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Investigating Impulses: A Look at Deep Brain Stimulation

Dr. Lisk:
Welcome to *NeuroFrontiers* on ReachMD. I'm Dr. Jerome Lisk, neurologist and movement disorder specialist, here with Dr. Jerrold Vitek, Head of Neurology and Director of Neuromodulation Research Program at the University of Minnesota. Dr. Vitek is also the Director at the University of Minnesota, Udall Center of Excellence for Parkinson's Research. He spent fourteen years at Emory, coming from Johns Hopkins, and was the first group to do physiological mapping of the basal ganglia, for localization DBS that allows our patients to get the efficacy that DBS is so well-known for.

Deep brain stimulation is approved in essential tremor, Parkinson's disease and epilepsy and has a wide number of uses that are being explored around the world.

Welcome, Dr. Vitek, how are you doing today?

Dr. Vitek:
I'm doing fine, Dr. Lisk, thanks for having me.

Dr. Lisk:
So, let's start off by just explaining to some of those physicians and non-physicians, what is deep brain stimulation? How did it come about?

Dr. Vitek:
Well, it's an interesting story. Basically deep brain stimulation is a pacemaker-like technology that delivers electrical impulses to targeted structures in the brain, and then those electrical pulses modify the abnormal brain activity that causes these problems, such as tremor, or Parkinson's symptoms, motor science, etc. The way it came about was interesting because we used to do lesion surgery, so you'd put a probe in a certain structure in the brain and you'd heat it up and destroy the tissue. And what they did before they would destroy tissue is they'd pass electrical current through that area, and if they change the symptoms, then they felt they were in the right location. And then they would make the lesion and destroy the tissue. The problem with destroying the tissue is you can sometimes get side effects, you can't do it on both sides of the brain, so there are some issues associated with it that people didn't like.

So a person named Alim Louis Benabid from Grenoble, France decided, why can't we do this chronically? And he partnered with some device company to help develop this so that you can do stimulation chronically, rather than making a lesion in the structure. That's how it started.

Dr. Lisk:
Now, a lot of people are going wondering, OK, so yeah, you stimulate, that sounds exciting. What actually is going on, because we know this basal ganglia is very complex, there's on and off switches and you stimulate on switch, you can stimulate an off switch. What is actually going on how's this working?

Dr. Vitek:
Well, you know, that's the million-dollar question, and if had an answer to that question, maybe I'd get a Nobel Prize. But right now, we're still struggling with that. Actually we do have some good ideas, you know, we started doing this work quite some time ago, back in the 90s, actually. So deep brain stimulation isn't necessarily new, but we are certainly getting better and better at it and the technology is improving every day. but in terms of how it works, we used to think that if you made a lesion and you stimulated because you got the same behavior benefit that they were doing the same thing. But what we realized now, is that's not the case at all. More than likely, what we're doing is when we stimulate an area, we're actually activating the output from that structure, and whatever that structure, if that

structure is projecting to a site and is activating it, or it could be projected to a site suppressing it. But you're activating the output, in general, so sometimes it may be more of a combination of activating certain elements and inhibiting other elements.

But we do, pretty much, understand now that, rather than just increasing or decreasing activity in an area, we're changing the pattern of the activity. So, instead of things, for example, firing too fast or firing too slow, there really is an abnormal pattern. And what we really believe, at this point, is that we are modulating these patterns into a pattern that shifts back more towards what we see with the normal state.

Dr. Lisk:
So, Dr. Vitek, from your vantage point, which Parkinson's patients make the best or worst candidates for DBS?

Dr. Vitek:
Well, I wouldn't break it down based on symptoms so much, I can do that, but I don't want to give the impression from other people that if you have gate problem, you're not a candidate, because some people with Parkinson's have bad gates and respond to medication; some people have bad gates, and they don't respond to medication. Those would be two different types of patients. The one that does respond, I'd say yes, they're a candidate. The ones that don't, you're probably not gonna get benefit from your gate and balance, but other things could improve. If, for example, they respond by 5% to levodopa, that's the best benefit they're gonna get from deep brain stimulation. So, probably isn't worth the risk. However, if they have tremors as a major problem, and that tremor doesn't respond, and that's the major issue, we know tremor will respond to deep brain stimulation, so they would be a candidate.

Typically, I think people see that in terms of the symptoms that respond very readily: tremor, the dyskinesias respond readily, fluctuations, wearing off, those things respond very well, rigidity, bradykinesia responds as well, gate, if gate is related to being slow and stiff or having tremor, or being dyskinetic, then your gate can improve, as well. The things that I don't look for as much would be speech, postural instability, these things are less likely to change. Most times they're not gonna change for the better or for the worse.

Dr. Lisk:
For those just tuning in, you're listening to *NeuroFrontiers* on ReachMD. I'm Dr. Jerome Lisk, neurologist and movement disorder specialist and I am speaking with Dr. Jerrold Vitek, also a movement disorder specialist and one of our foremost experts on deep brain stimulation.

I want to remind you that as we're talking about DBS in Parkinson's disease, we're talking about idiopathic Parkinson's disease, and not atypical Parkinson's syndromes that would be a contraindication to deep brain stimulation. Or those Parkinson's patients that may have dementia.

Dr. Vitek, any other advice you have for candidates that should not have DBS?

Dr. Vitek:
Well, I think there are a lot of people, when we first started doing DBS that had some motor signs that didn't respond to medication and you know, people get desperate and they feel, 'I really wanna try it.' What you have to be careful about is if you don't respond very well to a medication at all, your main issue, for example, are cognitive issues, speech issues, things of that nature, then it isn't something you want to do. And the reason is, you're not gonna like the benefit at all from this. And when you put a probe in the brain, you always run a small risk that could be a problem. And you don't want to take that risk if the potential benefit's not there. It really comes down to weighing the benefits you can obtain from this surgery to the risks you're gonna take to have this surgery. And really, the risks, in general, I think are pretty minimal. The risk of bleeding is the biggest concern, and that's about 2% per lead that's implanted. So, 98% of people would not have that problem. But if you're that 1% or 2%, then it doesn't matter, it's you. The other thing, is infection and that's about a 3% risk. It's usually at the site where the pacemaker wire is put in the chest, the pacemaker, itself internal bolus generator. Sometimes you'll have it at the site where the lead goes into the skull, and there's a little cap that's screwed into the skull, sometimes at the wound site, you can get an infection there. But if you have an infection, most of the time what we would do is we would take out the pulse generator where the infection is, give antibiotics, let the patient heal and put that back in again. So I think the biggest concern for most people would be the risk of a bleed in the brain. And again, that's small, 1 to 2%.

Dr. Lisk:
So, lastly, Dr. Vitek, what advancements do you see with DBS coming in the next ten years? What can we expect?

Dr. Vitek:
Well, I'll tell you, it's really incredible what's happened in the last probably four or five years. You know when we first had these devices come out, back, again in the 90s, actually, they were used in the late 80s; the first paper was out back in late 80s by Benabid. And we actually had one system for probably, oh twenty-some years or longer, but now we actually have three companies involved and they're all working hard to increase the technology. So, now we have different kinds of leads; we have these pacemakers that can put on

different patterns of stimulation, we can actually cord the neural activity from the lead that's in the brain, in some of these pacemaker wires. The leads themselves have multiple different current sources, so you can sculpt the current field of the lead that's in the brain. These are all things that are really just exciting. And this technology is driving, sometimes driving the things that we can do. But also as we do things in the operating room, we also realize, 'I need different technology.' So I think the technology drives the science and the science is driving the technology.

Dr. Lisk:
Well, I'd like to thank you for this educational tour that we've gone on in deep brain stimulation from the history to the future. And we'd like to have you on sometime in the near future to talk about DBS and other advancements.

Dr. Vitek:
Oh, happy to do it. It was fun. I always enjoy doing this kind of thing.

Dr. Lisk:
Alright, I'm Dr. Jerome Lisk. To access this and other episodes in our series, visit ReachMD.com/NeuroFrontiers, where you can Be Part of the Knowledge. Thanks for listening everyone.