different stages of data development and generation. The first, in terms of -- we can actually buy these massive leukopaks, basically they drain people with blood. We can create these huge pools of naive receptors, transfect and challenge them with different antigen presentations, basically the disease or the pathogen that they bind to. Then we can use our sophisticated suite of technologies and start filling out the map. And we don't need patient consent for that. Then secondly, there are...

A - Peter Lee {BIO 1416324 <GO>}

By the way, let me interrupt you. I want to say one of the things that, first, for us and for both of us is we're learning each other's language and lingo. One thing I will never get comfortable with, I hope, is the lingo of draining someone's blood. I just wanted to get that straight.

A - Chad M. Robins {BIO 17183354 <GO>}

We don't (toggle it), we buy it, although -- on many of our own experiments in the early days. So -- but then secondly, we're going to sequence well-characterized disease states. For example, one of the data sets that we're targeting is the Women's Health Initiative. And this is 30 years of very well-characterized data with the clinical data associated with the underlying molecular data sets. And the patients' consents -- in many, many cases, the patient consents have already been done for us. So that being said, it's clearly an area where our general counsel and legal and we make sure that we have the kind of right consents. Anything we do prospectively, we absolutely have to make sure that we have patient consents to be able to do this work on.

Q - Tycho W. Peterson {BIO 4279327 <GO>}

Is there any therapeutic angle here potentially around discovery that can be leveraged into drug development that you can partner up with? Or...

A - Chad M. Robins {BIO 17183354 <GO>}

Absolutely. That's the hope. I think the first step is for pharma and biotech companies to better understand how their therapies are impacting patients. And I think, actually, this is a good time to mention. And I think it relates to your timing question, what's important to note is, we already developed the delivery mechanism to be able to perform these tests. So there's really 2 components of it. One is creating this massive map, which crosses all of your attacker cells to your defender cells or your T cell receptors to your antigen. And it's like a huge VLOOKUP table in Excel. And the second component is when a patient walks into a doctor's office and gets his blood drawn and then sequenced. We've already developed and perfected over the course of eight years this bulletproof technology to sequence a patient's immune receptor. Once we have that, the idea is then you can map those receptors to this massive data table and have, knowing if you have receptor 2, 18 and 9 billion, that, that those correspond to. And are specific to, I should say, let's take Lyme's disease. So I think that gives us kind of that head start to say, hey, this isn't a theoretical exercise. Once the map is created, it's just truly a matter of leveraging it with the core technology. And Tycho, what was your question again because I don't think I answered it?

Q - Tycho W. Peterson {BIO 4279327 <GO>}

We'll go back to it. What about the risk of over diagnosis, labeling healthy individuals as patients due to false positives? How do you think about that aspect where you have situations where the immune system can naturally correct and you don't necessarily need intervention? How do you think about that in this process?

A - Chad M. Robins {BIO 17183354 <GO>}

Yes. So we've been having a lot of discussions on this. And it's a better question for Harlan to engage in. But I think -- first of all, we're doing a lot of work on this right now. And I think there's a lot of dogma in the field that happens to be incorrect. But if you think about your immune -- let's take your immune system and the properties of it to begin with. And then maybe we can kind of back into the question. So your immune system is actually the best natural diagnostic, right? It's job is to take a very small perturbation and amplify the signal, okay? Other aspects of it: it's highly specific, it's highly accurate and it's highly systemic. So you should be able to pick -- it's not a localized reaction. So you should be then able to pick it up in the blood. Now the question of whether -- and there's different types of immune system cells. And they go through different stages in terms of their immune cascade. The question of whether you have an immune reaction that you're picking up early that's leading to an incorrect treatment decision, I think the jury is still out as to whether the immune system is actually doing that at a level where -- once we're able to pick it up, we believe that it's already done its job. And you actually do have that disease.

A - Peter Lee {BIO 1416324 <GO>}

It's a really -- from a computer science perspective, this is really an interesting question and will be one of the things that we'll be mostly anxious to learn. One of the things in deep neural nets turns out to be that you don't actually get black and white answers, yes or no answers. You get confidence levels or signal strengths, just codified in terms of neural activations in the deep neural net structure. And so it's not the case that you get, yes, 100% Lyme's disease or no, you will get 97% confidence that it's Lyme disease. It's also possible to get conflicting signals of these things. And so exactly what will be common and how that information then is taken into a diagnostic regime I think is actually one of the most interesting aspects of this. One of the steady things then to realize is that the machine learning models are a little bit like living entities in and of themselves. The more data that we can feed, the more clarity in those ultimate signals that we get. And so this has also been an evolving point here. And in a way, another element that I think is so exciting here is when we are thinking about this sort of deeply embedded artificial intelligence into these tools, we are entering into a regime where the kind of accuracy and precision of the answers given by these tools evolves and ideally improves over time.

Q - Tycho W. Peterson {BIO 4279327 <GO>}

Where do you ultimately see the immune screening technology on the universal panel side once you have it out, settling out? Is it a primary preventative screen? Is it something for patient selection for a clinical trial? I mean, how do you see ultimately the use case when you do have the universal test?

A - Chad M. Robins {BIO 17183354 <GO>}

Again, I think that's a matter of time horizons and breaking it up into kind of tangible milestones over time. I think the goal would be to have it be a checkup at your doctor's office, every time you go in and have your blood drawn that you would have your immune system sequenced. If you think about it this way, Tycho, your immune system should know what you have -- what diseases you have before your doctor

does. So we've talked -- in the field, we've talked about this cancer immunotherapy and the term harnessing the power of the immune system to kind of fight cancer. This is really an immunodiagnostic, it's really you're harnessing the power of the immune system to diagnose disease. And it should be able to tell you, your doctor before. And that's where I see it going, in the longer term kind of -- but in the shorter term as you start kind of layering on disease diagnostics, I think they'll be kind of specific to different disease states. Again, hard to diagnose autoimmune disorders or chronic pathogens, a high-risk cancer patient, et cetera. Then it's a matter of letting the data -- we're an extremely data-driven company. And now we have a very high-powered machine learning data partner. And some of it is truly a matter of letting the data drive and tell us what this is actually capable of.

A - Peter Lee {BIO 1416324 <GO>}

I (sure love) the concept of a blood test that everyone takes every year, talk about a way to very clearly drive cloud consumption. I think it's as simple as that for us.

A - Chad M. Robins {BIO 17183354 <GO>}

It's also going to be good for patients.

A - Peter Lee {BIO 1416324 <GO>}

Indeed.

Q - Tycho W. Peterson {BIO 4279327 <GO>}

Pater, can you maybe talk a little bit about other tools that Microsoft has in its disposal that you developed that can be brought to this partnership?

A - Peter Lee {BIO 1416324 <GO>}

Right. I've mentioned before that, well, a big part of our team and our internal investments has been in silicon innovation, silicon strategy. And some of you might be familiar with the fact that Microsoft has -- in fact, the cloud business has been very rapidly evolving the silicon computing fabrics in the cloud. We're entering into what is -- what we refer to as the post-CPU era as silicon scaling is hitting certain limits. That infrastructure, just looking ahead to the future, is likely to become very important for the kinds of workloads that we're contemplating here. Having customized ASICs, reconfigurable computing fabrics. And having these things embedded in the network infrastructure of a cloud, of a global data center, all of those things, I think, are going to end up being -- if we meet with any amount of success, we'll be approaching a scale where those things are important. We already see that within Microsoft, for example, in the Bing search engine. If you use Bing in North America, you may not notice. But your web search results are being ranked entirely in the network of our data centers, not in the computing cores, in the data center blades. And that just happens for a whole host of technical reasons driven by scale. And we're really contemplating the same scale here with Adaptive.

Q - Tycho W. Peterson {BIO 4279327 <GO>}

As we think about the way this partnership is structured, is there room to expand it over time? How do you think about the partnership evolving? Are there -- is it (inaudible) in the disease areas?

A - Chad M. Robins {BIO 17183354 <GO>}

So absolutely. I mean, I think, first and foremost, the structure of the partnership where Microsoft allowed us to keep all of our assets together by making an investment in the parent company. And then on top of that, providing the resource commitments in terms of their people and expertise, I think, is very, very important. Second, if you look at the size of the problem and the dollars that it's going to take to be able to truly solve it, we're partially funded for that. But depending on the results that we see. And I'll let you speak for yourself in terms of kind of additional down the road interest in kind of moving forward at a greater scale. But we -- absolutely, we've been really looking at this as a long-term partnership. And that was -- if you look at our assessment criteria. And one of the reasons that we chose Microsoft to partner with was their long-term orientation around this. We actually don't know the true cost of what it's going to take to sequence the entire immune system. But you can start filling out this puzzle and make significant headway. But because of that issue actually that you asked me about earlier, about being able to use the technology on retrospective samples, we're able to do this at a fraction of the cost of some of the other technologies and strategies out there that are going after early detection, for example. We're talking in the low hundreds of millions of dollars as opposed to the billions of dollars. And that's meaningful not just in terms of a cost perspective but also in terms of a timing perspective which, by the way, dovetails into that question of kind of that false positive issue that you are bringing up. And when you start looking -- one of the reasons that if you look at -- for example, looking at peripheral mutations of the -- look in cancer genomics itself, having to run kind of large-scale prospective clinical trials, part of it is in relation to the type of sample those types of technologies work on. The other has to do a signal-to-noise problem, whereas if you're really trying to catch a disease at its earliest state, the tumor has to shed enough stuff, peripheral mutations, that you're able to pick it up. So you're truly looking at -- you have a needle in the haystack problem. That being said, I really hope that some of these companies solve it because it's great for the patient population. And I also want to say that these technologies are potentially complementary, right? You're just looking at it from the genomics of the cancer versus the host response or how your body's responding to the cancer. I'm just bringing the case up of cancer because I think there are large-scale efforts underway in cancer. But it is, as we've mentioned throughout the discussion today, I think what's important to note is getting your immune system and, again, from a business perspective and from a patient perspective, why we think it's one of the largest addressable kind of opportunities is because it does cut across autoimmune disorders, infectious disease, cancer, even kind of neurological disorders, depressions and allergy and things that you may or might -- may not think (remediated), there is mounting evidence across a large body of publication that shows that many of these disorders are remediated . So again, I think that we'll let the data drive but really interesting problems.

A - Peter Lee {BIO 1416324 <GO>}

What I tend to tell people is the cost of something like this, of a real AI system, is infinity. And that the reason is, these are fundamentally learning systems. So let's take a simple example. Let's take the Microsoft translator, which does language translation. It's never done. There is an infinite amount of engineering because you can always improve the quality, say, of English to Russian and Russian to Chinese. You can always integrate more data. You can always improve the algorithms. And in fact, that is the model. And so the real question isn't so much how much will it cost and what will be done. But at what point will we start being able to recoup some of that investment and then get ahead of it. And those -- when you're in this sort of AI regime, those are really the fundamental questions. And if you need -- you need to be very kind of analytical and throttle elements of the investment in order to ensure that you are on a glide path to the point where you're able to get ahead of the ongoing cost of -- march towards more and more intelligence.

Q - Tycho W. Peterson {BIO 4279327 <GO>}

I guess, as we think about what the output of this venture may be, certainly, the kits and the panel and the assay itself, I guess from Microsoft's perspective, is there a software opportunity here as we think about the interpretation either on the part of the physician or the reference lab?

A - Peter Lee {BIO 1416324 <GO>}

Yes. I think, first of all, just -- again, just from the pure computer science perspective, the beautiful thing about machine learning is that the algorithms generally have broad applications. So obviously, we are very, very -- we have blinkers on, we're very focused on the specific problems that Adaptive has brought to us. But we recognize through a lot of experience that those algorithms are likely to have much broader application. And so you have to train yourself to always be open minded to those possibilities. And the arrangement that we have, while the intellectual property portfolio of Adaptive remains very complete and clean, it still gives us an opportunity to look for this new applications. And so that's a really important element. I just look at this as how can Microsoft be relevant and become competent broadly in this genomics space? And so having a great partner just not only gives us a chance to get competent. But it gives us a chance to learn, learn how to be good. And so I have a lot of faith that if we do become good at this that, that will open up opportunities to invest in yet a broader set of areas in the genomics space.

Q - Tycho W. Peterson {BIO 4279327 <GO>}

I think we'll open it up to questions from the audience, if there are -- we have one there. Do you have a microphone?

Q - Unidentified Participant

Okay. So part of my questions were answered in the last few dialogues. But my first question is, have you thought of looking at it as a biomarker as well? So when you start giving the drug once you diagnosed the cancer, can you keep looking at the T cell receptors and see if they are going down?

A - Chad M. Robins {BIO 17183354 <GO>}

Absolutely. As a matter of fact, we're doing that today. Part of that battery of assay -- I'm sorry, tests around this concept of immune competence, we are partnered with 85 biotech and pharma companies, many around the immuno-oncology space, autoimmune disorder space, et cetera. And that is one of the things that we're looking at, specifically to look at different levels and how the drugs impact the clonality really of the immune system. And can that provide informative information for how a patient is treated. The technologies that we developed in the last couple of years that bind those receptors to the antigen and really, we're starting to understand and characterize the functionality of the receptor. And this is back to an earlier question is once you kind of know the diagnosis and what it's binding to, can you potentially use those immune receptors therapeutically? Obviously, that space has started in cellular therapy within oncology and cancer with the CAR T space. We have efforts underway in using naturally occurring TCRs to try to move the field from working in blood cancers to working in solid tumors. But I think there is quite a bit of hope with the information and the amount of data that we're collecting and our work with pharma that there's a chance not only to be able to help the pharma companies better understand what their drugs are doing and how they're impacting patients and how ultimately the clinician can change treatment decisions based on immune system information. But to be able to hopefully be able to use immune receptors in the therapeutic context as well.

Q - Unidentified Participant

That was one of my questions that you could even...

A - Chad M. Robins {BIO 17183354 <GO>}

This is like Back to School, like 27 parts?

Q - Unidentified Participant

Then, well, there's one other thing that you might want to look at because I think there's a huge need. So in the neuromuscular space, there -- it's been very hard to find biomarkers. And there's a good enough reason to believe that a lot of the neuromuscular diseases have an immune component to it and a T cell component actually, specific T cells, which I'm imagining they'll have specific T cell receptors. So not only is diagnosis tough there but also a biomarker. People are not able to run clinical trials because there are no biomarkers to find. So that's one exciting space to look at where there's a huge need.

A - Chad M. Robins {BIO 17183354 <GO>}

Thank you.

A - Peter Lee {BIO 1416324 <GO>}

Great.

Q - Tycho W. Peterson {BIO 4279327 <GO>}

Anyone else?

Q - Unidentified Participant

Does the partnership cover any of your nascent drug development work? Or is that option?

A - Chad M. Robins {BIO 17183354 <GO>}

That's not currently contemplated by the partnership.

A - Peter Lee {BIO 1416324 <GO>}

We're -- I think in something like this, the -- actually, the reason I'm having it (hanging) is that every leader within Microsoft probably approaches this a little bit differently. For me, it's very important when you're trying to drive some innovation process to get to some early wins quickly. And that, for me, dictates a level of focus that would be -- that I think we would, at least on our side, push pretty hard. But once we start to really understand that, that we're able to work very, very well together with a lot of agility, then we might feel freer to kind of expand the space of collaborative possibilities. Now that's not something that I can just dictate on my own. This is typically a situation where, I guess, we have to go to another Seahawks game and figure out a way to hash out. But it's that sort of kind of push and pull. And something I've appreciated in the partnership specifically with Chad is just the kind of easy level of transparency and just kind of sharing our philosophies, concerns, what gets us excited about this. Good.

A - Chad M. Robins {BIO 17183354 <GO>}

Absolutely.

Q - Tycho W. Peterson {BIO 4279327 <GO>}

Any other questions from the audience? Okay. We'll conclude it at that. I want to thank you both for taking the time today. Congrats on the partnership.

A - Peter Lee {BIO 1416324 <GO>}

Thank you very much.

A - Chad M. Robins {BIO 17183354 <GO>}

Thank you. Appreciate it.