Dr. Stukus; Hello and welcome to Conversations in the World of Allergy, a podcast produced by the American Academy of Allergy, Asthma, and Immunology. I'm your host, Dave Stukus. I'm a board-certified allergist and immunologist and serve as a social media editor for the Academy. Our podcast series will use different formats to interview thought leaders from the world of allergy and immunology. This podcast is not intended to provide any individual medical advice to our listeners. We do hope that our conversations provide evidence-based information. Any questions pertaining to one's own health should always be discussed with their personal physician. The Find an Allergist http://allergist.aaaai.org/find/ search engine on the academy website is a useful tool to locate a listing of board-certified allergists in your area. Finally, use of this audio program is subject to the American Academy of Allergy, Asthma, & Immunology terms of use agreement which you can find at http://www.AAAAI.org. Today's edition of our Conversations from the World of Allergy podcast series has been accredited for continuing medical education credit. The American Academy of Allergy, Asthma, and Immunology is accredited by the Accreditation Council for Continuing Medical Education to provide continuing medical education for physicians. Information about credit claiming for this and other episodes can be found at https://education.aaaai.org/podcasts/podcasts. Credit claiming will be available for one year from the episode's original release date. Today, we are pleased to welcome Sunit Jariwala, who will discuss the rapidly expanding field of mobile health technology. Dr. Jariwala is an associate professor of medicine and the director of research within the Division of Allergy and Immunology at Albert Einstein College of Medicine in Montefiore Medical Center. Dr. Jariwala is the vice chair of the Health Informatics Technology and Education Committee within the Academy and serves on the editorial board for the Journal of Allergy and Asthma. With over 40 peer-reviewed publications, Dr. Jariwala has extensive experience as an NAH-funded researcher investigating novel application of technology-based interventions for patient care. Neither Dr. Jariwala nor I have any relevant relationships to disclose. Dr. Jariwala, thank you so much for taking the time to join us today and welcome to the show!

Dr. Sunit Jariwala: Dr. Stukus, thanks so much for the opportunity. I'm very excited to be here and I'm looking forward to our conversation.

Dr. Stukus: Excellent. Well, before we begin discussing mobile health-- or it's also abbreviated "mHealth"-- can you just take a few moments and explain what that term means?

Dr. Sunit Jariwala: Absolutely. It's a great question to start since there are so many buzz words in the health information and technology space. So, first, digital health represents the use of information technology to support health and health-related fields. And digital health is a broad term that includes mobile health, or mHealth, and other emerging areas such as electronic health record systems and artificial intelligence. mHealth is a category within digital health and is a use of mobile wireless technologies, such as mobile phones and tablets, to provide health services and information.

Dr. Stukus: So, that sounds like it covers a lot of ground. Can you describe a little bit about how the realm of digital health has evolved over the past few years?

Dr. Sunit Jariwala: Absolutely. So, so many examples. So, car phones and land lines from a few decades ago evolved into the mobile phones and super computers that we now carry in our pockets. Floppy discs evolved into cloud-based servers that can hold billions of gigabytes of data. The common theme here is the widespread access to these technologies by patients, providers, and hospitals. And technologies continue to rapidly advance. The next wave of technology in healthcare will be even more personalized, engaging, cost-effective, and powerful.

Dr. Stukus: So, it really-- it seems like it's application of the technology that's been expanding naturally for all of us and just really applying that to our healthcare? Does that sound accurate to you?

Dr. Sunit Jariwala: Absolutely correct: application as well as accessibility by patients and providers.

Dr. Stukus: All right. So, this is exciting times. And I'm sure it's evolving even more rapidly currently. Do you have any sense of how well these mHealth technologies have been adopted? Do patients seem to like them and, if so, what features seem to be most desired?

Dr. Sunit Jariwala: So, patient adoption of mHealth tools has been increasing steadily with about 80 percent adoption in 2015 and nearly 90 percent adoption in the past year. And nearly half of patients are using mHealth apps compared to just 15 percent in 2015. However, there are challenges. So, the sustained patient use of apps is quite limited. A recent asthma mobile health apps study had, for example, 41,000 app downloads at baseline and 173 six-month active users. So, we need to do more in terms of usability. And the trending mHealth tools are wearables, remote patient monitoring tools, gamified apps, and also tools that enable telehealth visits. All of these have been linked to high patient satisfaction, although adoption is not yet widespread.

Dr. Stukus: Now do we have a sense of what features people seem to like the most? Does it seem to be more wearable technology or the ability to access their electronic medical record on the smartphone or something along those lines?

Dr. Sunit Jariwala: Right. So, a lot of these are emerging concepts. Interoperability, for example: Patient app data into the HR will be big in the next few years, although it has been difficult in terms of the access. Same with wearables and patient monitoring devices, such as electronic inhaler sensors. So, right, especially with features, patients seem to like the tailored, personalized features, such as games which are engaging as well as tailored push notifications. And, soon, wearables, remote patient monitoring devices, and EHR inoperability will be more accessible.

Dr. Stukus: And you mentioned a key concept of how there's a ton of people downloading these apps, but very few are actually using them on a regular basis. And if it's anything like what I do with my phone, it seems like a really good idea in the moment, I download the app, I open it, I use it a couple of times and then I forget about it. Do you think that's generally what's going on here as well?

Dr. Sunit Jariwala: Right, right. There are a lot of data, for example, of just the first use and then within six months I think less than ten percent of patients are actually using these devices, using these apps. So, a lot of it depends on which features are important to patients, how involved they are in the development process, patient feedback, and app iteration based on how the patients perceive the features.

Dr. Stukus: Well, I'm going to pick your brain more on that in just a minute. But let's go back for a second and talk about physicians and medical providers. Are we jumping on the mHealth bandwagon as well? And if not, what are some reasons why?

Dr. Sunit Jariwala: Sure. So, over the past few years, we have seen increasing adoption by physicians and providers. And, currently, almost 95 percent of clinicians feel that mHealth apps can improve patient outcomes. mHealth has, of course, real potential to improve provider workflows and also improve the quality of health, quality of care, and patient safety. But we're not completely there yet. There are thousands of mHealth apps that have not been validated or developed through user-centered design, which really means obtaining patient and provider feedback in the development process. Also, less than one percent of apps have been clinically validated. Many mHealth interventions lack reliable data collection and reporting; and others hinder rather than help provider work flows. Other mHealth apps lack basic privacy and data security features and also engaging features that really promote long-term use. So, these are important barriers to adoption, although opportunities for improvement.

Dr. Stukus: And it seems like with-- like you mentioned, a lot of these apps have not even been validated or are lacking certain key features. It seems like it's impossible for any of us to really understand the vast array of options that are out there and then to fully vet them. Are there any resources currently available to assist medical providers in doing that?

Dr. Sunit Jariwala: Right. So, I mean, in terms of repositories there are several being formed at the national level and then, of course, provider-- professional organizations, such as the AAAAI's HITE Committee. We really look at the apps critically, look at the published literature, and then can always help sort things out.

Dr. Stukus: And it's my understanding that as far as any sort of governmental or FDA regulation that unless it's really a Class 2 medical device-- so, some sort of attachment that does some special reading or office diagnostics or something like that, that these really-- they're not regulated on a higher level. Is that correct?

Dr. Sunit Jariwala: That is correct. The FDA-- they're still adapting the guidelines and there are varying parts of the spectrum-- for example, enforcement discretion-- and then they have the 510(k) and then the full PMA.

Dr. Stukus: Okay, so, stay tuned, I suppose.

Dr. Sunit Jariwala: Absolutely. In the next year or two we should get much more direction in the space.

Dr. Stukus: Now, as our podcast is geared mostly towards patients and medical professionals who deal with allergic conditions and asthma, can you give us some examples of mHealth technologies currently available for these conditions? What kind of features do they have and how are they being used?

Dr. Sunit Jariwala: Sure. So, existing and novel technologies include remote monitoring devices such as electronic inhaler sensors and also electronic peak flow meters. And these can promote medication adherence and also enable care coordination. And then we have the patient self-management apps for asthma, allergic conditions, which include symptom-trackers and wearables, text-messaging based on adherence support, educational apps that might include educational videos, push notifications, games and quizzes, and, also, electronic symptom diaries and asthma action plans.

Dr. Stukus: That sounds like a vast array with very different platforms that people are using. In your experience with your own patients, are people gravitating towards one or another or does it just depend on the person?

Dr. Sunit Jariwala: Right, it depends on the person, just really what's customized for the patient's use and whatever the patient sees as most important based on their pain points. In the asthma space, we're seeing gravitation towards electronic inhaler sensors and these technologies will be greatly enhanced in the next few years through other more sophisticated features, such as artificial intelligence and interoperability EHR integration.

Dr. Stukus: Now, can you speak a little bit about the sensors? That seems like an intriguing prospect, especially with asthma where we know the difficulty with adherence is quite common. What are some of the features that these sensors offer? Is it a reminder system or does it more just track usage?

Dr. Sunit Jariwala: Right. So, all of the above. So, these sensors are Bluetooth-capable and some have innate Bluetooth abilities. So, you track medication adherence with every actuation of the inhaler and then patients can self-track medications, medication use; and on the other side, the providers, outreach workers can also track on their end and then potentially reach out to patients who have some optimal adherence. And then a few of these sensors also have GPS-based air quality alerts and then also some sensors are embedded into the medications themselves.

Dr. Stukus: Wow, that's pretty impressive. Has anybody developed an app that actually can pick up the medication and hand it to the patient so they use it on a consistent basis?

Dr. Sunit Jariwala: Not yet, but, hopefully, one day.

Dr. Stukus: That would be nice.

Dr. Sunit Jariwala: Yeah.

Dr. Stukus: We'll talk offline.

Dr. Stukus: Now, let's go back to this important concept that you mentioned before, because I'd really like to pick your brain on this one. And we-- you talked about how rapidly this field has expanded in recent years and some challenges with widespread adoption. So, talk a little bit more about some of these challenges that patients face in adapting to these new technologies. They're downloading them, but not using them. What are some reasons why?

Dr. Sunit Jariwala: Right, so, first and foremost, access to technologies is always an important barrier; although, fortunately, most of our patients have access to smartphones and tablets, unlike in years past. The other issue is in finding reliable technologies since there's so many apps developed and launched on a daily basis, this is where provider recommendations-- also, recommendations from professional organizations-- can really help. The other issue is in the usability space. So many technologies have not incorporated user-centered designed, which involves obtaining user-- for example, patient-provider feedback-- through every stage of the development and implementation process and even before development starts. And this design process can really guide the target features and content in a patient-centered manner.

Dr. Stukus: Do we have a sense of-- are these mobile health technologies being developed by actual asthma experts and clinicians or is it more start-up companies? And people don't fully understand the medical aspect of these conditions or is it sort of a mixture?

Dr. Sunit Jariwala: Right. Definitely a mixture. So, apps are being developed by asthma experts, providers, as well as by companies, but there has been this documented divide between the end user and the developer. So, really, the target features, the patient's pain points, and really customizing the content is so important.

Dr. Stukus: Now we know that access to the mHealth technology is important. So, people need to have either smartphones or the ability to connect to the Internet or things like that. But what are some other optimal patient characteristics that might make some people more likely to use these mHealth technologies compared to others? Are there any other psychological aspects of this, perhaps?

Dr. Sunit Jariwala: Right, so, we always think of innovation adopters and the diffusion of innovations, for example, the spectrum ranges from innovators to early adopters to the early majority-- to the later majority, to laggards. So, when starting to develop and implement an mHealth technology or tool, early adopters are the most influential group of patients in using the product, providing feedback, and helping with dissemination through their influence channels. So, the key characteristics of early adopters include being tech-focused, willing to take risks and experiment even if the tool might be rough around the edges. And then, as the product evolves, the early majority becomes the most important group in sustaining the mHealth tool. But the key take-home is that there's no one-size-fits-all approach. It's really important to obtain user feedback from multiple users through all stages of the development and implementation process and rapidly iterate based on feedback from all parties from patients, providers, healthcare systems.

Dr. Stukus: Yeah, as you describe more and more of this, it just seems so complicated on many different levels and I think it would behoove all of us to really keep this in mind of "It's not one-size-fits-all" when it comes to feasibility and acceptability and things along those lines. So, thanks for that sort of background into that.

Dr. Sunit Jariwala: Definitely, because our healthcare system is so complicated. There's so many different stakeholders and it's always important early on in the process just to determine which types of features might help the different stakeholders.

Dr. Stukus: Do you envision anything in the future where it would be at the time of, say, office visit where these technologies are discussed and then office personnel actually take the time to run through them and try to get a better sense of which ones may be more likely to be adopted by that individual patient?

Dr. Sunit Jariwala: Yes, absolutely. Right now we are seeing more app repositories being created and then these could be personalized to the patients' use as well. Absolutely.

Dr. Stukus: We talked about how these mHealth technologies can assist patients, but how can they help medical providers?

Dr. Sunit Jariwala: So, these patient-facing tools can also supplement in-office clinical care by delivering education and adherence support, which just may not be possible within the time constraints of a clinical visit. And mHealth technologies can also collect patient-generated data, which can then be integrated with the EHR system and providers can use the point of care to help with clinical decision-making. As a result, mHealth tools can also help with shared decision-making. Then there are provider-facing tools which can help to improve clinical work flows and reduce documentation time while also helping to reduce provider burnout.

Dr. Stukus: Is this something like during a visit somebody has an iPad or similar device in the office while they're waiting for the physician or nurse to enter the room that gives them education,that they can interact with to get information? Is that sort of what you're alluding to?

Dr. Sunit Jariwala: Absolutely. So, on-site health educators as well as the digital health parallels. So, educational tools that can develop education. Then we also have the concept of-- emerging concept of virtual scribes, which have been shown to really reduce documentation time as well as pre-intake-- pre-clinical intake registration systems. So, in my typical allergy practice I have maybe 50 intake questions, but these can be entered maybe before the visit and then enter the EHR system just for improved clinical work flows.

Dr. Stukus: So, this really can just infiltrate all aspects of clinical care. It's really exciting.

Dr. Sunit Jariwala: Definitely. Optimize efficiency, otherwise reduce documentation time, and overall physician well-being. Absolutely.

Dr. Stukus: And how do these technologies address important features, such as maintaining patient privacy and secure data? I'm sure that's a concern among many people.

Dr. Sunit Jariwala: Right, right. That's a great question. And, especially among many mHealth tools, unfortunately, many do not adequately address patient privacy and data security. So, mHealth tools with identifying information can take precautions, such as-- not to get too technical, but encryption in transit, encryption at rest, and also tokenization. And these tools should also have easily accessible terms of use and privacy policies. Just in the development process itself, usually to really optimize security, there's always penetration testing to evaluate for potential security lapses, which can be fixed. But, just to kind of summarize, many mHealth tools lack these features. So, it's really important to vet these out properly before patients use them.

Dr. Stukus: Is there any easy way for somebody to know whether those features are present or not or do they really have to take a deep dive into each specific application?

Dr. Sunit Jariwala: Right, definitely a deep dive. There are these guidelines now, the security guidelines. They have a checklist that can help out with the process. For example, if an app has a terms of use, privacy policy, if it has backend data encryption, but, again, it become quite technical. So, just a deep dive and looking at it more closely.

Dr. Stukus: And I'm sure a lot of folks, including myself may not understand what a lot of this language means as well. Along those lines, what would you say to a patient who expresses concern about Big Brother watching, if they were to use some of these technologies?

Dr. Sunit Jariwala: So, since these are patient-centered technologies patient preferences must be first and foremost. For example, even mistrust of an mHealth tool could lead to a lack of adoption and use. However, I would try to explain that many mHealth tools have patient privacy features, help providers deliver and optimize care and could also help to improve clinical outcomes. At the very least, the tool could be worth a try.

Dr. Stukus: And are there aspects or are there applications where there's no private data that is entered or stored or anything like that? Are there options that just have more general information or medication tracking, things along those lines?

Dr. Sunit Jariwala: There are, for example, medication adherence reminders as well as educational tools. However, with the more general tools, then one lacks the personalize-able features. So, there is a trade-off.

Dr. Stukus: Can you describe your personal experience with developing and then studying the use of mHealth technology for patient care and, most importantly, have you learned any lessons that you can help our next generation of app developers?

Dr. Sunit Jariwala: So, since 2014, our team at Einstein Montefiore has been developing, implementing, and evaluating a patient-facing mobile health app for adults and children with asthma. And our solution helps alleviate the critical time constraints faced by outpatient or asthma providers. Throughout the process we assembled a multi-disciplinary team, which includes asthma clinician researchers, a behavioral scientist, a statistician, software programmers, study coordinators, UI/UX experts, and Animation Studio. And from the start of the project we sought patient and provider feedback to guide our development of the apps, features, and content, and the current features include tailored educational content, personalized push notifications, the collection of patient reported outcomes and EHR integration. Our pilot testing has shown that the app favorably impacts processing clinical outcomes, such as asthma control. And we are currently enhancing the functionality of the app and conducting randomized control trials for their validated platform. Our take-home lessons are the importance of a team-based effort; otherwise, the need iteratively refine the tool based on user feedback; and also promoting long-term use throughout behavior content and usability testing.

Dr. Stukus: That seems pretty involved.

Dr. Sunit Jariwala: It's a lot of fun!

Dr. Stukus: Yeah, it sounds like it. Can you help our listeners better understand what's the timeline from conception to implementation? Is this something that you did over six months or six years?

Dr. Sunit Jariwala: Great. So, this was the first app ever developed at Einstein Montefiore. So, it took, I'd say, longer than we'd initially intended. But, otherwise, initiated with a PowerPoint and then explored multiple funding sources. And then once the grants came through, then we hired a programmer, and then just enhanced the content. We initially had patient and provider feedback. We've gone through about 300 iteration cycles based on changing guidelines and really optimizing the educational experience. And then once we did the prototype, then it was all about pilot testing, recruiting patients. Then we had the pilot test for adults and kids. And then, based on our proven data, then the current RCTs. And now we are looking towards more enhanced features, such as EHR integration and the next wave of this field such as digital phenotyping, personalized medicine. So, the app has come a long way, but it's been so exciting and I can't wait to really-- the next steps will be a lot of fun.

Dr. Stukus: It sounds like it. What year did you start working on this?

Dr. Sunit Jariwala: We started in 2014.

Dr. Stukus: Okay. And for our listeners, this is 2019 right now. So, that gives us a good sense of really the dedicated, like you mentioned, broad team-based approach to development of these apps. It's a lot more involved than just "I have an idea for an app," and then putting it out there two weeks later. And I know there's going to be a lot of variability, but can you give our listeners a sense of the cost involved in developing some of these apps? And, of course, it'll all change, based upon the features and things like that, but is this something that can be done for a few hundred dollars or is it going to cost $100,000?

Dr. Sunit Jariwala: Right. So, nowadays-- that's a great question. Nowadays, there are a lot of services out there that even without technical expertise, one can build apps. So, that's an easy way to do it. Even our initial app, which is purely a PowerPoint base, we had homemade videos; so, a lot of just kind of sitting there in the exam room just showing videos in our phones. So, it was really exciting. But it was definitely a broad spectrum, for example, the minimal app to very, very enhanced features. But I think the take-home also is just kind of how many features do you really need and really what's sufficient for your intended purpose?

Dr. Stukus: Okay. So, good luck. And we can't wait to see what you find.

Dr. Sunit Jariwala: Thank you so much. Really appreciate it.

Dr. Stukus: Yeah. Now, I want to go back to something you mentioned early on and build upon that. You mentioned that a lot of the currently available apps haven't really been validated or studied in any way. And they're just out there. There's thousands and thousands of these that people can download and start using right away and be inaccurate or contain, you know, incorrect information. In regards to research surrounding mHealth technologies, what types of studies have been published and, in particular, have they been shown to positively influence truly meaningful outcome measures, for instance, emergency department visits for asthma? And, essentially, is this all marketing and hype or do we think that there's actually something clinically meaningful here?

Dr. Sunit Jariwala: So, most apps haven't been clinically validated. About one percent have been. So, remote monitoring devices, especially electronic inhaler sensors, have been linked to improved asthma control and their rescue-medication-free days. Otherwise, symptom trackers, which measure call frequency, have been shown to predict asthma control and a quality of life at three months. Text messaging apps for medication reminders have been linked with improved asthma quality of life. And while these results are promising, very few mHealth apps have been linked to reductions in asthma, emergency department visits, and hospitalizations. And there are several reasons for this. For example, many of the studies have been underpowered for utilization outcomes or have a short follow period.

Dr. Stukus: So, it sounds like those folks that are studying these in some manner, but not along the lines of the randomized control trials that you're conducting, for instance. Do you see a path where we need to see more and more proper studies done on these apps in order to build the evidence surrounding them? Or do you think that it's just a waste of time and we'll never get to that point?

Dr. Sunit Jariwala: I think it's so important. For example, even data regarding usability app usage behind the scenes: app analytics. And then we also have the pilot testing, which can help to power the RCTs, and then the next step, the larger pragmatic trials recording real-world use I think is really, really important. So, also, the need for rigorously designing studies, which can be challenging with this emerging space.

Dr. Stukus: And I know that the journals associated with the allergy organizations and the national meetings have devoted space to these issues as well and I'm sure that they'll continue to peer review any

studies that are submitted to them. So, hopefully, we continue to see researchers out there that are interested in doing so.

Dr. Sunit Jariwala: I agree. Studies, as well as guidelines, parameters, I think, might be the wave of the immediate near-future.

Dr. Stukus: And how do you see the mHealth field evolving over the next few years?

Dr. Sunit Jariwala: Sure, so, app-EHR integration will become more streamlined and this will enable personalized medicine-based approaches. And we'll also realize the value of the unstructured data elements within the EHR and apps through natural language processing. Also, mHealth tools will include immersive patient engagement features that include augmented reality, mixed reality, and virtual reality. And apps will increasingly support virtual visits and artificial intelligence-based decision support to improve clinical care.

Dr. Stukus: And along those lines, do you foresee, as you mentioned, patient characteristics being entered into the electronic medical record and then algorithms behind the scene sort of recommending specific treatment options based upon those characteristics? Or can you expand upon that a little bit more?

Dr. Sunit Jariwala: Right, definitely. So, patient-generated health data will be entered into the apps and then this data will be fed into the EHR system. And then the EHR will-- or another platform will at least help to analyze this in a more sophisticated way through AI and then, hopefully, will predict health outcomes, risks for re-admissions, risks for asthma exacerbations at the point of care.

Dr. Stukus: That will be truly amazing. And I know that a lot of our listeners-- or I don't know how many, but there are people out there that this technology just scares them. It's different. It's rapidly evolving and it's scary in many ways. Can you talk about some of the risks as well as benefits and possible even adverse effects of mHealth technology?

Dr. Sunit Jariwala: Sure. Regarding the risks, so many apps out there, how do we know which one to pick? For example, very few have been clinically validated. Some apps make medical claims, not really supported by clinical outcomes data and published studies. So, the keys are to identify reliable and clinically validated technologies that are usable by patients. But, however, so many benefits, including a positive impact in clinical outcomes; improved patient knowledge about their condition; improved patient engagement; as well as improved process outcomes, such as patient and provider satisfaction; and, ultimately, improved provider work flows. And then possible adverse effects include data privacy, security risks, and patients over-reliance on apps to self-manage their conditions. Apps do not replace doctors and can instead supplement the clinical care. They can instead facilitate shared decision-making, because the patient and provider and have such great potential that way. It's also so difficult to keep up with the latest technologies and policy updates; and, for this reason, I would encourage providers to participate in mHealth-oriented interest groups, such as the AAAAI's HITE Committee, in order to create an ecosystem of shared learned. By joining such communities, providers can really avoid re-inventing the

wheel and instead learn from the experiences of others in the mHealth space and contribute to this discussion as well.

Dr. Stukus: I love what you said about how these apps and these technologies do not replace current standard of care, especially given the lack of evidence demonstrating the benefit for the vast majority of these. Is that something that you think should be a standard sort of explanation between medical providers and patients in regards to these?

Dr. Sunit Jariwala: That'd be great. Absolutely. Apps are here to help patients as well as providers and really facilitate communication between the two.

Dr. Stukus: And do you have any words of wisdom to help patients and medical professionals better understand the optimal uses and limitations? Do you have sort of an elevator speech surrounding this complicated milieu of mHealth applications?

Dr. Sunit Jariwala: Definitely. So, there's definitely no one-size-fits-all approach. It's finding the app, finding that platform that really speaks to the patient, speaks to the providers' clinical work flows. Another aspect is also the users that are-- design the usability nature of the app. So, it should be usable; it should be user-friendly by patients. The other part of it is the clinical validation piece. So, the app should be supported by evidence.

Dr. Stukus: Okay, great. Thank you. Today we covered a lot of ground. I think that for each one of these talking points, we could probably spend 30 to 60 minutes really going into the weeds, but I think this was a fantastic overview for our listeners just to give them a sense of the broad range of currently available mobile health technologies as well as a lot of the challenges that exist and potential future applications. So, thank you again for taking the time to be with us today. I think this was really helpful and very interesting. Is there anything else you'd like to add?

Dr. Sunit Jariwala: No. Thank you so much for your invitation. I really enjoyed our conversation. And, Dr. Stukus, thanks so much for your efforts and help putting this together and for your leadership in the AAAAI community. So, really appreciate it.

Dr. Stukus: Well, thank you. We hope you enjoyed listening to today's episode. Please visit http://www.AAAAI.org for show notes and any pertinent links from today's conversation. If you liked the show, please take a moment to subscribe to our podcast through iTunes or Google Play so you can receive new episodes in the future. Thank you again for listening.