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SURAJ KAPA: Hello, everybody, and welcome back to the Mayo Medscape video series. And today we're going to be talking with our colleagues about the role of artificial intelligence in health care, specifically as it relates to cardiology, and identifying novel opportunities we are slowly identifying with work in this area.

I'm joined today by Dr. Francisco Lopez-Jimenez, professor of medicine at Mayo Clinic, Rochester, with an expertise in preventive cardiology, and his colleague Zachi Attia, assistant professor of medicine also at Mayo Clinic in Rochester and a bioengineer by trade. They, together, comprise the leadership that are heading up the artificial intelligence efforts within innovation in the cardiovascular department at the Mayo Clinic.

My name is Suraj Kapa, and I'm also an assistant professor of medicine.

So, Francisco, I've been hearing so many things that have been excellent about all the opportunities that exist about applying artificial intelligence to health care data. So when you look at the landscape of artificial intelligence and how it intersects with health care in general, what do you see as the future, or the present, of applying AI to cardiology, and health care in general?

FRANCISCO LOPEZ-JIMENEZ: Thank you, sir. This is a very, very important question. I see the future being developed in three different areas, or three main areas. The first one is the optimization and automatization of interpretation of echocardiograms, coronary angiograms, cardiac CTs, and other diagnostic modalities.

And the second one is identifying people at risk. And I think that artificial intelligence has a big potential to identify those at risk for sudden cardiac death, those who might have [INAUDIBLE] infarction, and those who might die from heart failure soon after they leave the hospital.

And the third one would be the management of big data. As we know, big data is everywhere, so we need artificial intelligence to better handle those massive amounts of information that we get from wearable devices, from Holter monitors, et cetera, that will help us to better understand the underpinnings of cardiovascular disease.

SURAJ KAPA: So, Zachi, when we talk about artificial intelligence, if you had to explain it to a layperson, what is it, exactly?

ITZHAK ZACHI ATTIA: Thank you so much. That's a great question. AI, artificial intelligence, is the ability of machines to mimic human intelligence. It enables them to automate the process of taking an ECG for example, and give us the rhythm analysis.

We also discovered that it can see patterns that humans cannot see. Maybe it's the more interesting parts of AI. It can look at thousands, or hundreds of thousands, of ECG, look at the prognosis, and decide if the patient is going to have a disease. It does that just by looking at a lot of examples and the labels.

We don't say what to look for. We don't define any specific features. We're starting completely unbiased and without a specific hypothesis, except for the label we're looking for. And just by showing the neural network, for example, a lot of examples. It learned to find the patterns that are unique for each label.

SURAJ KAPA: So if you had to think, between the two of you, all the work you've done so far and that has been accomplished so far-- I've read a lot of articles that have come out in this space-- what do you think is the most promising or exciting discovery you've made applying AI to cardiac data?

FRANCISCO LOPEZ-JIMENEZ: Well, I will mention one, and I will let Zachi mention the other one. To me, the one that has been very exciting and innovative was this publication identifying people who have paroxysmal atrial fibrillation, but the electrocardiogram is in sinus rhythm. It really opens up a new era in cardiology, in particular in the analysis of electrocardiography, because it's finding a condition that we generally require an electrocardiogram that shows the atrial fibrillation to make the diagnosis. And now, we've figured out a way to identify those with paroxysmal atrial fibrillation with an electrocardiogram that might seem otherwise normal.

SURAJ KAPA: And Zachi, your thoughts?

ITZHAK ZACHI ATTIA: As Dr. Lopez mentioned, the interesting parts are in looking at an ECG, saying, well, it looks totally normal. The AI algorithm said something else, and the AI algorithm is the right one.

Another example is the low ejection fraction detection. When we did the low injection fraction detection, we divided patients by their current echocardiogram. We later on looked at patients that had a false positive, meaning an AI that says that they have heart failure, or low ejection fraction, and normal echocardiogram, meaning the ejection fraction was actually above 50, not only 35 point.

When we looked at the future echocardiograms, we noticed they have six times more risk of developing low ejection fraction in the future. Now, we don't think that the neural network was able to predict the future. We think it was able to locate subclinical features of the disease. So it can see something that humans can't see because it's below the surface. It basically helps us to define the term of [INAUDIBLE], patients that are going to have a disease, and maybe we can do something to prevent it instead of waiting for the disease to happen.

SURAJ KAPA: Wonderful. And Francisco, speaking from your clinical hat as a clinical cardiologist, what do you see as the potential-- and the potential hurdles, as well-- of implementing these algorithms into general care?

FRANCISCO LOPEZ-JIMENEZ: Well, first of all, I think we have to be mindful that artificial intelligence might represent some challenges in terms of the validity of the data, the validity of the algorithm. We need to be sure that what we call artificial intelligence comes from good data, comes from data that can be reproducible, can be applicable to a variety of populations, not just a very, very specific group of people.

The second thing is that the application of AI, or artificial intelligence, is challenging in the sense that we know that the application of technology doesn't happen just automatically, and we are used to old paradigms of medicine. So this is going to be, or might become a slow process if we don't think a forewarning in what is the best way to implement artificial intelligence.

We also need to be careful not to assume that the implementation is going to be all successful. There is always unintended consequences of applying new technology. So we have to measure and evaluate every time we implement new algorithms to see if there is any unintended consequence in the application of that. An algorithm might be very good to diagnose a condition, but may have an extremely high rate of false positive results. And that will just make the health care explode into an exceedingly expensive health care system if we're not careful implementing this step-by-step.

SURAJ KAPA: I think you bring up a number of interesting points there-- namely, that the implementation science that underlies deployment of algorithms that are built out of big data is unique compared to where we've come from, right? Because where we've come from is we might create scoring systems, we might create guidelines, but, still, it was contingent upon the physician, the clinician, to make a decision based on entering the scoring system in or thinking of the guidelines as they apply to a patient. But now you're actually getting an automated read from a device saying you should think about this.

What are your thoughts on-- how do you think clinicians behavior is going to change? Do you have any thoughts on that?

FRANCISCO LOPEZ-JIMENEZ: A good point, because I think the question is still up in the air. At the end of the day, there have got to be clinicians who will be ultimately responsible for what the machine is saying. So how can we reconcile this completely automatic system that is going to give you a diagnosis and, at the same time, having a clinician who is responsible for that diagnosis? That's something that we have to define.

Right now, for example, a car that is completely automatic-- if the car has an accident, who is responsible? Right now, you might say the company is responsible. But in medicine it's more complicated because there may be errors happening occasionally, and who's going to be responsible for that?

So we have to really work on that and how the clinician is going to still have the final word, which I think is going to be the case for many years to come-- that no matter how automatic a system becomes, the clinician will have the final word to determine whether he or she thinks this diagnosis is present or not.

SURAJ KAPA: OK. And Zachi, one of the major criticisms I hear sometimes of this kind of, quote unquote, "AI work," realizing AI is a broad field that includes many different machine learning and other techniques for data analysis, is the explainability. In other words, somebody tells us the ECG can tell us if you have a low ejection fraction or not, but why?

And do you think it's always going to be a black box? Or do you think we'll get to a point where we will very readily be able to explain what these obscure neural networks are actually seeing?

ITZHAK ZACHI ATTIA: That's another great question. I think we will be able to open the black box and look, and maybe peek into it and see what are the main features, what are the main drivers of the network. But we wouldn't really know exactly what it does. We will get hints. We will say, OK, I see that when this happens, the network decides this way or another. But I don't think it will ever be a fully-explainable model.

And I think it's actually a strong point for these models because the ability to explain also holds us back, because it only enables us to do what we can explain. If there's a very nonlinear, very gestalt-like feature that the network is seeing, and even a human being, an expert that can do the same test, wouldn't really know what it's seeing, he will just say, well, I see there's something wrong with it. I think we want to make sure we're not limiting our systems to only the very simple things we can explain.

I do think that, looking at big data, there is another issue that needs to be addressed-- bias and the difference between different data distributions. So when we are testing a model, we want to make sure that we are testing it on a big variety of patients.

We know that these neural networks, and other AI models, are very good in AI pattern recognition. If we have a pattern that we don't want it to recognize, there's still a chance it will recognize it. And we want to make sure that we can globalize and generalize the network and make sure it works for everyone. I think it's a key point that, when you develop an AI model, when you validate it before using it, you want to make sure it actually works for the group you're planning.

SURAJ KAPA: And I think you've brought up a great point, which is when we talk about explainability. When we have an expert clinician, an expert cardiologist, leader in the field walk into a room and say, oh, you're doing this wrong, it should be done this way, we accept it as gospel, even if they can't discreetly explain it in terms that will necessarily lead that person to be able to redundantly do it the same exact way that person was able to. They're actually giving their clinical gestalt often based off of decades of experience.

It's like our expectations of the computer is very different than our expectations of the human because our expectation of the human is they don't necessarily need to be able to explain it as long as they get it right. And it seems like we need to trend ourselves a little bit more towards that way of saying, OK, the data relationship is so complex that, if it's getting it right all the time, that's actually what matters. Your thoughts, Francisco?

FRANCISCO LOPEZ-JIMENEZ: I completely agree. And, indeed, I think the clinical decision-making is a great example for that, but also the use of medications that we don't really understand. There are some medications that have been used for many years, and it took decades to understand the mechanism of action. But as long as those medications were proven to be effective, I don't think people were complaining about it.

I mean, we have, for example, the preventive effect of aspirin for colon cancer. We don't really understand how or why, but there are several studies showing that. So how can we stop using a preventive strategy just because we don't understand very well the way it works? We don't do that. And I don't think AI should be any different.

SURAJ KAPA: No, I totally agree. And I think as we forge ahead into these activities, we need to marry the concepts of, well, we're replacing humans with the idea that we're actually augmenting the ability of humans to provide the care that we need. Because, as you're pointing out, otherwise why invent new drugs? Why invent new techniques of doing the same type of work in a less invasive way? We do it because we think it will provide better care, not because we want to replace a certain person or a certain group of people. We do it because care will improve and expand as we push forward.

Now, I feel like here we have a very unique relationship within our clinical innovation space. It's led by a data scientist and a clinical cardiologist. And, just from your perspective, how do you envision that role? Do you envision health care evolving in the way of having data scientists embedded into the programs from the beginning? Or do you envision it as us calling upon individuals with data science expertise to come and do projects, almost like we do our statisticians today? What's the unique element of bringing the data scientists versus the traditional model statistics into play in our health care schema?

FRANCISCO LOPEZ-JIMENEZ: Well, what we have done here at Mayo Clinic is to have the engineers embedded into the clinical day-to-day activities because that's really the best way for them to understand the needs, for us to explain them what we do. And, together, we can come up with better solutions than just limiting ourselves to what the clinician believes is important.

I think engineers can come up with amazing ideas, as it has been the case at Mayo. Zachi and others just come up with a recommendation, or even a question, why do you do things this way. And the response many times is, well, because this is the way we have been doing this for years. And just challenging those paradigms is very important.

Zachi, any words on that?

ITZHAK ZACHI ATTIA: I think the main thing is that, while we can outsource some of that work, I don't think it will allow us to create more innovative solutions as we go. A lot of our projects start in one point, and as we go along-- for example, age and sex from ECG. When we did the ejection fraction model, we were looking at trying to find ways to improve it. When we didn't, we said how is it that age and sex don't improve it? And during our conversation-- Francisco and I were talking to you, actually, and thinking maybe the ECG can predict age and sex, and it worked.

And I don't think that if we were disconnected, and I would sit in a different office doing the technical part, you will do the clinical part, we would ever get to these questions. And a lot of these questions started a new project in different fields. And I think the concept of working together side-by-side is much more thought-provoking and creates a lot of new beginnings.

SURAJ KAPA: And I think it brings up-- it's been well-known for a long time that to disrupt industries, or disrupt ways we practice-- which, frankly, I think all of us would agree in health care is necessary in this day and age-- to achieve that disruptive innovation you actually need to have a mindset that's anti-disciplinarian and anti-establishmentarian, such that you can actually bring novel insights that exist outside the existing paradigms of how you normally practice.

And once you're entrenched-- as you were pointing out, Francisco-- in a situation, it can be extraordinarily difficult to bring in a new insight or a new idea that would actually go against the very grain of how you'd been trained to practice and how you have been practicing, unless you're forced to do so by someone like Zachi coming in and saying this can be done a different way or thought of differently.

FRANCISCO LOPEZ-JIMENEZ: And you being an electrophysiologist, you have seen this for the last 20 years or so, how the war between the clinician and the engineers developing new technology to solve a lot of medical problems-- pacemakers, ICDs, and a number of other things-- truly require people outside the medical expertise to essentially get into the clinical feel and see what the needs are and working together with the clinician to develop what we have right now.

ITZHAK ZACHI ATTIA: I also think it's beneficial for the engineer, as well. I think my questions, or my ideas now, are very different than what I would ask five years ago, when I had just arrived. I think working with physicians is much easier to understand what are we trying to serve, how to make a change on the patient's prognosis, and looking for projects that are worth doing. Eventually, we have a limited bandwidth through all of us, and we want to focus on things that can get the patient and actually help them.

SURAJ KAPA: Great. One of the biggest things I see, personally, as a potential with artificial intelligence isn't really for health care, but for delivering health. Because right now we're all talking about patients. And the fact is most of the human population aren't patients. Most of the human population have never been a patient and might never be a patient until they get truly sick and are close to death.

And I think when we start talking about how do we cost-effectively scale our expertise and our abilities to everybody, to deliver health as opposed to delivering health care, artificial intelligence techniques might actually allow us to achieve that, where, frankly, no number of physicians could accommodate, even if you spread them out worldwide and spend several trillions of trillions and trillions of dollars to create.

But going forward, in terms of final thoughts-- Zachi, what do you see the next steps in these relationships, and building AI, and incrementally adding AI into the health care system?

ITZHAK ZACHI ATTIA: I think that today, as we can get ECGs from our phones, from our watches, from a digital stethoscope, we have much more control on how we monitor our health. And the use of AI can help us do that and only send this to the physicians when we actually need it, or before we actually need it. But I think it can reduce anxiety. It can help you scale health care.

It can especially help in rural areas, where it's harder to see a physician, or to other countries when there's one physician over 10,000 people. I think it will be much more significant there. And just by scaling everything to the cloud-- just send your ECG, for example, or your echocardiogram. It's done first analysis by a machine, and only if needed it goes to an actual human being. I think it can help reduce the amount of patients.

SURAJ KAPA: And, Francisco, any final thoughts?

FRANCISCO LOPEZ-JIMENEZ: One common concern around is whether AI is going to take our jobs. And I don't think that should be really a concern. How many years have I remembered when CT scanners and MRIs became standard practice, the idea was that neurologists would be out of work because most of the work they used to do was just trying to make the clinical diagnosis? Well, we know now that neurologists can do amazing things thanks to the technology that MRIs and CT scans brought.

So I think AI is going to help us to be better doctors, to practice better medicine, more individualized, more precise medicine every day. And it's going to, perhaps, give us more time to spend face-to-face with the patient, particularly as AI might help us to navigate the electronic medical system in a smart way, in a more efficient way that will definitely impact the quality of life of providers and the health of our patients.

SURAJ KAPA: So, in other words, AI might let us become human again?

FRANCISCO LOPEZ-JIMENEZ: Perhaps.

ITZHAK ZACHI ATTIA: We're getting somewhere, I think.

FRANCISCO LOPEZ-JIMENEZ: That's a great point.

SURAJ KAPA: So, thank you, Francisco. Thank you, Zachi, for joining us. And thank you, everybody else, for joining us on theheart.org, Medscape Cardiology.

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