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KAI MILLER: My name's Kai Miller. I'm a neurosurgeon here at Mayo Clinic. I was recently hired as both an adult and pediatric surgeon, but with a emphasis in epilepsy, deep-brain stimulation, and eloquent cortex brain tumors. And eloquent cortex brain tumors means tumors in the part of the brain that controls speech and movement, and focusing on surgeries that allow us to maximize the resection of the tumor while, at the same time, preserving as much a function as possible-- so speech and movement.

And that overlaps very nicely with epilepsy surgery, where the goal is not to take a tumor out, but to take out the part of the brain where seizures are starting. I was selected as the Van Wagenen Fellow for 2018-2019. And that's a fellowship that one American graduating neurosurgery resident a year gets, and it lets you go anywhere in the world.

There is a dual focus on operating and on research. So operatively, I'm focusing on pediatric neurosurgery with an emphasis on epilepsy. And I'm also doing research in trying to understand the electrical brain signals that we measure in the course of monitoring for epilepsy as well as focusing on the effect of stimulating the brain. And when we stimulate different areas of the brain, we don't really understand everything about how that influences, not just the part of brain we're stimulating, but every where else connected to that part.

And for epilepsy surgery, that's actually particularly important because our therapies are moving into a new area where we stimulate to try to interrupt seizures, rather than only focusing surgery on cutting out the part of the brain where seizures start because there are many cases where we can't actually take that part of the brain out, and we want another therapy we can offer our patients.

For the past 15 years, I've been doing research in decoding signals that we measure from the brain surface. When I started, this was focused on learning how to decode what the cystical properties of populations and neurons in the brain are. So the populations of cells that make up the brain, turns out that we really had to spend time understanding the signals that they produce.

And now that we've made some headway on that, we've started to take these signals and decode them in order to control cursors on the screen, and in order to, for example, control a mouse on a tablet at the patient's bedside. Now, we want to translate that into devices that can be used to help patients who have entered a locked-in state where they can't control their body.

And, typically, these are patients with ALS or patients who have sustained a brain-stem stroke. And my hope is that we'll be able to provide a portal to the outside world so they can interact independently by decoding the signals from the surface their brain to let them control objects in the outside world.

So I also do research in new mechanisms for deep brain stimulation, where we will focus on decoding activity in the brain and use that as a guide to initiate stimulation. And we think that as we make progress in that, it will open up new mechanisms for deep brain stimulation surgery, where instead of just shutting down particular regions, which is the mechanism that we try to use now, we'll actually modify the disease over time so that we'll help patients actually recover, not just mask particular regions the same way that you would by, let's say, burning the lesion out with a laser or cutting it out surgically.

I also do research in understanding the map of the electrical activity from the middle of the temporal lobe where most seizures start, with the hope that we can have more focal and directed surgery, either with laser ablation, so with laser applied to certain parts of the brain where seizures might be started, or by putting electrodes in that will stimulate to shut down seizures after they start.