EP01: Using Machine Learning to Gain Insight Into Medical Symptoms

**Andrew Le:** We could get better and better at actually understanding how people, not doctors, describe their situation, perceive their pain, and their symptoms, and how that ultimately relates to what ended up happening to them and what they did.

**Dr. Bob Kaiser:** Welcome to the Business of AI and Healthcare podcast. Our mission is to discuss practical insights and share knowledge on how to navigate the transformative technology of AI. It is important to understand how AI can be used safely and ethically while revolutionizing patient care, streamlining operations, and enhancing medical research.

Dr. Bob Kaiser: I'm your host, Dr. Bob Kaiser. Be sure to subscribe on Apple Podcasts, Spotify, or your favorite podcasting app to ensure you don't miss any of the featured episodes. You can also join us online at thebusinessofaiinhealthcare.com. Today, we had the opportunity to virtually visit with Dr. Andrew Le, CEO and co-founder of Boston-based Buoy Health. Buoy Health provides a free digital health tool powered by advanced machine learning to resemble the consultation you might have with your doctor to determine a diagnosis of your symptoms and direct you to the right path to getting better.

Dr. Bob Kaiser: Welcome to the podcast, Andrew.

Andrew Le: Thanks, Bob. Appreciate you having me. Well, this is going to be a very interesting discussion. Let me start by saying we're featuring more and more interviews related to AI, artificial intelligence, and ML, machine learning, as it relates to the business of healthcare. We see a lot of clinical issues and problems being addressed with AI and ML, such as improved processes, disease detection, and better patient outcomes.

Dr. Bob Kaiser: However, I'm very interested in what you're doing at Buoy because it's so personal, impactful, and empowering for the individual. In this podcast, with your help, I want to cover the background of differential diagnosis systems that physicians are using, the value it's created for them, and how you've transformed this value beyond the clinical scope just for physicians into the lives of ordinary people. So let's start with the beginning of your story and the problems you're addressing with Buoy.

Andrew Le: Sure, Bob. So, you know, the origin story was I was in my last year of medical school. I was at Harvard. I was going to go be a neurosurgeon. That was my life's dream. And in that last rotation, I was in the emergency room, and I was seeing all these patients who were Googling their symptoms before running to the ER.

I still remember one night; it was 2 a.m. I saw a woman with a jammed finger, followed by a man who had an ulcer on his foot from a history of poorly controlled diabetes. And we had to amputate his leg that night. And I still remember, you know, talking to the first woman and saying, "Hey, you know, your finger is fine, you can go home." And she pulled out these printouts from the internet, telling me why she thought it was broken and why she was here at 2 a.m. at a tier-one trauma center. I told her she could go home, and the very next patient, of course, you know, when I said, "Sir, I'm so sorry, you know, had you come in two days ago, we could have saved your leg," he pulled out these printouts from the internet, telling me why he had waited and why he didn't think we should amputate. And, you know, that was just really a start to see those two patients back to back.

Unfortunately, right around then, my dad got really sick. He had a mini-stroke on his employer's treadmill. He didn't go to the doctor. I found out about it months later. When I asked him, you know, "Why didn't you call me?" or "I have two younger sisters who are both doctors too," he was like, "You were working." And I was like, "Oh my God, you know, this guy has infinite access to healthcare and certainly has paid for it, and yet, you know, he's not leveraging us to make these decisions." So I was like, "Alright, why didn’t you Google it?" And he said, "I don’t trust what I had to find on Google." So for me, that became this emotional tipping point. Three months before graduating, I took this very delusional sabbatical from school and started Buoy.

I became obsessed with this idea that you have all these different front doors to healthcare. You know, you have the emergency room, you have primary care, you have urgent care, and then now there's this proliferation of new virtual front doors, like telemedicine. But there are now so many different niche telemedicine plays for different parts of the ecosystem, and all of that is great. But it ignores the fact that the sidewalk to those front doors—to extend the analogy a little bit—is still Google, where 72 percent of Americans start their healthcare journey. And the core problem that we're trying to solve, you know, our core thesis is that when you get sick, you suddenly have to turn into both a medical student to figure out clinically what's going on and an insurance or benefits expert to understand how to pay for the right care or what's covered by your insurance. And with those two knowledge gaps that the average person has to fill, it's no wonder that people just turn to something that's free and at their fingertips like Google to get some semblance of what's going on, or they're calling their mom and asking for some advice on what to do.

What ends up playing out is that people just have no idea where to go. They shotgun into care in a way that leads to bad outcomes at high costs. And so what we're doing at Buoy is, you know, we built this AI program that talks to you like a clinician, helps you figure out clinically what's most likely going on. And then if we understand your insurance, we understand your benefit design, we could then point you into the right care at the right time. And the ultimate goal of the company is to build the first perfectly competitive marketplace in healthcare, one that empowers the patient—the demand—to finally understand what exact part of the supply side, if any at all, they should be going to when they are sick.

Dr. Bob Kaiser: That is a great story. I can see, Andrew, that you had this epiphany moment and identified the fact that there’s a serious issue and problem that you might be able to solve. And that’s not uncommon when you look at the healthcare system, because it’s really not a system. There are all types of breakdown points. What in the world gave you the idea to use advanced technology like artificial intelligence or machine learning? Do you have a background in that? How did you come onto that as part of the solution process?

Andrew Le: Oh, yeah, I don’t have a background in that whatsoever, Bob. I actually studied economics as an undergrad, so I've been thinking a lot about efficient marketplaces for a really long time. And that's why, you know, I talked about kind of the vision of the company to create that perfectly efficient marketplace in healthcare. But when it came to how AI and machine learning ever came to be involved, I was a medical student, so I did see how we were taught. And how we were taught was that we would read medical textbooks to kind of understand the connection between different risk factors and diagnoses, the connection between diagnoses and symptoms. And then we were taught to use that knowledge to interview patients. And the more you interview patients, the more comfortable you were with recognizing patterns of different diagnoses.

And, you know, at the end of the day, when I was thinking about the problem to be solved, I was like, "Man, I am a very imperfect human when it comes to memorizing all of those statistics in those textbooks, memorizing all of the patterns that I’m seeing in the clinical room. I’m a human being, so there are limits to my ability to remember and to take into account all these different data points." Well, obviously, a computer can be taught, and a computer has a lot of strengths that are limitations for humans, but, you know, of course, vice versa. And so, you know, the idea really became, "What if you could teach a computer program like you teach a medical student?" And how that played out was we ended up looking at all of the clinical papers that roll into a medical textbook. We read thousands of them by hand to build this massive statistical graph of medicine that could understand the connection between, say, smoking, which is a risk factor that increases your risk of pneumonia by a factor of five based on these three papers. Pneumonia has some baseline probability based on these two papers. Pneumonia 90 percent of the time will have a fever based on these three papers. Literally taught this AI program as if it were a medical student that had infinite memory. And then we had people starting to use it and then tell us what they ended up being diagnosed with or where they ended up going. And now we've had millions of people use Buoy. And with these millions of people, now it’s kind of like the doctor who’s seen a lot of patients and memorized what they’ve seen and learned from each interaction. So that’s where the machine learning has come into play. Originally, all of the data came from textbooks and papers, and now it's coming from real-life usage of the program that enables us to get better and better with every use.

Dr. Bob Kaiser: Well, that makes great sense, Andrew. A lot of people believe that artificial intelligence and this technology is something to be feared. Your view is obviously different, I think. You use this technology, and you use it with confidence

and with trust. And that kind of brings up a topic I want to explore just a little bit, and then I want to get down into the details of what you do at Buoy. Before we do that, though, you’ve got to give us an explanation of the name Buoy, B-U-O-Y, Buoy. I've heard that name before out on the boats and stuff. What's the background with that?

Andrew Le: Yeah, so when we were doing a lot of user testing with people, you know, when they're Googling their symptoms, someone in the user test said, "It feels like I'm drowning in information." And you can imagine someone, you know, they’re sick, they’re alone, they’re scared, and you’re reading, you know, gobs of articles. You're deep in the weeds of a forum like Yahoo Answers to try to figure out what's going on. And the sense that you're drowning, you know, is actually a very apt description of that. And so then the name Buoy came about as something that, you know, as a verb, keeps you afloat, as a noun, is something that helps lead ships to shore in a safe way. And so we were like, "Oh, you know, it has a lot of interesting kind of visual components to it that really fit with what we heard, you know, from users."

Dr. Bob Kaiser: I guess we'd expect nothing less from a Boston-based company with the great seaside there. Well, that's interesting. That's interesting. You know, the overall concept that we're talking about is helping people survive in that sea of infotoxology. So much information out there becomes toxic and actually poisons you. And so let me, for the benefit of our audience, and I want you to kind of help me through this, but I said earlier that this methodology, this decision support using computers to help do diagnosis, you know, decision support along that line. It’s been around for a while for the physicians, for the doctors. You know, we’re in this age of IBM Watson, you know, with natural language programming and all this machine learning. And, you know, if you’re a doctor doing diagnosis, it’s fairly complicated. Let alone for an individual to kind of self-diagnose, but you know, the technology out there, I ran into some of this diagnostic decision support as we're teaching at the university our health information technology course, and the topic of Isabel came up, and it’s a product that really broadens the differential diagnosis and provides direction for more pointed questions for the doctors. And it’s not simple to use. I mean, but it’s kind of based off some of the philosophy and ideas. You know, you put in the age of the patient, the gender at birth, the travel history. You might type in something like sharp pain in the abdomen, and it'll come back and give you a series of ranked chest list items, maybe a dozen of them, you know, kind of tell you the reason why it gave you those. You know, it might be an aortic aneurysm or intestinal ischemia or pancreatitis, you know, something like that. And then it has a lot of support material. And getting doctors to use this, especially the specialists, they don’t want it because they know everything. But the concept there is that there’s so much information available. They provide stuff from the Merck Manual Professional and Medscape and PubMed and MedlinePlus and support all this information for a doctor to help make a good diagnosis. Now, have you leveraged that way of thinking with the Buoy product?

Andrew Le: Yeah, it’s a really good comparison, Bob, to what we’re trying to tackle for a different audience. The core of Buoy’s algorithms initially were all clinical papers, basically the primary literature that rolls into, say, a PubMed, or sorry, would roll into someone like an UpToDate, or a Dynamed, or a Medscape, like medical textbooks that clinicians or medical students would read. And so the initial concept was similar in that we wanted to look at real published literature on how symptoms, diagnoses, and risk factors were related to each other. The challenge, though, was turning that information into a product that is usable and useful for people rather than doctors. And there’s a big delta there, right? You know, doctors kind of learn doctor-speak; they describe things the same way. You know, describing an abdominal aortic aneurysm to a clinician, everyone kind of knows what it is because they went through all this training about it. Even describing an abdominal aortic aneurysm, you're kind of taught in medical school to look for a specific type of symptom described in a very specific type of way.

Well, when you then turn that onto the patient-facing side, what we have come to really understand is that there’s significant variability in how people present with diagnoses, but also how they describe those presentations. So I'll give you an example. Let’s say, Bob, you and I both have sinusitis, which is like an infection of your sinuses. You might have a fever, a runny nose that is purulent, so it's like yellow. You, um, and you might have a sick contact that also has sinusitis. I might have a fever, I don’t have a runny nose, but I have a really full face, and I don’t have a sick contact. You and I have the same diagnosis, but we have very different presentations. Well, it turns out there are a lot of different presentations, right? So when you think about the tool that’s helping the doctor, that’s where the variability really is trying to end here, is that trying to figure out per presentation what are the possible diagnoses that could explain that to help them with their thought process? There’s a level of variability that is beyond that, though, that becomes very, very difficult, which is to say, well, Bob, because you are in Texas and I am in Boston, and because you and I have different pain thresholds, maybe, or because you and I grew up in different areas, or maybe because we are of different ages or different levels of health literacy, you might just, even if we had the same facial pain, the same fever, and the same sick contact, we might describe those phenomena differently, just because of all those factors that I have described. And so, if you think about the problem here, something is wrong with your body, you have a symptom. To translate that into English words is really difficult, right? So, like the example that I always give is, you know, in medical school, they always talk about pain as like, "Is it knife-like?" Well, I personally haven't been stabbed by a knife, right? So my perception of what knife-like pain is may be different from someone else's, right? Or when pain is like another example, we dull, it seems so straightforward, but again, there's a ton of variability. If you ask a hundred people what dull pain meant to them, they would say something slightly different to you. So given that, how do you then create a product that can start to understand and learn about that variability person to person when they are coming in with a clinical situation?

So that’s why our evolution was, okay, let’s start with the medical textbooks. Let’s start with the clinical literature, but then let’s release Buoy for free and let as many people use it as they want. And as more and more people use it, we could get better and better at actually understanding how people, not doctors, describe their situation, perceive their pain, and their symptoms, and how that ultimately relates to what ended up happening to them and what they did. And so that’s kind of been a departure from a pure physician-facing product to one that is really helping the patient at the end of the day.

Dr. Bob Kaiser: That's a great explanation there. I've kind of laid down this next path there. I know there's more dimensions to Buoy. You know, we're talking about how it deals with the individual. And we'll talk about a broader set of stakeholders that might be interested as well in a few minutes. But when does somebody really want to become their own doctor? When do they want to, you know, seriously evaluate their symptoms? If it's something common or ordinary, they may not, but maybe if it's more significant, they might want to do that. So when something feels off, when something doesn't feel right, kind of step us through the user experience. What would they do by using your digital tool? When something feels off, what do they do?

Andrew Le: Yeah, that's a great question, Bob. So before I answer that question directly, I kind of want to lay out the typical patient journey according to our data.

Dr. Bob Kaiser: Yes.

Andrew Le: So initially, you feel like something's off. And then you seek care, then you get some sort of care, and then you recover at home. That's kind of like the typical pathway for somebody who decides to seek care. Well, according to our data, what's really fascinating is that from the moment you feel off to when you actually see a doctor, on average, is about a three-day waiting period. We call it the tipping point where there's this marination period that happens. So anecdotally, Bob, you know, if you think back to the last time you saw a doctor, I would venture to say that it wasn't the minute you recognized that something was off, right?

Dr. Bob Kaiser: Right.

Andrew Le: What's also really fascinating is that according to our data, 40 percent of the time, people actually don't seek care whatsoever when they get sick. And so again, think back to the last time you had a symptom; I'd also venture to guess, probably you didn't see anybody at all. But what's really interesting

is that the use of Buoy, 67 percent of people who are using Buoy, because it is free, because there's no barriers to entry, you can use it even anonymously. You don't even have to download an app. The average person who's using our product has been sick for less than 12 hours.

Dr. Bob Kaiser: Wow.

Andrew Le: So it's literally right when you feel off, you are finding Buoy because you're doing a Google search and you happen to land on Buoy because you've read some of our content, or you know about Buoy, you're coming directly to Buoy, or you get Buoy through your employer or through your insurance plan, and you're going through your insurance carrier and finding Buoy there. Or you're going through your employer, you're finding Buoy there. We interview you. Like I said, you don't have to tell us exactly who you are, but you would tell us things like how old you are, what's your sex at birth, what's going on with you. We then interview you. And it looks like you're texting with someone, except the answers are largely pre-filled for you. And it feels like you're just texting with a clinician. At the end of this two-minute visit, we help you figure out a maximum of three possible matches, and it's self-educational; we're not practicing medicine. We're just helping you narrow down the scope of what might be going on. And then for each match, we're trying to explain, "Okay, based on this, here are some reasons for this match, and here are some reasons against, based on the questions you answered."

Dr. Bob Kaiser: So that's a differential diagnosis in a way.

Andrew Le: Exactly. And then when we understand your insurance design or your employer benefit design, and you tell us that, you know, "Oh, I'm covered by United Healthcare," as an example, okay, then we can say, "Okay, based on your insurance design, the time of day, so what's open, right? Your location, so what's nearby. And then ultimately, what's really important here is your clinical situation. You're stable; it looks like you could see someone virtually, or you're stable; you should see someone in urgent care." We can then show you what services are in-network for you in your area or available virtually, but is also clinically appropriate. And so we fill both those knowledge gaps that I described kind of end to end, from the moment of discovery all the way to when you decide to seek care.

Dr. Bob Kaiser: So in the healthcare equation, there seems to be a big component called helplessness. A lot of people say, "You know, I don't know what to do. I just feel helpless. I don't feel like I'm in this situation, and there's a lot of pressure and a lot of grief." You know, in this experience, this sounds like it could kind of be a guide to maybe remove some of that feeling, help you kind of feel like you have some direction. So when you stop and think about this, is there any type of follow-up that you get? Or is it one and done? Then you're through with Buoy.

Andrew Le: Yeah, we have a follow-up feature, Bob, that people can opt into, and we text people to follow up to see how they're doing and what ended up happening to them. That feature is something we're really focusing on over the next few quarters and making it more sophisticated. But the point is not to be one and done. The point is to really be that guide for you, not just for this sickness, for this episode until it resolves completely, but also for the next time around that you may be sick. And if you decide to create a profile with us, we would know you better. So now it’s like going back to the same doctor who happens to understand your history, right? There's a lot that we're working on there to build that longer-term relationship with folks.

Dr. Bob Kaiser: Okay, so this is the Business of Healthcare podcast, so we have to bring up the topic of how does your business make money? And you said that this tool is free. How have you monetized this to a broader audience beyond the individual? Is there a play here with the employer community, with health plans, etc.? What's the next step or the bigger vision of this?

Andrew Le: Yeah, Bob, you hit the nail on the head. You know, we make money by selling a membership to Buoy to self-insured employers for their employees, as well as members of large health plans. And what the health plan or the employer gets to do is customize the experience for their employees or members to be specific to their particular network design across the country, wherever they may be. So to spell that out, let's say you have an employer who, again, is footing the bill for this at the end of the day. Regardless of where people go, they have employees across the country. This is becoming more and more relevant as people are moving to remote-first work environments, but they have employees all over. They have a very rich set of services across the country, but it's very disparate. It's hard to communicate exactly what service you should be using, depending again on your clinical situation, the time of day, your benefit design, your location. Right. And so they get to then take that whole set of services, and we map it back to Buoy's endpoints, such that at the end of the experience, we are showing them exactly what they should be doing next. And the comparison I always make is today, when you look at an online healthcare portal for an employer or an online healthcare portal for an insurance company, it really feels like the Cheesecake Factory menu, right? It’s like 50 pages of link farms; you know, you can eat anything under the sun. At the end of the day, people just want to get better. And so turning it from an experience like that to being a much more guided experience, that’s more akin to turning on Netflix at night and seeing the top four titles that you're most likely going to want to watch based on your family's watching history. In the same vein, we’re showing, "Bob, for your particular situation right now, your benefit design, where you are in the world, I'm going to show you exactly what's going on." So self-insured employers and payers pay us per member per month or per employee per month to be part of that Buoy marketplace for their particular members and employees. But then beyond that, where we're headed is starting to also offer services directly on Buoy in the form of a managed marketplace, such that someone could go ahead and opt into just taking care of it right then and there on Buoy, curating those solutions on behalf of not only the employer, the member, but also just the end patient or the end user at the end of the day.

Dr. Bob Kaiser: It certainly brings a lot of efficiency to the person who doesn't have the skill of navigating the healthcare system. I know I worked for a large financial institution. We had 200,000 employees who spent about $3 billion a year out of pocket for our health, health for our employees, and we tried all types of things to try to get them to deal with hypertension, lower back pain, things of this nature. And the process of educating and reaching out to them to get them to adopt using something was the big challenge. But if you're successful with that, you can certainly reduce the overall expenditure by a significant amount of money. So I could see where this would fit in. So, Andrew, there's a lot of discussion today about healthcare equity, you know, a lot of these social determinants of healthcare. I hear it stated that maybe 80 percent of our health is not actually tied to seeing a healthcare provider, but instead having access and information to the best resources. So, with COVID-19 and all these things going on, does Buoy fit into this aspect of health?

Andrew Le: Oh, I mean, big time. And when I say big time, I will say, Bob, you know, we've been thinking about this since, you know, largely our inception, but we still feel like there's so much further that we can go from the perspective of access, equity, and inclusion. So to start, you know, everything that is written on Buoy is written at a fifth-grade reading level to try to enable as many different parts of the population to understand what might be going on. You could imagine it being very disempowering to use a lot of jargon, especially in a complicated space like healthcare when you're using our service.

The next thing is that we elected to focus our product on a web mobile browser or a browser as opposed to an app, which really has ramifications where, you know, with an app, you really need kind of the latest and greatest smartphone to run a lot of apps while that rules out a large part of the population that may only have access to the internet via their computer at work or their computer at the public library, or they might have an older smartphone that can't run the latest and greatest apps. And so by focusing very much on the most accessible type of virtual product, we felt that was very important at a price point—free—that should not be a barrier for usage and adoption, with also the fact that we allow people to use things anonymously. This is a real aim at building trust first by proving value to you, as opposed to trying to lock you into a profile and lock you into sharing data with folks. And we would never sell anyone's data. That's not the business that we're in. Obviously, I told you how we monetize, but that's another big, big component of this.

But you know, where we're headed with this, there's so much more to really work on. So today, one thing we're really proud of is that we looked at the zip codes of our users on

Buoy. And if you could use the zip code to back into the median income of that particular zip code, we found that the median income of users of Buoy is exactly the same as the 50th percentile median income of the United States.

Dr. Bob Kaiser: Wow. I've heard it said that the zip code is probably more important than your genetic code when it comes to healthcare services.

Andrew Le: Right. And so what that shows is that literally 50 percent of the population on Buoy is below the median income of the United States, which is a really interesting opportunity for us to improve access to make them aware of the services that may be in-network for them, of course, but also available in their community. And then I think where we're headed is thinking about things like language barriers, right? We're talking first about health literacy from the perspective of English, where we need to go is thinking about literacy, health literacy across different languages. Another component is today, we're thinking about services paid for in-network by your network, your employer, or your payer. We want to get to a world where we're also offering you cash options that are even cheaper than what you might have to pay out of pocket for your in-network services. That's another component of it. A third layer is thinking about accessibility. We've gone through multiple accessibility audits to make sure that folks who are vision impaired are able to use Buoy. And what this means is actually when you look at the average user of Buoy, you would expect that it would be a bunch of millennials, but actually, the majority of our users are over the age of 40, with 26 percent of our users being over the age of 55. But there's still more that we can do there. So in terms of having better coverage of diagnoses that tend to manifest themselves later on in life, as an example, or different use cases that are more specific to an aging population. Those are all just examples of areas of opportunity for us going forward to improve on accessibility, equity, and inclusion.

Dr. Bob Kaiser: We started off with the idea, Andrew, that you were stopping people from going into the emergency room with their Google printouts unnecessarily. You know, we have a program at the university. It's called the Alliance for Physician Leadership, and we bring in physician leaders from across the country. Survey says that most of the doctors, they hate Dr. Google. They don't like Dr. Google. You know, but this is different. I think this is different because what you're doing is you're providing a level of education that isn’t misleading, and it has direction and help associated with it. Is that a safe statement to make?

Andrew Le: Yeah, that's exactly right, Bob. Obviously, we've talked on the podcast about the ways in which we're looking to continue to improve, but at the end of the day, what we're trying to replace is not the doctor, to be very clear. We're not practicing medicine. Our intent is not at all to replace doctors; it's to replace Googling your symptoms, which Google is really good at a lot of things. It just so happens to not be the best way to help people figure out what to do in a moment of illness and get them into the right care at the right time that leads to physicians practicing at the top of their licenses, patients getting the care that they need, and ultimately getting better outcomes at lower costs.

Dr. Bob Kaiser: Well, I'll summarize with a statement that I read about Buoy. Your purpose is to create technology with heart for the health of every person in the world. Very ambitious and very successful. Dr. Andrew Le, thank you for being part of the podcast. We're going to stay in touch with you and follow up with you. And thanks for sharing this important information with our audience today.

Andrew Le: Thanks, Bob. You bet.

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Let me know if you need any further adjustments!