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Cracking the Migraine Code: How AI May Transform Diagnosis and Treatment

Announcer:
You're listening to *On the Frontlines of Migraine* on ReachMD. Here's your host, Ashley Baker.

Ashley Baker:
Welcome to *On the Frontlines of Migraine* on ReachMD. I'm Ashley Baker, and joining me to discuss the role of artificial intelligence, or AI, in migraine care is Dr. Chia-Chun Chiang. Dr. Chiang is an Associate Professor of Neurology and a consultant in the Department of Neurology at Mayo Clinic in Rochester, Minnesota.

Dr. Chiang, we're so glad to have you here today.

Dr. Chiang:
Thank you so much for having me. I'm very honored to be here.

Ashley Baker:
To set the stage for our discussion, Dr. Chiang, could you walk us through some of the current gaps in migraine care and how AI could help address them?

Dr. Chiang:
Certainly. I think one problem is that migraine is such a highly prevalent neurological disorder, and there's not enough headache specialists to meet that need. So, just to give you an example, around 16 percent, or one million people, globally have migraine. However, for example, in the US, the prevalence was similar at 16 percent, but there are only 700 or 750 headache specialists. So there are not enough doctors to meet that need. So one problem is access to care to address this highly prevalent disorder.

Second, once a patient is even able to get the diagnosis of migraine, a lot of times patients are not offered treatment. They do not know treatment exists for migraine, or they are not offered appropriate treatment for them. For example, a lot of patients with migraine, they either don't talk about it with their doctor, or they use over-the-counter medication. They don't know migraine-specific medications exist. And even sometimes they use or misuse it, and sometimes they overuse it. Even once patients are able to use it, sometimes the treatments that are offered to them are limited as well. So I think that is the second gap, meaning that the first gap is access to care, being able to be diagnosed migraine. The second is, once migraine is diagnosed, a lot of times they are not offered appropriate treatments.

And then getting to the third gap, I think, once a treatment is started, currently, the standard of care for migraine is a trial-and-error process. It means that there are many medications that are available for the acute and preventive treatment of migraine, and there's no way to predict whether the patient would respond to one of these medications or not. So we offer the medications to the patients. We ask them to try this medication and see if that's helpful or if they tolerate it. If it's not effective, we offer a second medication and a third, and this process might continue. So I think there's certainly room for improvement in the standard-of-care treatment, that we should be aiming to offer a more precision personalized approach, rather than the trial-and-error process. And that is certainly a gap in migraine care.

So I think those are the gaps currently I see in migraine care. One is access to care. Once they are diagnosed, they are not offered appropriate treatment. And the third is, even when they start treatment, the standard treatment protocol is a trial-and-error process.

Ashley Baker:
Given that context, what types of AI models have shown the most promise so far in predicting treatment response? And what data do

they typically rely on?

Dr. Chiang:
I think that's a great question. There are several groups that have published using machine learning to predict treatment response to migraine-preventive medication, mostly targeting this group of migraine-specific medications called CGRP monoclonal antibodies, or CGRP-targeting therapy. Based on the papers published, most people are using clinical data, meaning demographic information like their age and sex, and the clinical presentation, like their migraine frequency—how many days they have migraine per month—and some of the symptoms that they are having. For example, our own group have published machine learning models to predict treatment response to different migraine-preventive medications as well, and we are mainly using clinical data, including demographic data, how they describe their headache, the migraine-associated symptoms, medications they have tried in the past, family history, et cetera, to fit in the machine learning model so that they generate a response of whether the patient would most likely be a responder to this particular medication or not.

Ashley Baker:
Let's zero in now on technology like wearable sensors and mobile apps. What are some of the pros and cons of using those tools to predict migraine attacks or monitor treatment outcomes?

Dr. Chiang:
I think wearable sensors and mobile apps are getting increasingly used for different prediction tasks. In our field, forecasting or predicting migraine attacks is certainly a big area that a lot of researchers are working on, hoping to develop a tool or machine-learning model that can accurately predict migraine attack so that it would be easier for the patient to plan their day or to plan whether to take a medication on that particular day or not. I think the pros and cons of using this tool is the data might be difficult to harmonize, especially the wearable sensors. The data might be in different format. They're a complex data format.

Second, I think one of the challenges is that for forecasting or predicting migraine attack, it's typically very individualized, meaning that different individuals might have different factors that affect the probability of whether they will have a migraine attack or not. So, based on the current research that have been published, specifically in this area of forecasting migraine attack, there's room for improvement to optimize the performance of these models.

I think there are certainly challenges in using different data sources to forecast migraine attack. But the benefit of doing so is this wearable sensor or mobile app or other type of data format—once developed and fed into an AI model, and once they reach an adequate performance—certainly could optimize the performance of these models so that it can provide more accurate prediction for patients in terms of knowing or predicting when they would have a migraine attack.

Ashley Baker:
For those just tuning in, you're listening to *On the Frontlines of Migraine* on ReachMD. I'm Ashley Baker, and I'm speaking with Dr. Chia-Chun Chiang about AI tools for diagnosing and treating migraine.

So, Dr. Chiang, let's shift gears and talk about multimodal models, which bring together imaging, genetics, and clinical data. Why is this approach so important, and what are the practical barriers to using it in real-world care?

Dr. Chiang:
I think that is a great question. In the review article that we recently published in *Cephalagia* discussing using AI to predict treatment response to migraine-preventive medication, we did emphasize that one of the areas to move forward is incorporate multimodality models in the prediction.

I think this is a very important approach because migraine is a highly complex and heterogeneous disorder, and if we only use a single aspect of data or one single modality, such as clinical data, we might be missing the subtle nuance or signatures that a patient might have in the genetics or in the imaging. For example, they bring MRI or the genetic profile. So I think incorporating multimodality data enables us to capture the complexity of data and incorporate signals or biomarkers from different data modalities.

In terms of the practical barriers to using this, at the model development stage, given that, for example, imaging or even genetic data are highly heterogeneous from different sources, we need to spend huge effort for data harmonization and standardize data extraction protocol.

Ashley Baker:
And looking further ahead, what can you tell us about more innovative tools, like Digital Twins or agentic AI? How might they reshape migraine diagnosis and treatment?

Dr. Chiang:

Certainly, I think that is a very exciting area. So Digital Twins is a virtual replica of an actual patient that updates in real time and can simulate and analyze its real-world counterpart. So I think that would be a very, very powerful tool to model or predict how a patient would do with different interventions, and that can be very helpful for treatment planning.

In terms of agentic AI, that is another area that is gaining a lot of attention. That is certainly a very exciting area as agentic AI is an AI system that has the capacity to operate autonomously and to take initiative in complex decision-making and task execution with minimal human intervention. So, for example, there are different agents, and these agents can work together proactively, monitor and extract data, and identify issues in these systems and proposed solutions. I gave an example in the paper so that we can think about that. For example, when we are working in the hospital, physicians typically work with different teams, or a team of different specialists. So, for example, a hospitalist might be working with a consulting neurologist, cardiologist, a pharmacist, a social worker, or an administrator to take care of a patient. So in an agentic AI system, you could imagine that one AI chatbot could be assigned as a hospitalist, one could be assigned as a social worker, and one could be assigned as an administrator. And then these AI agents could certainly work together to gather information from different aspects, and then the main hospitalist AI agent could gather all the information. So for the physician, they can interact with one main agent to gather all this information for decision-making that was gathered from different aspects. So that is just one of the examples of how an agentic AI system can work.

So I think using an innovative tool, such as Digital Twins or agentic AI system can certainly move the field forward for the AI or machine-learning models to achieve better performance on more sophisticated tasks.

Ashley Baker:
As we come to the end of our program, Dr. Chiang, what do you think needs to happen for these AI tools to move from research settings into routine clinical practice?

Dr. Chiang:
Oh, I think that is an excellent question. Currently, there are a lot of papers being published, mostly on research tools developing AI models and machine-learning models from a research standpoint, but to actually move those AI tools into routine clinical practice, I think there are a lot of steps that needs to be done and completed. First, if the AI model is developed within a single healthcare system, I think validation is needed, whether that will be prospective validation using the same patient population or external validation using a different patient population to make sure to ensure the generalizability of these AI models.

Secondly, I think all AI tools should go through evaluation and governance in terms of evaluating the risk of using this AI tool and the potential bias of these AI tools. So I think the hospital committee—certainly now there are a lot of AI officers in different healthcare systems—would review the performance of these AI models and look at the potential risk of implementing these models and the usability of whether these models are easy to use or understand for clinicians.

And so I think those are the different aspects that need to be considered when moving an AI tool from research into clinical practice.

Ashley Baker:
With those key takeaways in mind, I want to thank my guest, Dr. Chia-Chun Chiang, for joining me to discuss how artificial intelligence can help advance migraine diagnosis and management. Dr. Chiang, it was great having you on the program.

Dr. Chiang:
Thank you so much for having me. I really enjoyed the discussion.

Announcer:
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