



EPILEPSY SURGERY ADVANCEMENTS, OPTIONS, CONSIDERATIONS (WEBINAR TRANSCRIPT)

- Laura: [00:00](#) Welcome, everyone, to today's webinar. I am Laura Lubbers, and I'm the chief scientific officer of Citizens United for Research in Epilepsy, or CURE. I want to thank you all for joining us today. Today's webinar is entitled Epilepsy Surgery: Advancements, Options, & Considerations. We'll discuss how people with epilepsy, their family, and their neurologist or epileptologist may utilize surgery to treat some forms of epilepsy. In this webinar, Dr. Kate Davis will discuss recent advances in epilepsy surgery, which have increased the types of surgery available to patients, and also how many people may qualify for surgery.
- Laura: [00:41](#) Dr. Davis will also discuss the different tests performed as part of the surgical evaluation, and review current surgical options including resective surgery, laser ablation, and implantable devices. This is the fourth installment of our 2019 Leaders in Epilepsy Research webinar series, where we highlight some of the critical research that's being done on epilepsy. Today's webinar is being sponsored by our friends at the BAND Foundation. CURE's mission is to find a cure for epilepsy by promoting and funding patient-focused research. CURE's robust grants portfolio has advanced research across areas such as infantile spasms, post-traumatic epilepsy, sudden unexpected death in epilepsy or SUDEP, and epilepsy genetics.
- Laura: [01:31](#) Dr. Kate Davis, our speaker today, is the medical director of the Epilepsy Surgical Program and the Epilepsy Monitoring Unit at the University of Pennsylvania. Before Dr. Davis starts us off, I'd like to encourage everyone to ask questions. You may submit your questions anytime during the presentation by typing them into the Q and A tab located at the bottom of your Zoom panel, and then click send.
- Laura: [01:55](#) My colleague, Brian Laughlin, will read them aloud during the Q and A portion of the webinar. We do want this webinar to be as interactive and informative as possible. However, to respect everyone's privacy, we ask that you make your questions general and not specific to a loved one's epilepsy. I also want to mention that today's webinar, as well as all previous

and future webinars, will be recorded and are available on the CURE website. So with that, I'd like to turn it over to Dr. Davis.

Dr. Kate Davis: [02:28](#)

Thank you so much for this opportunity to talk to you all today. I'm really excited, and of course CURE is an amazing organization that helps so many of my patients. These are just some of my disclosures. Then I think first, whenever talking about epilepsy and surgical options in epilepsy, it's important to take a step back and recognize how common epilepsy is, and how many patients worldwide epilepsy and seizure disorders are impacting. As many of you know, it is much more common than most laypeople or people outside of medicine, and even people within medicine, realize. Part of that, I think, is because of the unfortunately still ongoing stigma surrounding epilepsy and seizures. We still have a lot of work to do there.

Dr. Kate Davis: [03:23](#)

Epilepsy impacts about three million people in the United States, and not only do these patients have seizures, but it also degrades quality of life, limits driving, difficulty finding work, and also causes social and psychological harm. Of these three million patients in the United States, about one third of patients have what we call drug resistant epilepsy, where patients are not responding to medications adequately, and continue to have seizures. Unfortunately in these patients, they have increased risk of injury and death, including from sudden unexplained death in epilepsy, and accidents leading to an 11 times greater risk for death than expected for their age.

Dr. Kate Davis: [04:11](#)

So what is drug-resistant epilepsy? We have a definition from the International League Against Epilepsy that really is supported by very good research in our field. The definition is that the patient has failed two appropriately chosen and tolerated seizure medications, or antiepileptic drugs, whether as monotherapy, meaning one drug at a time, or in combination, that's also called polytherapy, to control seizures for what we call an adequate period of time, so not just a week or so.

- Dr. Kate Davis: [04:43](#) That data come from really good, as I mentioned, research showing that, fortunately, about half of patients will have an excellent response when they have new onset epilepsy to their first drug. But unfortunately, there's diminishing returns with additional medication trials. So when you try the second drug, another 11% of patients will have very good response and become seizure-free. But when you get past that to the third drug, or multiple drugs, you have very, very few patients becoming seizure-free. That is why we term them drug-resistant.
- Dr. Kate Davis: [05:22](#) I'm going to focus on treatment options for this category of patients, the drug-resistant epilepsy patient population, who has failed at least two of these appropriately chosen seizure medications that have been prescribed by their doctor. There are four main avenues of treatment. I'm going to focus on the ones to the left here of your screen mostly during the talk. The other two options are additional seizure medication trials, or other medications, which I won't have time to talk about today.
- Dr. Kate Davis: [05:56](#) Dietary therapies, which are definitely more commonly used in pediatrics. Again, I'm not going to address that topic today. Then different brain surgery options, including resective surgery, newer approaches such as laser ablation, and intracranial, or inside the head, device placement. And finally, another device called the Vagal Nerve Stimulator. I'm going to focus on these two categories to the left here during the talk today.
- Dr. Kate Davis: [06:29](#) Also important whenever we're thinking about this drug-resistant epilepsy patient population is to recognize, not only are there a lot of these epilepsy patients that are not responding to medications in the United States, estimated to be between 800,000 and 1,000,000 patient. But unfortunately, a lot of patients are taking a very long time to get to appropriate therapies. The researchers have looked at this, and unfortunately, the average patient is stalled in getting the appropriate evaluation for potential cure from surgery or a device for about 20 years.
- Dr. Kate Davis: [07:09](#) That is a huge gap in our treatment of epilepsy patients that we all need to work on. Things like this

webinar, I think, will help as we get more of the word out about what the options are. That really leads to a big treatment gap where we have tons of patients that could benefit from some of our surgical therapies, but really overall a very small number of patients undergo these interventions or surgeries or device placements every year. Hopefully, things like this that CURE are doing will help bring this knowledge out to the patients with epilepsy and their families so they can get the best therapy and places for treatment.

Dr. Kate Davis: [07:55](#) As mentioned by Dr. Lubbers, I'm going to go through what the standard presurgical evaluation is for an epilepsy patient. This varies somewhat from epilepsy center to epilepsy center, but hopefully you all listening today and on the recording, as well, will understand better what all these tests do as I go through them, and how your epilepsy physician team and treatment team uses these tests to make decisions for each patient about what treatment option would be best. I'll go to the next slide and talk about each of these one by one.

Dr. Kate Davis: [08:41](#) First is MRI, that stands for magnetic resonance imaging. We will do MRIs typically in most patients after the first seizure, and that can be very helpful in finding out whether the patient has a high risk of having more seizures, and also why the patient is having seizures. But MRI really plays a critical role in our epilepsy surgical evaluation. We know that if we can find a lesion or an abnormality or a hotspot in the MRI, that increases the chance that a patient is a good surgical candidate, and will have good surgical outcomes significantly.

Dr. Kate Davis: [09:26](#) What kind of MRI do we do? There's actually a special MRI, if you're considering surgery, that you should have. We call it an epilepsy protocol MRI. This is done on a higher field strength MRI magnet that gives us higher resolutions pictures, similar to your high-res TV screen that you may have at home. Also, we will get fine cuts, which are just more thin image acquisitions through certain areas of the brain that have a high chance of having seizures coming from them. That is the area called the hippocampus, or the mesial

temporal lobe. You may have heard those words from your physician prior.

- Dr. Kate Davis: [10:17](#) Why do we do the MRI? We're looking for the different causes of the epilepsy. You can see on the right side that there are generalized seizure types, and on the left side, that there are also focal seizure types. I'm focusing on the focal seizure types today, and those are the patients that are typically considered for an epilepsy surgery. Within focal seizure types, there are multiple different causes of focal seizures. Some of them patients are born with, and that can include that the cells in the brain, as the baby is growing in their mother's womb, have migrated to the wrong place in the brain. That abnormal cluster of cells can cause seizures.
- Dr. Kate Davis: [11:03](#) It also can be infections when the baby is in the womb. There are also structural things on the MRI that we may see, including scarring in that hippocampal region I mentioned before. Of course, brain tumors or neoplasms can cause seizures as well, in addition to multiple other causes including trauma or brain infection. These are all things that we're looking for on the MRI. As I mentioned before, if we can find one of these focal abnormalities or scars, that really improves the prognosis for surgery significantly. It's very important.
- Dr. Kate Davis: [11:49](#) Another test that we do very early on in the epilepsy surgical evaluation is called video scalp EEG. Some people call this Phase 1 as well. That is admission to the hospital into a special part of the hospital called the epilepsy monitoring unit, where we can record EEG brainwaves. The patients are wired up with EEG on their scalp, similar to how you have an EEG as an outpatient, and we record video 24/7 with experts watching the video to make sure that the patient is safe. There we can as safely as possible lower the seizure medications and do other things to bring on seizures so we can actually see them on the EEG, and also on the video.
- Dr. Kate Davis: [12:44](#) When we see them on the EEG, that can help us know where in the brain the seizures are coming from. When we see the seizures on the video, it tells us about what we call the patient's seizure semiology. All

that means is what a patient does during a seizure. That can be extremely helpful, because many seizure semiologies will really give us a lot of information about where in the brain the seizure is coming from. For example, if the right hand is twitching during the seizure at the very beginning of the seizure, we will think that the seizure is probably coming from somewhere right near that part of the brain that controls the motor function of the right hand. That can be extraordinarily helpful.

Dr. Kate Davis: [13:37](#) Another test that many centers, including my center, do for almost all of our epilepsy surgical candidates, is an FDG-PET study. This is another type of brain imaging study similar to getting a brain MRI, but instead, for this study, the patient is given an injection of a substance that will bind to the areas in the brain that are using a lot of sugar or glucose for energy. We are looking for areas where there's not much energy usage in between seizures. That is called hypometabolism.

Dr. Kate Davis: [14:17](#) That is where we would think the seizures are coming from, then. About 80% of temporal lobe epilepsy patients will actually get a lot of information from this test. It also matches other types of tests, like intracranial EEG, which I'm going to talk to you about in a little bit, in many of the cases. This is another piece of the puzzle that gives us a lot of information about where in the brain seizures are coming from.

Dr. Kate Davis: [14:51](#) A few other tests that are standardly done in most centers. One is neuropsychological testing. This is done by a doctor of neuropsychology who is typically on the faculty at whatever epilepsy center that you are going to, and involves pen and paper testing and also some testing with seeing how fast your hands move, and how coordinated the patient is. That test gives us a lot of information about where in a patient's brain isn't working so well. In that area that's not working as well, that is the more likely area that the seizures are coming from.

Dr. Kate Davis: [15:34](#) That gives us a lot of information. It also helps us predict whether there will be any problem with cognition and how the patient's thinking or speaking after the surgery. We use that for a lot of our

discussion while we're considering a patient for surgery. A functional MRI, which is pictured here, during that, you're in an MRI scanner, there's no IV required or injection. It feels to the patient like a fairly normal brain MRI. But during the MRI, the patient's asked to do various tasks like completing sentences, or saying some words, or rhyming.

Dr. Kate Davis: [16:16](#) That causes more blood to go to those areas of the brain, and we can actually image that on this special scan. It gives us a lot of information about where in that patient's brain language is being generated, which can vary from patient to patient. Typically, your language side is the same as your side of your brain that gives you most of your verbal memory, which is very critical for how we function on a day to day basis. Very important information.

Dr. Kate Davis: [16:49](#) Another type of imaging test that is done less frequently at some centers, but there are many centers that do this in a large proportion of their patients, so there's a lot of variability here, is MEG, or magnetoencephalography. This, essentially, again, feels sort of like an MRI to the patient, but is measuring something very different. There's a way that the MEG works that it can actually create synthetic electrodes that are measuring from inside the brain.

Dr. Kate Davis: [17:24](#) If we find that there are consistent areas that show a lot of activity that look like it's where the seizures are coming from, that can be very predictive of surgical outcomes. When it's positive, it can be very helpful. The other thing that can be done during a MEG study is different tasks, like the language tasks that I talked about functional MRI can also be done during a MEG. Also motor tasks, like finger tapping to know where your hand function is located in the brain.

Dr. Kate Davis: [18:01](#) The final imaging study I'll talk about is done even less frequently than MEG, so it's not standard in every patient, and that's a subtraction ictal SPECT. Ictal is a term we use for seizure. That means that's the seizure itself. What a SPECT scan is, is there's an injection given in the epilepsy monitoring unit when the patient's in the hospital at the very, very start of the seizure. This injection will bind quickly to the area that is very highly active in the seizure, the hotspot. Then

the patient, after they go home, will also have another SPECT scan when they're not having a seizure.

Dr. Kate Davis: [18:42](#) Then we can use different software to subtract the two from each other and pull out the hotspot that's hopefully the seizure area. If this is positive, if we can catch the seizure at the beginning, it can be very, very helpful. There are a lot of difficulties with getting the injection right at the beginning, and often this is most appropriate for patients that are having very frequent seizures, and in whom the other tests didn't help us that much. It's done less frequently.

Dr. Kate Davis: [19:15](#) Those are all of the tests that we do prior to deciding what therapy to recommend for a patient. At this point, at most epilepsy centers, all of that data is collected and presented in a multidisciplinary conference where a big team of doctors and other professionals will discuss a patient's case and make a recommendation about what would likely be the best therapy. At our center, that includes the neurosurgeons, all the epilepsy doctors, our epilepsy training doctors, our fellows, the neuropsychologist, the neuroradiologist, and our nuclear medicine doctor. All of the people that do those tests that I just went through in detail are present at that conference, and we spend a lot of time for each case going through each one of these tests and seeing what we think will be the best treatment for a patient. Now I'm going to go through some of the treatment options here for brain surgery interventions and vagal nerve stimulation therapy.

Dr. Kate Davis: [20:30](#) I mentioned at the beginning of the talk that if a MRI is what we call lesional, where we see something on the MRI that's clearly abnormal, those patients have the best surgical outcomes. This is just an example of one of the types of lesions that have the very best surgical outcomes by the research that we have in epilepsy. That is mesial temporal sclerosis. You can see here that the arrow is pointing to the hippocampus of this patient's brain, and you can see, hopefully, that compared to the other side, it's a lot smaller, and we would call this very scarred looking. This is a clearly abnormal MRI, and this patient would likely be a very good surgical candidate.

Dr. Kate Davis: [21:18](#) Why do I say that? The initial studies were in temporal lobectomy in this kind of patient. There was a very nice study published over 15 years ago now where they randomized patients to continue to get medications, or to get a temporal lobectomy in patients that had this mesial temporal sclerosis. What was very clear is that the patients that had the temporal lobectomy had about a 60% chance of being seizure-free after one year, whereas the medical group continued to have seizures for the most part. That is one of the most important studies that have led us to continue to recommend temporal lobectomy to a lot of our patients.

Dr. Kate Davis: [22:09](#) Fortunately, we also, now, in the last few years, have less invasive options for patients that have scars on their MRI like mesial temporal sclerosis. A temporal lobectomy requires a bigger surgical procedure where part of the skull is removed, and then the brain region that needs to be removed is then taken out by the neurosurgeon. Laser ablation is, as I said, much less invasive. What is laser ablation? This is done in an MRI scan by a neurosurgeon, and the patient has a catheter kind of a tube put in through a small hole in the skull that is targeting the area of the brain that the seizures are coming from. This case that I show here is an example where the seizures are coming from the hippocampus.

Dr. Kate Davis: [23:05](#) Then the software in the MRI machine is able to calculate how much heat needs to be given to burn that area of the brain that the seizures are coming from. The patients really tolerate this very well. Often when I see a patient even the same day that they've had a laser ablation, it's hard to tell that they've even had surgery. Frequently, the patients go home the next day. This procedure is thought by most experts to be a little bit less effective, and the outcomes not quite as good as temporal lobectomy, probably within 10%. But again, it is much less invasive surgery. The field is doing a lot more laser ablation overall.

Dr. Kate Davis: [23:52](#) What about in patients that a lot of their tests don't fully match up? We don't have a clear lesion on their MRI, or some of the other imaging tests don't have the same area that is abnormal, so we have some confusion about where in the brain the seizures are

coming from. In these patients, most centers are considering doing something called intracranial EEG. That is where electrodes are placed by the neurosurgeon inside the brain at targeted areas that we think the seizures are likely coming from.

Dr. Kate Davis: [24:31](#)

That allows us to record from those areas from inside the brain, and really definitively tell where the seizures are coming from before we do a laser ablation or other surgery that would be permanent and we couldn't take away again. It gives us a lot of information. This is just an example of a map that we make for a patient where we think the seizures are coming from somewhere near the hippocampus, but maybe in one of the other structures that are connected. I just give that as an example. This often will have some recording on both sides of the brain.

Dr. Kate Davis: [25:10](#)

Easier to picture here is a reconstruction of one of our patients where you can see the electrodes have been placed inside the brain, and were able to record from inside the brain. Again, this gives us an incredible amount of information. We also can give some electricity through those electrodes to stimulates seizures themselves, and there's very good recent evidence that if you can bring on a seizure with stimulation, that's a typical seizure, that the patient has very good surgical outcome. Again, gives us a lot of information.

Dr. Kate Davis: [25:52](#)

After all this evaluation, what are the other treatments? I mentioned laser ablation and temporal lobectomy. What I didn't mention is that for some patients, there are other parts of the brain that you make you a candidate for resection, for it to be removed, or laser ablation. But if those options are not determined to be good options for you by your team of physicians and providers, there are still now other new options that can be really highly effective. The NeuroPace RNS system is one of them. This has been available clinically for several years now. This is what we call a palliative option, which means that it's very rare if ever that it would result in complete cure. But it can substantially improve seizure frequency and quality of life in epilepsy patients.

- Dr. Kate Davis: [26:53](#) The NeuroPace system is often referred to as a defibrillator of the brain, and I'll show you some examples of this. But what we do is we implant electrodes inside the brain, and they stay there. We target them over where the seizures come from. We put these in the patients that are not good candidates to have that part of the brain taken out. For instance, if we're worried that if we did that, it would cause problems with speech or memory, or if a patient has seizures coming from multiple different areas.
- Dr. Kate Davis: [27:30](#) What do we do with this? Actually, your doctor, if you have an RNS system, will be getting recordings from inside your brain that look like this. They're EEG waves. We can look at those EEG waves and change the setting on the device so that the patient will get stimulation through the electrodes when they're abnormal EEG waves, and hopefully defibrillate or stop the seizure from occurring. This is the basics of how this device works. Practically, the patient will have a computer at home with them, and they actually upload their data to the cloud where your doctor, sitting in their office, can see that data. So you can change things and learn a lot about what seizures look like from this device that's continuously recording information over years or more. This is, again, increasingly used across the United States for patients that are not candidates for a curative epilepsy surgery.
- Dr. Kate Davis: [28:39](#) Why do we use it? You can see here from this study that was done that patients have a pretty good response. It actually works better over time. You can see here that three years after implant, about 60% reduction in seizures, and there's a wide range with some patients having over 85% reduction in seizures. That actually gets better as the years go on. We have had very good clinical experience with this at our center, and also I know at other centers across the country.
- Dr. Kate Davis: [29:18](#) Another device that's an option is the Vagal Nerve Stimulator. In contrast to the other devices I'll talk about, this device is not put inside the brain. I think that's a really important thing to remember, because it's much less invasive because it doesn't involve a

brain surgery. It also doesn't involve a night in the hospital. It's an outpatient procedure. It's overall very safe. It actually works not just in focal epilepsy, but in generalized epilepsy as well. We don't know a lot about why it works. What we do know is, from the studies, that it does work.

Dr. Kate Davis: [29:59](#)

What it's doing is that this device in the chest wall is giving a stimulation on a set time point 24/7. It may be every minute or two. Whatever your doctor sets it to, you're getting a stimulation. Most patients tolerate this really well. Some patients will have some hoarseness, shortness of breath, maybe acid reflux related to the device. But otherwise, it's very well tolerated. There are some newer versions of the device. One is the Aspire device, which most centers I believe are implanting at this time, that in addition to working like how I just said, it also can give additional treatments if the heart rate spikes, which is called tachycardia.

Dr. Kate Davis: [30:45](#)

Why do we do that is because that in a large portion of epilepsy patients, during a seizure, their heart rate goes up. That allows you to get some extra treatment. You can also give yourself extra treatment if you have a warning with your seizure, or if there's a caregiver around, by swiping a magnet across the device that's present in the chest wall. That just gives some extra treatment, hopefully shortening the seizure.

Dr. Kate Davis: [31:14](#)

This is just the data from the vagal nerve stimulation study, and you can see that this does work better over time, just like the NeuroPace device. That's just something to remember, and I always encourage my patients to really give this device some time. We don't expect a dramatic response, for instance, in the first month or even six months. We really need to wait it out and see what the total effect is.

Dr. Kate Davis: [31:44](#)

The last device, which is the newest device that has been FDA approved that I'll talk about, is deep brain stimulation in epilepsy. You may be familiar with deep brain stimulation in movement disorders, like Parkinson's disease. This is very similar. The target is just different. Instead of targeting the areas of the brain important for movement, the electrodes are implanted in a part of the thalamus called the anterior nucleus of the thalamus. That area is highly

connected to seizure generators very common in a lot of patients, including the hippocampus which I mentioned earlier.

Dr. Kate Davis: [32:26](#) The way this device works is very similar to a Vagal Nerve Stimulator in that the doctor puts in preset settings, and it goes off every few minutes or so 24/7. It doesn't respond to seizures or any recording of brain activity like the NeuroPace device. Maybe you were going to pick on this before I say it. What is the case as well for this device? It also seems to work better over time. Seeing that the efficacy where the percent of patients who responded to the device goes up over time, whereas you can see here when you get to the four year mark, you have almost 60% of patients seeing a significant response to the device, or a greater than 50% reduction in seizures.

Dr. Kate Davis: [33:19](#) I think that this slide is a research slide, so that we are going to skip over. I had some research slides in here, which, if time allows, I'll talk about. But I'm going to just skip towards the end. I want to give more time for questions. Before I do that, I'm just going to show you the large group of people, at least at Penn, that go into making decisions for epilepsy surgical evaluations. You can see here that it's a combination of a multidisciplinary group including epileptologists, nurse practitioners, neurosurgeons, neuroradiologist, nuclear medicine physicians, neuropsychiatrists, et cetera. Social workers, our other nurses, and of course, administrative support. It's a huge team that is helping make decisions for our epilepsy patients.

Dr. Kate Davis: [34:15](#) I think we're going to stop to ask some questions now. I was going to put this slide back up that had the different options for treatment, because I thought that would be helpful when we're asking questions. So I'm going to flip back to that slide. Oh, there we go. I think that might be helpful just to stimulate some discussion.

Laura: [34:40](#) Great. Thank you, Dr. Davis. That was a terrific overview. I really appreciate the introduction to all of the tests that are a part of the surgical evaluation. We'll now go ahead and start the Q and A session. I know that there are a number of questions that have already come in. If there are more questions, please

do submit them via the Q and A tab located at the bottom of the Zoom panel, and click send, and Brandon will go ahead and read them. Brandon, take it away.

- Brandon: [35:12](#) Sure. Dr. Davis, the first question is, "How do you make sure that someone won't have any new problems with either memory or function after surgery?"
- Dr. Kate Davis: [35:23](#) Sure. That's a really good question. There's a lot that goes into that. There are some parts of the brain that we don't worry about it that much. However, there are a lot of parts that are really critical real estate. The neuropsychological testing is really helpful for us to determine whether there's risk. There are clinical factors that come into play. The age that the seizure started actually is really important. If seizure started really early in life, most people will have had a lot of reorganization of the brain and the areas of the seizures are usually not functioning. So we can do some testing for that.
- Dr. Kate Davis: [36:07](#) The functional MRI, as I mentioned, can look at where language is. We can also look at where motor function is, or what allows you to move your hands or your legs. Then finally, with patients that have intracranial EEG, we can use those electrodes to map function. We do a combination of these things, plus our knowledge of what brain regions do in most people's brains, and that can help us make an assessment of risk. Then that should be discussed by your treatment team with the family and the patient, if there is risk.
- Brandon: [36:44](#) Wonderful, thank you. The next question actually is a very general question. This is asked by someone who wanted to know if, generally, the ketogenic diet and AEDs are tried before surgery even becomes an option.
- Dr. Kate Davis: [37:02](#) Sure. It's also a good question. I briefly mentioned that the ketogenic, or the keto diet, which most people call it, is mostly used in pediatrics. I'm not a pediatric epilepsy specialist, but many pediatric patients will try the keto diet with seizure medications before considering surgery. Not all. That's something definitely should be discussed with your treatment

team. In adults, there's very little evidence that the keto diet and other dietary therapy substantially helps with seizure. We do not have a trial of a diet therapy before we consider surgery because the data is really not there to support that decision.

Brandon: [37:51](#) Great, thank you. The next question, actually, I'm going to piggyback off that in regards to pediatric patients. I know you stated you weren't a pediatric epileptologist. But do you know if DBS or RNS can ever be implanted in pediatric patients?

Dr. Kate Davis: [38:07](#) Sure. I don't know the specific age cutoffs because I don't treat pediatrics, but they designed the NeuroPace device for the skull or the head of a seven year old or older. I think they're trying to change labeling to push the age back to pediatrics, and there are some centers that are implanting NeuroPace devices in pediatric patients. It is being done. Some of it is off label use, meaning it's not under the FDA approved label. The deep brain stimulator device is much newer, and I honestly don't know if there are pediatric sites that are implanting that yet. I'm sure that we'll learn that soon. I know that the pediatric epileptologists are very passionate about bringing these kind of technologies to their patients when they think it's indicated.

Brandon: [39:10](#) Thank you very much. The next question is going to deal with back to the tests you were discussing earlier. You mentioned that there was a large number of tests, and then a multidisciplinary team. Can you ever skip any of the tests, or is there a certain order that you always have to go through?

Dr. Kate Davis: [39:28](#) Yeah, that's a really good question. I went through a whole, what we call, a laundry list of tests. Not every patient needs each one of those tests. There is some variation in what centers use which tests. Some centers may not have availability of some tests, or have more experience with certain ones of those tests or others. One test that I did not go through is a Wada test, which is done less frequently, but still at many centers is done. We will sometimes do Wadas in some patients. We will frequently do a functional MRI before doing that. I know Wada, just as an offside, is a test that's been done for a very long time in epilepsy

that is more invasive than the functional MRI, and that's really one of the reasons there's a move away from that test.

Dr. Kate Davis: [40:24](#) Because it involves an injection of a drug that puts one side of the brain to sleep for a few minutes, during which time the neuropsychologist can do testing to look at function. Then you do it for the other side of the brain. That can give us information trying to determine the risk of the memory or language problems after a surgery, going back to the first question. In isolated cases, we are still doing Wadas. I hesitate to say there's a certain group of tests that each patient really needs. At a minimum, a brain MRI and EEG data is really done I think at every center. Then there's some variation.

Brandon: [41:13](#) Great, thank you. Next question actually specifically deals with the NeuroPace system that you discussed earlier. Somebody asked how many times and how often the battery needs to be replaced in that, and if there was another surgery that is required to replace that battery.

Dr. Kate Davis: [41:32](#) That's a really good question. I know NeuroPace is working on a rechargeable battery. But right now, you do need to replace that battery. Depending upon the settings of the device, it'll burn through the battery more. So if you're device is going off more, it's going to take up more battery. The average is between three and five years that you need to get a battery replacement. But that could vary, like I said, based upon the patient's individual settings. The battery replacement does involve a minor skull surgery, because the battery itself is put in flush with the patient's skull. Then the neurosurgeon has to just go in and flip out the battery. But it does involve a surgical intervention.

Brandon: [42:23](#) Great, thank you. The next question, actually, we're going to stick with the RNS implantation. "Are there any long term or short term effects that one should think about when thinking about the RNS implant?"

Dr. Kate Davis: [42:41](#) I think the biggest thing to think about, it is a bigger surgery than the Vagal Nerve Stimulator. It's an intracranial surgery. So it is a type of brain surgery. As

already mentioned, I think that it's still a big deal to get your battery changed. That's another surgical procedure, so, something to consider. Any surgery has some risk, but overall, it's very safe in experienced hands to put that device in.

- Dr. Kate Davis: [43:18](#) The side effects, once the device is in, they're very rare. It's very rare to have any feeling when the device goes off or sensation when the device goes off. If there is any problem, your doctor can change the settings so that you can't feel that. It's the same with any of the devices, including the Vagal Nerve Stimulator. If there's some hoarseness when the device goes off, we can alter the setting so that it's better tolerated.
- Brandon: [43:51](#) Great. We're actually going to switch to a few questions that came in regarding laser ablation. "Regarding laser ablation, how many different laser systems are there? Should you actually pick a center based off what they may use?"
- Dr. Kate Davis: [44:08](#) You got me there. I think that there are two main ones. The one I'm most familiar with is a company called Visualase. That's what we use at Penn, and most centers that I've discussed have used that. I can't comment on how one type of laser system versus another. That would be a good question to ask your neurosurgeon who is the one that operates that device, and is more involved in purchasing the whole system for their hospital system.
- Brandon: [44:41](#) Great, thank you. The next question we're going to stick with laser ablation, and if there's a general rule of thumb when determining whether you're going to perform a resection surgery or laser ablation.
- Dr. Kate Davis: [44:53](#) That is such a good question. Because there is incredible variability right now in the field from center to center on this exact decision. As I mentioned in the talk, it seems that resective surgery, at least for temporal lobe epilepsy, is more effective than laser ablation. But just modestly. Outside of the hippocampus for laser ablation, there aren't good studies regarding outcomes. But a lot of centers, including our own, are doing laser ablation in other areas of the brain.

- Dr. Kate Davis: [45:35](#) We will have data soon, and I would say that we are having good outcomes with some of those interventions. But because we're still learning a lot about this technology, you may get different recommendations based upon the experience in the center. If you're really interested in a laser ablation as an option, it may be a reason to consider getting more than one opinion before proceeding with surgery, and specifically looking for a site that has a lot of experience and a neurosurgeon that has a lot of experience with laser ablation.
- Brandon: [46:08](#) Great. "Does laser ablation itself actually create any scarring that could trigger additional seizures down the road?"
- Dr. Kate Davis: [46:16](#) Another great question. Laser ablation is still a surgery, and is definitely creating a scar. Just like when we do a resective surgery, that's going to create a scar. It's done in a controlled way where the neurosurgeon, who's very experienced, will avoid critical areas and try not to cause damage that would cause a different type of seizure, for instance. But that is always a potential concern. It happens very infrequently that we really think that the scar from the surgery causes more seizures afterwards. But it could be a concern.
- Brandon: [46:59](#) Great, thank you. The next question, actually, is more of a clarification question from one of our attendees. "Could you go over, again, when SEEG would be needed during a surgical evaluation, and can all centers do SEEG?"
- Dr. Kate Davis: [47:13](#) That's a good question, and I did gloss over that, so I apologize. I think SEEG or intracranial EEG is a really complex topic and talk all on its own. There are several different kinds of intracranial EEG, which I should mention. There's stereotactic EEG, which is SEEG, and that is a method that are the pictures I showed where the electrodes are put in through small holes in the skull and targeted at certain brain regions. There are a lot of centers across the United States that have been moving in the last five years to using SEEG for several reasons, one of which is that it tends to be much better tolerated for patients.

Dr. Kate Davis: [48:03](#) The other technique is what we call grid and strip in depth intracranial electrodes. That requires bigger holes to be cut in the skull to put the electrodes down, and a lot of the electrodes are put on the surface of the brain. There are still situations where that may be the best way to find out where a patient's seizures are coming from. But as I said before, there's a big movement towards using stereotactic EEG. When do we need intracranial EEG? That would vary somewhat from center to center. However, at our center and in colleagues that I've discussed this with extensively, it's typically recommended when we don't have enough of the tests lining up so that we're 100% sure where the seizures are coming from, or that we don't have enough confidence that we know the seizures are coming from one area.

Dr. Kate Davis: [49:00](#) It's very frequent that we need to do that intracranial EEG or stereo EEG step when a patient's brain MRI doesn't show a clear scar that the seizures are coming from, or if their tests have some mismatches. So if your PET study shows low glucose use in one area, but your EEG showed that the seizures might have started from another area, and then what you do during your seizures doesn't quite match up perfectly, then getting some additional information before doing a permanent surgical intervention really is indicated. We get such amazing high resolution information from the intracranial EEG when we're recording from inside the brain.

Brandon: [49:48](#) Great answers. The next question actually deals with a different test. This attendee wanted to know, "In which cases do you perform the Wada tests?"

Dr. Kate Davis: [49:59](#) Okay. I glossed over that, and I should have included a slide on the Wada test. Every center is going to be a bit different in this decision making as well. For my patients and in our center, we're standardly doing a functional MRI in almost every patient before presenting them in that multidisciplinary surgical conference. There are rare cases where the patient can't get in a functional MRI scanner, or can't participate because of their cognitive abilities in some of the tests that we need for the functional MRI.

Those patients may not be able to participate in the Wada test, either.

- Dr. Kate Davis: [50:42](#) For us, the typical patient that we may do a Wada on still is a patient where we think that the seizures come from the dominant temporal lobe, so the side of the brain that is usually the left side in most patients, and their fMRI didn't give us a clear answer on what side their language was. Or, the fMRI suggested that the language is actually on that area, and we think the Wada will be able to give us a better assessment of the risk of having a memory decline after surgery.
- Dr. Kate Davis: [51:20](#) Really, for us, we only are doing this in patients that have your language dominant side seizure onset, and in patients where we're considering taking out the hippocampus on that dominant side. But it's a complicated decision. I think one of the things I find so fascinating about epilepsy surgery evaluations and treating epilepsy patients is that each patient is very unique. You really need to have these questions on a patient-specific basis with your physician and caregiver team.
- Brandon: [51:58](#) Wonderful, Dr. Davis. Thank you. Going to try to end with a couple questions dealing with the future of surgery and other devices. One attendee asks, "During treatment decision making, could you talk a little bit about how some patients weigh the 'do nothing' option versus the possibility that technology advances might make less invasive procedures and options available in the future?"
- Dr. Kate Davis: [52:30](#) Again, this would be very patient-specific. But I can give somewhat of an answer there. I think for patients that have a treatment option right now that their physician team thinks could make them seizure-free, that the risk of waiting is high. As I talked about in one of the very first slides, patients with ongoing seizures have a higher risk of death and injury. The ongoing seizures also greatly impact quality of life. Ongoing seizures can, in some patients, continue to make memory or other function worse and worse. Acting earlier can be really beneficial in those patients.
- Dr. Kate Davis: [53:18](#) For other patients who are maybe being offered a palliative option, meaning an option that their

doctors don't think will cure them, and they're not having seizures that are very, very dangerous, that might be a group that waiting for advanced technology might be appropriate. But I would really caution, because the risk of ongoing seizures can be very high. That's dependent upon the seizure type, the seizure frequency, and where the seizures we think they're coming from, and a lot of other factors.

Dr. Kate Davis: [53:56](#)

I think where this question was going is, what are some of the devices of the future? The NeuroPace device can only have two active electrodes at a time, and there are devices in development that have more complicated electrode designs that can cover bigger areas of the brain, and potentially may work better. That's one thing that may be coming down the pike. I think that we're just at the beginning of, likely over the next few decades, a kind of explosion of more options. Or I hope that's the case.

Brandon: [54:34](#)

Well, you kind of went ahead and answered my final question for you, which was discussing the advancements of artificial intelligence and how that might open up new avenues of study for epilepsy centers to treat patients.

Dr. Kate Davis: [54:48](#)

This is big data question. I think artificial intelligence is a big buzzword right now, as is machine learning and a lot of these very computational approaches to improving treatment. I think epilepsy is a perfect disease to think about that, but you have to have really good data coming in to use these methods. I do think that these devices that have the ability to record a lot more areas of the brain are more likely to result in us being able to use things like machine learning or artificial intelligence to design on a patient-specific level how to best have the perfect defibrillator for their brain. But we need good data coming in to have good outcomes coming out with those kind of computational approaches. Our lab group is working with some of the NeuroPace RNS data to start doing that, but that field is really just at its infancy.

Brandon: [56:02](#)

Great, thank you so much, Dr. Davis. Laura, I'm going to turn it back over to you.

Laura: [56:07](#) Great. Thank you so much to both of you. This concludes our webinar about surgical options for the treatment of epilepsy. I do want to thank you, Dr. Davis, for your presentation, your very thorough response to questions as well. There was a great number that came in, so I'm glad we were able to address those. I want to also thank the BAND foundation for sponsoring today's webinar and our entire webinar series. Thank you again to our audience for your engagement and your questions.

Laura: [56:38](#) If you have additional questions about this topic, or wish to learn more about CURE's research programs or future webinars, please visit our website at www.CUREepilepsy.org. I also encourage you to check out an episode from our Seizing Life podcast, which you can also find on our CURE website, which explores this topic through a personal patient perspective. Finally, I hope you'll join us for our future webinars, which include an upcoming two part series to discuss rescue medications, and the timing of those will be announced shortly. Thanks to you all.