Cardiac Allograft Rejection Using AI-ECG

Announcer: Welcome to Mayo Clinic's ECG Segment: Making Waves, Continuing Medical Education podcast. Join us every other week for a lively discussion on the latest and greatest in the field of Electrocardiography. We'll discuss some of the exciting and innovative work happening at Mayo Clinic and beyond with the most brilliant minds in the space, and provide valuable insights that can be directly applied to your practice.

Dr. Kashou: Welcome to Mayo Clinic's ECG Segment: Making Waves Continuing Medical Education podcast. Join us every other week for a lively discussion on the latest and greatest in the field of electrocardiography. We'll discuss some of the exciting and innovative work happening at Mayo Clinic and beyond, with the most brilliant minds in the space and provide valuable insights that can be directly applied to your practice. Welcome to Mayo Clinic's ECG Segment: Making Waves. We're so glad you could join us. Today, we have an exciting episode planned for you as we discuss the use of an ECG-based artificial intelligence model to screen for allograft rejection among heart transplant recipients. We have an expert discussing, joining us who will help us, give us a unique perspective and experience from her end on this topic. So let's get started. Now, allograft rejection remains an important complication to screen for in following a heart transplant. However, a non-invasive means of detecting allograft rejection have shown limited discrimination. A recent study from our Mayo Clinic team looked at a non-invasive means using an AI ECG-based model to detect allograft rejection. In this episode, we have a chance to explore this work. We're fortunate to have the lead investigator, Dr. Demilade Adedinsewo with us today to discuss it more. Dr. Adedinsewo is an assistant professor of medicine and non-invasive cardiologist at Mayo Clinic in Florida, with research interests in the application of artificial intelligence tools in cardiology. She is currently a K-12 scholar in the Mayo Clinic Building Interdisciplinary Research Careers in Women's Health program funded by the National Institutes of Health. Dr. Adedinsewo, what a true honor to have you with us. Thank you so much for joining us.

Dr. Adedinsewo: Thank you so much for having me.

Dr. Kashou: You know, well this is really an important topic. We see this in our patients in the hospital and the transplant, and it's quite unique and that's why I really wanted to get you on here to share a little bit. Maybe you can introduce the project to our listeners and tell us about why this study is so important to us from the clinical side.

Dr. Adedinsewo: So you mentioned this earlier, allograft rejection is a big issue among our heart transplant recipients and it's one of the things that we have to monitor them for clinically. So I would say in the last several years really, the transplant community has been very much interested in finding a non-invasive way to screen these patients. So what is considered the gold standard of care is an endomyocardial biopsy, so this is an invasive procedure where we take the patients to a procedure room and we are inserting catheters into the heart and we're trying to get a piece or a sample of the heart tissue that we then evaluate, you know looking under a microscope, do a pathological analysis to see if there's any evidence of rejection. So, so far currently available non-invasive methods use blood tests and this blood test is gradually, should I say becoming more mainstream now because providers are looking to get away from this

invasive procedure which is not only expensive for the patient, is also comes with risks of an invasive procedure. There's the risk of significant complications like a pericardial effusion or damage to the heart valve that might even require either another cardiac surgery or even a repeat heart transplant. So this is a big issue and with the available blood test-based methods, there's also limitations to them and they're not of course a hundred percent accurate and it also takes time to turn around. So that's why the study was important, can we use something as ubiquitous as the ECG which we already obtain in this patient to predict the likelihood of rejection and save them an invasive procedure?

Dr. Kashou: It is quite fascinating. So going from almost you know, the endocardial biopsy to you know, invasive means but you're saying going completely non-invasively you know, with this approach to screen them. So I guess, what do the steps in developing this project look like?

Dr. Adedinsewo: So the great thing about Mayo Clinic is we have a large database that we can potentially look at to evaluate this research question and you know, we've been performing heart transplants now for a number of years. So using the Mayo Clinic database from all three sites, Mayo Clinic in Rochester, Arizona, as well as in Florida, we were able to extract data on heart transplant recipients over time and this included digital 12-lead ECG data, data of their heart transplant, as well as all endomyocardial biopsies that these patients have had and the final results of those biopsies. I should mention that early on, and you know the practice varies across site that it's possible that patients are getting up to 14 biopsies within the first year of having a heart transplant. So, a lot of results that we could look at and what we did was, we developed a model that is based on a convolutional neural network that takes this data from the 12-lead ECG to see if we can train it to predict the results on the endomyocardial biopsy.

Dr. Kashou: Very neat and speaking of the results, what are the results from this study look, look like?

Dr. Adedinsewo: So they've actually been quite interesting, we found that using the 12-lead ECG data by itself we are able to predict the likelihood of cardiac allograft rejection with an AUC of 0.84 and that was what was recently published in the manuscript that you referred to early on. We also conducted a smaller pilot study because we wanted to make sure that apart from looking at the data retrospectively, wanted to be sure that this works prospectively. So what we did was a small pilot study here in Florida, where we enrolled whole heart transplant recipients that were coming in for an endomyocardial biopsy. So we approached them just before they got, you know on the day of their procedure to see if they would be willing to participate and what we did was, we recorded 12-lead ECG just before they got their biopsy and then we followed up their results to see what it showed and the likelihood of rejection now is becoming more rare with advances in the medical therapies that we use, but we found two cases of rejection in that small perspective study where we enrolled roughly about 80 patients over a few months and the AI ECG model correctly identified both cases of rejection.

Dr. Kashou: Hmm, it's quite fascinating and you wonder you know, if it's looking at the change between the baseline, a different arrhythmia and some maybe conduction disturbance from that and I, I don't know if you looked into that but I guess what are, this is such an important study. What do you see as the potential implications of this to the patients we deliver care to?

Dr. Adedinsewo: So I would answer both parts of the questions, like what could the model be looking at? So one thing we did was we also evaluated you know, the clinical features of the ECG, what are the changes that we see on the ECG among patients with rejection? And one of the reasons why we thought that this would be a potentially good way to create a model was because we do know that among patients who'll have severe rejection, there's evidence of ECG changes that we clearly see. So our thoughts are, is it possible that there's some subtle changes that happen early before they get to that severe rejection that the model could pick up? So of course, we found differences in the ECG features, so heart rate was a little bit faster among ECGs that for patients who had rejection, atrial fibrillation was also more common amongst patients who had rejection. We also noticed things like changes in the QRS duration and all of this is also detailed in our paper, but when we created a separate logistic regression model just based off of those changes that we saw clinically, the AUC wasn't as predictive as the AI model by itself. So it is possible that some of these features that have been taken into account, as well as maybe additional subtle features that we cannot see on the ECG.

Dr. Kashou: Hmm.

Dr. Adedinsewo: Now I am going to switch and talk a little bit about the clinical implications. The implications for us is it allows us to monitor our patients more closely, which means we can monitor them more frequently. Since ECGs are non-invasive, you can get as many as needed. Typically, for this patient within the first year of a heart transplant it usually, you know changes their life in a significant way, they have to be close to a heart transplant center you know, they have to be able to go in to have this procedures done. So if they're living out of town or out of state, they basically have to relocate within the first six months of getting a heart transplant which can be a little bit hard on the patients, but now this allows us the opportunity to have remote monitoring. They can be anywhere and have the ECGs done and transmitted to us, you can check as frequently as you need to if you wanted to monitor them every week or even every day within the first few days of having a heart transplant. So I think that this can be a big issue for the patients as well as providers, reducing healthcare costs, improving convenience for the patients and ultimately improving outcomes.

Dr. Kashou: It's quite amazing and I, I think you hit it on the head why we do sometimes some of these things and you, the quality of life is important and to our heart transplant patients, they're going through such a, a significant thing in their lives and if they could be closer to family, closer to home yet still have the proper care they deserve, it's amazing. Screening approaches to detect early cardiac allograft rejection are important. The ECG appears to offer a non-invasive, readily available, inexpensive, and a rapid approach to do just that. Dr. Adedinsewo, thank you for sharing your exciting new work in this field. It's exciting to see the potential application of these AI-based ECG models for our heart transplant patients. On behalf of our team, thank you for taking the time to join us. I hope you'll come back, it's been a true pleasure.

Dr. Adedinsewo: Thank you so much, I truly enjoyed being here.

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