09| Electrical Injuries: Cognitive and Emotional Sequelae – With Dr. Neil Pliskin

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NAVIGATING NEUROPSYCHOLOGY

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Speakers: Neil Pliskin, John Bellone, Ryan Van Patten

Intro Music 00:00

John Bellone 00:17

Welcome, everyone, to Navigating Neuropsychology: A voyage into the depths of the brain and behavior. I'm John Bellone...

Ryan Van Patten 00:23

...and I'm Ryan Van Patten. Today we have Dr. Neil Pliskin on the show. We talk with Neil about an area of particular interest for him, which is the cognitive and emotional sequelae of electrical injuries. Neil is a board certified clinical neuropsychologist at the University of Chicago, Illinois. He is a professor of clinical psychiatry and neurology, and he is the director of the neurobehavioral program and the neuropsychology service. He is also the ex-president of APA's Division 40, the neuropsychology division.

John Bellone 00:56

Today's topic is unique relative to other recent topics because it's pretty specialized. It's not too common for neuropsychologists to see patients with electrical injuries. So you might be wondering why we're bothering to talk about this, but we actually think that this low base rate is all the more reason for us to discuss this on NavNeuro. Neuropsychologists and trainees already receive a lot of instruction on common patient populations, like older adults with dementia or children with ADHD. But we don't really tend to learn much about less common etiologies for cognitive impairment. This can put us in a tough position. When we do see these patients, we would have little training to go off of. So today we'll talk about electrical injury because it's a pretty cool topic - let's be honest. And when you do encounter someone who has experienced this type of injury, you'll know the basics at least. So now that I've hopefully sold you on the importance of this topic, we give you Neil Pliskin.

Ryan Van Patten 02:11

We have Dr. Neil Pliskin. Thanks so much for coming on the show, Neil.

Neil Pliskin 02:15

You're welcome. Glad to be here.

Ryan Van Patten 02:17

Yeah. So we'll just go ahead and launch right into it. So how did you get involved with this unique type of injury, electrical injury, initially? It's not a common specialty area for neuropsychologists, so I'm curious.

Neil Pliskin 02:29

Sure. It's not a common specialty area for most behavioral health providers. Well, I'm what I refer to as an "opportunistic researcher" because opportunities present

themselves and that's how this came along. Back in 1993, when I was an assistant professor at the University of Chicago, I was contacted one time by a plastic surgeon and an electrical engineer by the name of Raphael Lee, who turns out is really one of the world's experts on the physics of electrical shock injuries. He was also on the faculty at the university. And he said, "You're the neuropsychologist that does testing, right?" And I said, "Yeah." And he said, "Well, I have a clinic full of electrical burn patients and for reasons that I don't quite understand, a lot of them have cognitive complaints. They seem to need psychiatric help and support. Would you be interested in seeing a few of these patients?" So I did what any neuropsychologist would, which is go to the scientific literature and do a quick lit search and discovered that, back in 1993, there were like, maybe 6 or 7 papers on electrical shock injuries, at the most. The largest sample at that time was like 11 people. So I'm like, "Sure. Okay. Let me take [a look]."

Ryan Van Patten 04:07
Yeah.

Neil Pliskin 04:07
So I started seeing a few of the patients. And he was very connected to the world of electrical injury, so he was asked to do a - he, meaning Dr. Lee - was asked to do a special issue for the Annals of the New York Academy of Sciences. So he said, "Would you be interested in writing something?" And I said, "Well, there's really nothing to write because there just hasn't been much scientific work done in our field on this." And he said, "Well, say that." Which I did. And suddenly I became an expert on electrical shock injury. I had only seen just a few patients, but since then I think we're up to seeing now 260 electrical shock injury patients. Then that brief contact became the beginning of what was then a multidisciplinary research group devoted to studying electrical injury. We discovered a lot of those folks had psychiatric issues, we got a psychiatrist involved in the team. We discovered a lot of those individuals had chronic pain related issues, we got one of the pain docs to be involved. And that was basically the beginning of my work with electrical shock injuries. It's pretty amazing that just a clinical researcher and clinician like myself just happened to be in the right place at the right time with the right individual who had a population that most neuropsychologists just have not been exposed to.

John Bellone 05:50
Yeah, that appears to be the case quite often where you just jump on whatever population is there and ready for you. Do you have a sense of why the literature is

so sparse in this area? How common of an injury is this? What are the base rates? Do you have a sense of that?

Ryan Van Patten 06:07
Well, I think, yes. In terms of overall occupational injuries, it's not that common. It accounts for about 5000 occupational injuries a year. But it's who it affects that has caused a lot of consternation and money because 90% of these injuries occur in young employable men, usually between the ages of 20 and 34, with an average of 4 to 8 years of experience on the job. So you're talking about a lot of years of unemployment and disability that has cost our society around a billion dollars annually.

John Bellone 06:55
Wow.

Neil Pliskin 06:56
It's the fifth leading cause of fatal occupational injury. So it's not as common and that's, I think, why most neuropsychologists haven't seen these patients - because they end up in burn centers. I remember a few years ago now when the American Psychological Association meeting was in Chicago, and I - oh, this maybe was a decade ago now - and I thought, "Wow, what a great opportunity." We'll create a symposium. We'll get people who normally wouldn't come to the American Psychological Association meeting, like our plastic surgeon, our occupational medicine doc, [and] put together an amazing, of course, unbiased opinion…

John Bellone 07:44
Of course. [laughs]

Neil Pliskin 07:45
…an amazing symposium that was given a Sunday morning at 8am time slot.

Ryan Van Patten 07:52
[laughs]

John Bellone 07:53
The perfect slot.

Neil Pliskin 07:54

About 15 people showed up. And I said to Dr. Lee, I said, "Oh, my God." And he said, "Neil," he goes, "that's because most people in your field haven't been exposed to this type of injury." I was then, maybe a year or so later, asked to come and give a talk about our work at the American Burn Association meeting, and there were over 200 people sitting in the room. So context is everything. Neuropsychologists don't see these folks as much as they need to in the acute stages of injury. They end up seeing them after there's litigation or lingering issues. But in the occupational medicine world, these injuries are very profound and very expensive.

Ryan Van Patten 08:52

Well, hopefully this conversation we're having now will raise awareness, at least a little bit, within our field. Tell us, Neil, what are some of the common acute and chronic physical symptoms that occur post electrical injury?

Neil Pliskin 09:09

Well, that's a very complicated question because really no two cases, unfortunately, are the same. Electrical trauma can produce a very complex pattern of injury because of the multiple modes of frequency-dependent tissue, current interactions, the variation in the current density along the path through the body. These are things that are hard to estimate. People try to use voltage as an indicator - low voltage, 1000 volts or less, high voltage. But really, that is not an informative statistic.

I think that there are three ways that it's now understood that electrical exposure can injure the body. Keep in mind that the body is comprised of about 60% water, in which 33% is intracellular and 27% is extracellular fluid. The body fluid in both intracellular and extracellular compartments are separated by a relatively impermeable, highly resistive plasma membrane. With electrical exposure, the current conduction within the body is carried by mobile ions in the body fluid. As these ions pass over cell membranes, they cause pores in the cell membranes. That process of injury is called “electroporation”. So that the important diffusion barrier that the cell membrane serves is compromised and there's a leakage of intracellular and extracellular fluid. So you get cell death and necrosis. This is most commonly seen in the peripheral nervous system because that's usually the initial point of contact - a hand, a leg, a hip.

So when one wants to consider the severity of injury, one needs to consider the microscopic injury, which is electroporation. But also consider some of the other characteristics like how long the person was actually in physical contact with the electric power source because the longer the contact, the more likely there is a thermal injury. Especially in the high voltage injuries, when you're exposed to the current, it causes muscular contraction. So the person comes in contact with an electrified power source, and can't let go of it. They have the so-called "no let go" experience. The longer that they're in contact, the more likely there has to be a thermal injury in addition to the electroporation and the electrochemical interactions that occur.

And then finally, if that isn't enough, again, you have to evaluate the injury characteristics and the accident scenario for each individual because some individuals are up on ladders, they fall, and they have a secondary head injury. Other individuals sustain an electrical exposure in a closed space, it causes heating in the air to occur and a thermal acoustic blast develops. So, in high energy exposures, the heating of the air can actually lead to a thermoacoustic blast. So, to sum it up, you're talking about thermal burn injury, you're talking about cellular injury, the electroporation, and you're talking about blunt mechanical trauma, either secondary to the thermal blast itself or to the secondary fall off of a ladder. And, so each of these cases, each of these electrical accidents, the characteristics are different. So to try to measure them through traditional means of voltage alone is problematic. How's that for a long-winded answer?

Ryan Van Patten 13:38

[laughs] No, that was really helpful. [It] really walked us through the mechanism of injury and how there are different mechanisms and different potential outcomes. I've read in a few places that although people's physical profile is different following an injury, as you discussed, visual disturbances are pretty common. Is that your experience?

Neil Pliskin 14:04

Yes, there's a range of physical symptoms that you can hear from folks. Visual disturbances and ocular abnormalities have certainly been documented in these folks. I hear a lot about problems with temperature regulation. Other people I hear [say], "My brain feels like it's on a screensaver." "Anything that I could do automatically before I now have to work so hard to do." So the injuries are complex and multifactorial, and that's why we've long since advocated that you need multiple

specialists, multiple disciplines working together in the care of these patients because these injuries can be lingering.

Ryan Van Patten 14:54
To follow up, I'd like to move into CNS effects of electrical injury. First, what comes to mind is that a person, an individual who suffers an electrical injury can have neurological sequelae even if the head is not a point of contact with the current, correct?

Neil Pliskin 15:15
Correct.

Ryan Van Patten 15:16
Do we know why that is?

Neil Pliskin 15:18
I think that people try to look for an entrance and an exit wound, and then they draw a straight line between the two burns. Well, first of all, most of these injuries are alternating current, not direct current. So alternating current cycles back and forth so many times per second. The notion that there's a single entrance and exit is overly simplistic. And…I forgot your question. I'm sorry.

Ryan Van Patten 15:51
No, that's okay. It's interesting that a person can be exposed to a current through an extremity, not through the head.

Neil Pliskin 15:59
Thank you. That's right.

Ryan Van Patten 16:01
To an outside observer, it appears like, “Well, how are there CNS effects of this if the brain was never impacted?” But it's more complicated than that.

Neil Pliskin 16:09
Yeah, and speculative I should say. But I think that, to get back to something that I said earlier, your body is a large conductant, so much of it is water. So the idea that if you have an electrical exposure on one hand, and then you have a burn on your

hip, that the electrical current just went in a straight pathway like a river is not my understanding of how it works. Electricity diffuses within the body. It goes along myelinated fibers.

So how could a peripheral exposure cause a central nervous system change? Well, I like to think about it several ways. One is, when someone loses a limb, they experience phantom pain. As the central nervous system is cut off from peripheral nervous system information, some reorganization of the efferent fibers has to occur. In electrical injury, if you look at the myelinated fibers for example, the corticospinal tract crosses over in the brainstem and synapses for the first time in the spinal cord. So if you have someone who has a peripheral exposure, the idea that electricity, the ions, the electrons, can travel through those myelinated fibers into the central nervous system might be one way to consider it. We can talk about some of the functional imaging studies that we've done to try to address that.

Then the other part of it is, if you have a peripheral nervous system injury, it causes a disconnection and the need for reorganization with central nervous system functions. So those are speculative ways to understand this. It doesn't change the fact that when you test these patients, and you carefully screen them to ensure that you're getting a full effort from them, there's a percentage of these patients who end up having cognitive complaints and objective cognitive findings. Even though I can't necessarily explain them, that doesn't, in my mind, diminish the importance of them.

John Bellone 18:36

We definitely want to get to some of those more specific cognitive effects. Also the imaging studies that you mentioned, we'll definitely want to get your take on those. But more from a clinical standpoint, do these patients typically undergo a neurological workup? Is it routine to have clinical neuroimaging or EEG or other types of diagnostics?

Neil Pliskin 18:59

I think more so now than before. I think that, depending on the nature of the injury, some of these injuries are pretty catastrophic. You're talking about significant total body surface area burns. You're talking about amputations, multiple skin grafts. So the notion of, "What's their cognitive status like?" takes a backseat because there are so many other pressing physical issues. But I think that for those individuals who eventually it becomes apparent that they have lingering cognitive concerns or neurologic issues, they certainly do end up seeing neurologists and they do end up getting worked up.

John Bellone 19:45

Yeah, it makes sense. Are you aware of any data to suggest that demographic factors might affect the response to injury? Like do younger people or more highly educated people respond more favorably or recover quicker?

Neil Pliskin 20:00

You know, no one's ever asked me that question before. Yeah. I don't think that there's an answer to that one. I don't think that - the demographic ends up being largely male. There's some considerations that we can talk about as it relates to psychiatric functioning in this group, but I don't think that there is a clear cut demographic as to who gets better and who doesn't get better. I don't think that's a demographic issue. I think that's an injury characteristic.

Ryan Van Patten 20:38

Could we speculate that cognitive reserve as it applies to other neurological insults would probably apply here? So people who are more highly educated etc might respond better, and then younger folks with more plasticity might recover better. But there aren't any direct data on this, right?

Neil Pliskin 20:56

No direct data on it. I think that there's a lot of areas of research that need further direction. That would be one of them.

John Bellone 21:07

Sounds like [its] similar with the effects of electrical injury on children or in the older adult population. It sounds like we're just not there yet in terms of understanding it.

Neil Pliskin 21:18

Well, you know, with children, what you see are more household, low voltage things where they're sticking things into outlets they shouldn't be or biting on things. Those can end up being pretty devastating injuries because, even though they're low voltage exposure, the electrical field strength can be pretty high. So to answer your question, there's case studies. But there really hasn't been any formalized, systematic research that examined age or cognitive reserve. Mostly because people still question and debate the presence and the significance of cognitive impairment. I guess one caveat would be, you have some individuals who after they have their electrical exposure it disrupts the electrical rhythms of the heart and they go into fibrillation and they suffer a cardiac and respiratory arrest. Those folks have

more typical anoxic brain injuries and then the usual parameters of age and cognitive reserve and severity of injury influence outcome.

John Bellone 22:32

So that's another potential mechanism there, it sounds like. How often do electrical injuries result in a neuropsych eval? We talked about the neurological workup, but how about neuropsych? And what sources of injury do neuropsychologists usually see? Is there a difference?

Neil Pliskin 22:50

Well, I would say that neuropsychologists are more likely to see occupationally based injuries, just as probably most other providers are. And could you ask your question again, please?

John Bellone 23:07

Sure, sure.

Neil Pliskin 23:07

I'm not sure I'm understanding it.

John Bellone 23:09

I'm curious how frequently they actually walk into a neuropsychologist's office. It sounds like the occupational types of injuries are more common, which completely makes sense, especially if there's maybe a lawsuit that's tied to it.

Neil Pliskin 23:24

Yes, I think that's right. I think that maybe 10 or 15 years ago, one of my former students, Lauren Miller, sent out a survey to the membership of the International Neuropsychological Society, this had to be in the late 90s, just asking the question, "How many folks have you seen that have had an electrical shock injury?" I think the average among the neuropsychologists was two. Most of them just don't make it to see neuropsychologists. And, of course, to me, a lot of what I've been advocating for in my work has been the the need to get health psychology and neuropsychology on the treatment teams much earlier so that you can address the concerns, the attributions and the misattributions, early in the course of the injury scenario before there's more socialization to the injury lifestyle.

John Bellone 24:27
So it's not that these people couldn't benefit from a neuropsych eval or general psych, it's just that they're not walking through the door, it seems like.

Neil Pliskin 24:35

Correct. And it's for reasons that we've talked about.Usually they have much more pressing physical concerns before it even comes down to their psychological well-being or their cognitive well-being.

Ryan Van Patten 24:51

Right. In your experience, and based on the literature, when we do see them what is the typical neuropsych or neurocognitive profile of someone with an electrical injury?

Neil Pliskin 25:01
Well, it doesn't cause a - typically, and I'll keep saying typically because each case is different. I mean, I had a case where it was a window washer who was holding a metal rod over his head and the electricity from a high voltage line arched over and the point of contact was his scalp. Now, that's a very different scenario. Or the woman who was putting up a Christmas tree and got too close to the high voltage lines and the electricity arched over to her and part of her scalp was burned away. Those kinds of patients, you're more typical to find focal injuries that are structural injuries that are demonstrable on neuroimaging, typical structural neuroimaging.


But the typical case is one that does not have a focal pattern. What we've seen more and more are patients who have slowed processing speed, problems with attention, and then the downstream effects of that - decreased ability to learn new information quickly and efficiently. Hence, they complain that they have memory problems, it's really more acquisition problems. More difficult time multitasking. Slower at performing executive functions. And, again, in our experience, that's been more commonly a downstream effect of reduced processing speed and problems with maintaining attention and mental focus. That really maps very well to what I hear from a lot of these patients, which is, "It's not that I can't do things, it's that I have to work so much harder to do the things that I could do automatically before." So things that involve effortful processing are more commonly affected when you give a neuropsych battery. So you're accounting, of course, for things like peripheral motor system deficits. When you take into account those things, then really what you're looking for are processing speed changes, attention difficulties,

and problems with maintaining mental stamina. That comes out as more of a generalized pattern of impairment.

Ryan Van Patten 27:34

Gotcha. I have one follow up about something you mentioned earlier. Speaking about the voltage of the injury, those of us who are less familiar with the mechanics of how an electrical injury might take place would assume that higher voltage would lead to more severe injury, more severe cognitive impairment, but that's not always the case, right? Even if we divide people by high voltage injury, like above 1000 volts and low voltage injury, that's not a good predictor of severity of injury. Can you speak to voltage and how it relates to neurocognitive impairments?

Neil Pliskin 28:10

Well, you see neurocognitive impairments in low voltage and high voltage scenarios. That's why voltage is not - you know, I think it's ironic that I hated physics when I was in high school…

Ryan Van Patten 28:23

[laughs]

Neil Pliskin 28:23

I find myself all the time trying to explain it in a way that I can understand it. But I think it relates more to the electrical field strength, which has to do with, amongst other things, your proximity to the power source and the speed and strength of the current, which is actually measured in amperage not voltage. So the answer is, you do see cognitive and psychological changes in patients with what we would typically consider to be low voltage exposures. But, again, you have to look at each accident scenario differently because - I mean, why don't you see more household injuries? That's because in your house, you have a circuit breaker. So that when there's a break in that circuit, power shuts off essentially. That's why you don't see more low voltage injury scenarios or household injury scenarios. But in houses that are being redone or someone who's working on the electrical panel, something isn't wired properly [and it] leads to mishaps, even in the household, even with low voltage power sources.

John Bellone 29:37

How about lightning strikes? Do people generally survive those and is it different?

Neil Pliskin 29:43

Yeah, lightning strike is really a completely different scenario altogether. It's very hard to estimate the field strength and the effects associated with lightning injuries. I've learned that a lot of it has to do also with things like, is the skin wet at the time when you're exposed to it? Many people survive lightning strikes. It really does depend on the magnitude of the exposure. If lightning strikes in the vicinity of several people, usually only one gets a serious or fatal injury. Why that is I'm not sure.

John Bellone 30:24

Okay. Okay.

Neil Pliskin 30:25

In all of the studies that I've done we've been careful to separate out and study separately lightning strikes.

John Bellone 30:33

Fascinating. To get back to the discussion on cognitive effects, are there any specific tests that you give for these groups? Or is it a generalist battery?

Neil Pliskin 30:47

This is the challenge because our tests are sensitive, but they're not specific. The injury characteristics of these electrically injured folks is general and not specific to an electrical shock injury. If you take somebody who's got a chronic pain condition, let's say it's low back pain, so that every time they roll over at night, they wake up. They're waking up three or four times a night, they're in pain, their mood is lowered, they're sleep deprived, you put them into a testing situation and you give them a coding or a symbol digit, a block design, something that involves processing speed and some new learning, you're going to see deficits. You're going to see deficits like this in chronic pain patients. You're going to see deficits like this in sleep deprived patients. So I tell my students that the work of a neuropsychologist is not just about the test scores. It's about integrating the test scores with what you know about the individual, what you learn historically, and what you discover about the nature of the electrical accident itself. Was it in a closed space? Was there an explosion? Did the person suffer any kind of cardiac arrhythmia? Did they fall? Were they traumatized by what happened to them? So I tell my students that the work begins when you get the neuropsychological test scores. It doesn't end with getting the test scores.

Ryan Van Patten 32:28

Right. This may be obvious, but neuropsych testing is not used for differential diagnosis here, of course. Sort of like TBI, we already know that the injury happened. In this case, part of the role of cognitive testing and those results can be to predict functioning and outcomes. So these are often young men, their cognitive performance can give us a sense as to when and whether they can return to work and what level of functioning they're at. Is that what you tend to use it for?

Neil Pliskin 33:01

Oh, definitely. I'm glad you brought up traumatic brain injury because neuropsychologists try to evaluate, in my experience, electrical injury through the same lens as traumatic brain injury - did they have a loss of consciousness? And for how long was that loss of consciousness? Did they have post traumatic amnesia? And those labels and ways of measuring severity of injury don't really apply as much with electrical injury, where you might hear a co-worker say, "We heard an explosion. We ran over and he was standing there, but he couldn't tell us his name and [he] didn't know who he was." So there might be alterations in mental status. In fact, in our sample of 260 individuals, what we found was something like 8% of our sample suffered a loss of consciousness associated with their injury. So you can't measure electrical injury using the same parameters as a traumatic brain injury. It's most often not associated with a loss of consciousness. There may or may not be post traumatic memory loss. In our experience, more often than not, if you give them a CT or an MRI, you don't see evidence of structural change.

I think that the functional outcome that you're talking about relates to other factors - partly cognitive functioning, but also some pretty substantial psychiatric changes that occur in these patients at a much higher rate than we're used to seeing even in traumatically brain injured samples. I could talk your ear off for another hour on the full psychiatric thing because it's so confounding. I'll just give you an example of what I'm talking about. In the last couple of years I've seen two patients in particular that stand out to me. One was a man, a firefighter, standing on the second floor of a burning building putting out a fire and holding a hose that has an aluminum ring. I learned a lot about how they fight these fires. One of the things that they do is they haul up generators to provide light so that the firefighters can know what they're doing. In this case, the hose that the person was holding came in too close contact to the generator, and our firefighter who's standing in a burning building trying to put out a fire sustains a pretty significant electrical shock. Following his electrical shock injury, independent of his obvious physical thermal injuries, he experienced a substantial change in his personality. He didn't want to go outside, didn't want to talk to people, was easily upset, had trouble regulating his emotions, easily

agitated. I saw a second patient later that year whose job it was, he worked in the coal mines. It was his job to lead an emergency response team into the coal mines when there was a disaster. So our guy actually was an emergency responder, leading people into the mines. Well, one day he's in the mines, has an electrical accident, is exposed to some faulty equipment, and he sustains an electrical injury. Our guy, our emergency responder, becomes depressed, anxious, tearful, doesn't want to be around other people, has trouble regulating his emotions. And you go, "Okay, well, look. You know, anybody who's been through a potential life threatening experience could be profoundly affected by it." But here we have two individuals, no prior psych history. One of them stands in burning buildings for a living, and the other goes into and deals with coal mining disasters for a living. Both of them have electrical exposures, both of them go through profound psychological changes. And I got to ask, and have been asking for years, "Is this just an understandable reaction to an injury scenario? Or is there something more? Something that affects the way that these individuals can regulate and manage their emotions?"

Indeed, what we've seen over the years is that there is a higher than expected rate, in our convenient sample admittedly, of individuals with post-traumatic stress disorder, anxiety related conditions, depression at a very high rate. That change dominates the clinical picture more so, in my experience, than typical cognitive change. In my mind, there's something about the electrical exposure that might be impacting the systems that are involved in regulating emotions. We've done studies where we've subjected our patients to 3.0 Tesla magnets, high resolution MRIs, we even ran a couple of them experimentally through the 9.4 Tesla magnet that the University of Illinois has. These are not structural injuries. These are more functional injuries.The way that I think about it is, when you have a patient who has severe medically intractable depression, they've been tried on multiple medications and they're completely not functional in life. What's the next mode of treatment? Electroconvulsive therapy, ECT. And what is ECT? ECT is applying a small electrical field to the brain that induces a seizure, and, in colloquial terms, causes a neurochemical reboot of the central nervous system. Whatever neurotransmitter systems - noradrenergic, serotonergic, whatever systems were dysregulated somehow going through the electrical exposure, the seizure associated with ECT, somehow causes a re-regulation of these neurotransmitters. Well, what happens if you have someone who's exposed to a much larger electrical field? Who doesn't have a, for lack of a better term, “chemical imbalance” to begin with? That exposure to that larger electrical field could certainly act on those same systems.

Before you dismiss it outright, consider the fact that there are some studies that show that the most efficacious dose of ECT involves providing an electrical exposure that is one and a half times greater than is necessary to induce a seizure. So maybe it's not the seizure. Maybe it's the electrical field exposure that acts on these systems that affect emotion regulation. So that's the speculative way that we understand it. Phenomenologically, what we know is that while we have in our larger sample, 7% of our sample of 262 had a prior history of psychiatric contact and symptoms. 75% in our study that was published in General Hospital Psychiatry were given at least one DSM diagnosis. So either we're looking at a high psychiatric morbidity, we're looking at an effect of my convenience sample, or we're looking at some specific effect that electrical exposure has on brain systems. And I'm sorry to say that behavioral testing like neuropsychological testing, despite its sensitivity, won't be specific enough to answer this question, which was why I became involved with colleagues who did functional imaging.

Ryan Van Patten 41:37
Right.

Neil Pliskin 41:38
Because we said, "Well, if we don't see the structural changes, maybe if we use a different modality we could see functional changes to help us appreciate this." So there were two studies that were done by my colleagues, Alona Ramati and John Sweeney, where they took a small group of electrically injured patients and a small group of controls - I don't have the study in front of [me, I] want to say it's like 12. And they were taught in advance of going into the MR machine, they were taught to do two tasks using nothing but eye movements. One was a spatial working memory task that involved eye movements, and then the other was a learning task, a procedural learning task. So they rehearsed it, they learned how to do the task, and then they were put in the scanner and they were given these tasks. We chose the working memory task because working memory, as I've already said, is a domain that we have found to be commonly affected in these patients. What we found was that electrically injured patients could perform the spatial working memory task just as the healthy controls could perform the spatial working memory task. It took the electrically injured patients longer and they had to activate more brain systems to do the task. Conversely, when given the procedural learning task, they learn the task more slowly than the control subjects did and they showed hypoactivation in key frontal systems used to measure the brain activity conducted during the procedural learning task.

So, let me say this again, on one task, the patient had to recruit more brain regions to do the task. On a second task, they were unable to activate enough brain regions to perform the task as effectively. So if you wanted to make the argument, “Well, you put them in the scanner, they're traumatized. You put them in the scanner, they're on medication. You put them in the scanner…”, you pick some other demographic difference [it] doesn't explain the dissociation between overactivation on one task and underactivation on the other task. The message that we walk away with is, when electrically injured patients say to us, "I can do these things, it just takes me longer. It's just harder for me." That's that need to recruit more brain regions to do what previously has been much more automatic. The fact that some patients have a harder time with acquiring new information, albeit procedural information, suggests that it's not just a function of medication effects. It's not just a function of some emotional factor. There's something, in our opinion, the patterns of activation differ. What that different pattern of activation actually means and how to correlate that with what we see on using neuropsychological endpoints, there's plenty of work to be done.

Ryan Van Patten 44:56
Right. It's all great content. Thanks, Neil. One follow up question on that paper you just mentioned, and then a couple of others on a few things you mentioned earlier. The pattern of activation you described - dysregulation, increased recruitment in some regions and hypoactivation in others - has that been replicated?

Neil Pliskin 45:18
I don't know. Has it been? We haven't.

Ryan Van Patten 45:21
Not that we found. Yeah.

Neil Pliskin 45:24
Yeah, I mean, you'll find case studies out there. There's some spec studies. There's one or two functional imaging studies that have been done in other countries. But it's a very understudied area. There's a large group in Toronto, there's a large group in France, that studies this work. There's a group in China. But not that much interest in the US.

Ryan Van Patten 45:51
A lot of work to be done.

Neil Pliskin 45:52
A lot of work to be done.

Ryan Van Patten 45:54
Everything you described about the emotional sequela of electrical injury is really helpful. I just want to summarize, make sure that I understand and that we're on the same page. It sounds like emotional symptoms tend to, typically, as you mentioned, emotional symptoms dominate the clinical picture more so than cognitive symptoms. I definitely found that in looking over the literature on this topic - that it seems depression, anxiety, somatic symptoms are very prominent. Now, all neurological conditions lead to emotional symptoms at least sometimes, right? Neurodegenerative disorders, stroke, epilepsy, TBI, but my impression is that you feel that electrical injury, in particular, more so than other neurological diseases, leads to more severe emotional symptoms. And that's maybe due to a direct effect of the current on limbic or HPA axis systems.

Neil Pliskin 47:01
Yes, I mean, I think that is speculative, but that is how I see it. Electrically injured patients evidence generalized impairment in attention and processing speed. It's not typically associated with primary memory loss or focal neurologic deficits. But these patients seem to have a higher frequency of psychiatric adjustment issues or personality change than has been reported in the studies that I've seen with traumatic brain injury. And, to be clear, there's multiple contributing factors. When we say that the psychiatric change is predominant over cognitive, I mean, there's a strong interrelationship there. In this sample, you have chronic pain, you've got sleep issues, you've got multiple medications, and then you have these mood regulation issues. Any of those factors in and of themselves can cause changes in cognitive functioning. That's why the work of the neuropsychologist is so important. Because the treatment plan that you devise is going to be only as effective as your sense of how to go about addressing the complex multifactorial nature of these injuries.

John Bellone 48:16
I'm also guessing that this is why patients typically tend to get worse in the first few months after the injury rather than improving due to more of these psychiatric and the sleep and chronic pain and these other ancillary factors.

Neil Pliskin 48:32

Yeah, but I think also some of it is that, in those first few months, they're dealing with heavy duty, burn-related and other recovery related factors. So they're not back at work. And so they don't necessarily appreciate all of the changes that they're experiencing.

John Bellone 48:51

Yeah, that's a good point. When you're writing up a neuropsych report for someone with an electrical injury, is there anything different that we should be thinking about? Anything else that goes into the report that we might not jump to in a normal case?

Neil Pliskin 49:08

Well, I think you're going to want to make sure and give - of course, you're going to want to chain together performance validity tests because it's a complex situation, need I say more. But I think also you need to give psychological tests that measure pain and sleep and emotional factors including post-traumatic stress disorder, and you have to use measures that have at least embedded symptom validity components to them. So I think when you give a neuropsych battery, you have to be sensitized to the potential influence of post traumatic stress symptoms. I like to give tests that measure those symptoms, even in patients where it's not obvious. I also make sure that I give measures that are validity controlled measures because 75% - you haven't asked about it, and I know you will, so I'm going to jump the gun…

Ryan Van Patten 50:07

[laughs]

John Bellone 50:07

[laughs] Yep.

Neil Pliskin 50:08

75% of our sample is in litigation. Litigation is a common component with these injuries. Why? I've already said they're young, employable males, so you get a lot of workers comp. You also have a lot of personal injury cases. And, you know, those create competing forces and you just need to be sensitized to that. But what I would say to answer your question is, you want to make sure and include good validity controlled measures of psychological functioning. You don't want to miss that. Electricians and construction workers, as a group - I'm going to make a sweeping generalization here - that as a group, they are not as emotionally

insightful or as emotionally, let's just say, demonstrative. Stoic might be a way to think about it. So if you don't ask, they may not say. Or it just may come out as irritability. Why aren't they sleeping? Well, it might be because they're having nightmares or flashbacks. These injuries are oftentimes very sudden and unexpected, of course.

The other part of it is, these construction workers and electricians, they go through so much safety training and that's drilled into them. But you could do everything right - you're on your ladder, your head is in that ceiling, you could be following every correct safety protocol, but that guy or that woman down at the end of the hall may space out and may do something that then causes you to get injured. These electricians in particular, they're used to having minor electrical shocks, they're used to working in high intensity situations, but when something bad happens to them and they become more in touch with the mortality and the dangerousness of their work, independent of whether there's some direct effect of the electrical exposure on central nervous system function affecting emotions, just the abruptness of the injury, the suddenness of it, the potential lethality of it, and the fact that you could be doing everything right and something bad can still happen to you, really influences how people respond to these injuries. If you've trained your whole life to be an electrician and you're used to working six days a week and overtime, and when you're not working you're hanging out with your buddies who are electricians. Now, what an identity dilemma that you're put in. Where, you know, you get the crapola scared out of you doing what you thought that you loved. And now you're in a situation where all you know is how to be an electrician, all your social contacts are in the electrician world, and now you're afraid. And you have a fear reaction to the very thing that you've been trained your whole life to do and that you identify with. So it creates a huge dilemma for people and contributes to their problems with mood and their sense of, "Where do I go from here in my life?" And when you're 28 years old and that happens to you, that's devastating.

Ryan Van Patten 53:44

Yeah, it's really unfortunate. I think it's helpful for us to try to take the perspective of these folks and what this injury can do to their lives. And then also helpful for us to step back and, as you've done for us, characterize what the typical person with an electrical injury looks like sociodemographically, personality wise, because that's who we're dealing with in the office during a neuropsych eval. A follow up question...

Neil Pliskin 54:10
A negative MRI does not suggest that the symptom complaints that someone comes in with are not legitimate.

Ryan Van Patten 54:16
Yeah.

Neil Pliskin 54:16
Just keep an open mind. Do your own evaluation. And even if you can't explain everything, as you said very eloquently, your job is to clarify what they can and can't do and help them to get to that next level of recovery.

Ryan Van Patten 54:34
Right. You've mentioned, of course, every person with an electrical injury is different. But are there any general pieces of advice you can give us for writing the recommendation section of the neuropsych report? Anything different about this group as you're going about this process?

Neil Pliskin 54:53
I'm going to say no. You would approach it like you would any other neuropsych case. You'd be sensitized to both the psychological and the neurocognitive aspects of the case. So no. I mean, there's no signature pattern in MMPI performance, there's no signature pattern in cognitive performance. But that's not to say that there isn't impairment and that there aren't psychiatric changes. One just needs to try to appreciate the different factors that contribute to those changes and devise a treatment plan. If chronic pain dominates the clinical picture, then you're working with health psychology and pain management. If problems with attention and processing speed dominate the picture, well, then you're working with them in cognitive rehabilitation and cognitive strengthening strategies. If emotional factors dominate the clinical picture or are part of the clinical picture, then you're certainly going to want to seek psychiatric consultation, but you're also going to want to be doing, if appropriate, empirically-informed trauma treatment for these folks who need that.

John Bellone 56:10
Yeah, this has been really, really helpful. And for those two patients that we see, with electrical injuries, this will be super helpful. [laughs] No, I say that kind of tongue in cheek because I think, you know, we should be seeing more of these

patients. I think maybe as the awareness grows, about this type of injury, not just the physical injuries associated with it, but also the cognitive and like you've fully demonstrated the emotional impact, I think we're going to see more of them in our clinics. So this has been really, really helpful.

Neil Pliskin 56:46
Sure.

John Bellone 56:47
We do have some bonus questions. So that would be where most interviews would end. But we have two questions we want to ask you that we ask all of our guests. If you could improve one thing about the field of neuropsychology, what would it be? What's your top pick?

Neil Pliskin 57:05
Oh, I would say right now it would be communication. I think that, as a field, we need to do a better job communicating. Communicating with each other. You know, the famous expression that psychologists are the group that circled the wagons and shoot inward. Sorry to say, I've seen that more than a few times in my career. I think we need to do a better job of communicating with each other, and appreciating let's just say the differences that exist amongst us. But I also think we need to do a much better job of communicating to the outside world who we are and what we do. We're talking about a world now where, "Can you devise for me a quick 6-minute test that I can give to my patients that will tell me if they have Alzheimer's disease?"

Ryan Van Patten 58:00
[laughs]

Neil Pliskin 58:00
I mean, I think that the world is changing and it's going to be extremely important for neuropsychologists to be more in the public eye and conscious. Aware of who we are and what we do, especially with the aging - you know, the “silver tsunami” that's on the way that people like to talk about. So I think we need to be better communicators and more organized as a profession. I think that we need to - I mean, most of the world out there does not know who neuropsychologists are and what they do. The days of "if you build it, they will come" are over. Even the last question that you asked really relates to integrated care. I mean, you said neuropsychologists don't see enough of these folks, electrically injured folks, and

the reason is because neuropsychologists are not integrated into many treatment teams outside of some of our specialty areas like epilepsy and memory disorders and concussions. So I think that we need to do a better job of informing the public and working with our colleagues and respecting each other and finding a way to come together as a profession.

Ryan Van Patten 59:28

Great answer. Our second bonus question is, Neil, what is one bit of advice that you wish someone told you when you were in training, or that someone did tell you that really made a difference? So what we're looking for here is an actionable step that trainees can take that they might not have thought of that can improve their training, their learning, and their eventual performance.

Neil Pliskin 59:50

Yeah, okay. Well, I have a different perspective on some of these things because of some of the advocacy work that I do. But my advice to trainees now coming up is, don't be a one trick pony. Don't spend all your time learning neuropsychology not preparing yourself for a world where you're going to be on a treatment team, where you're going to be expected to do briefer cognitive assessments, where you're going to be expected to engage in brief interventions. I think what I would advise trainees going forward is don't forsake your general training in the interest of acquiring as much neuropsychology training as you can. You're going to have a 2-year fellowship and I think that in the world to come, it's going to be not silo-based care. It's going to be “on the ground, in the clinic, how can I help? what do I need to do" kind of care. Some of that's going to be briefer assessments and quick turnarounds, that same day for report information. But it's also going to be being trained and being able to do brief interventions.

So what I would say, my advice to the student is, make sure that you come out well-rounded. If you have a choice, do I take that extra neuropsychology practicum, even though I've already had two full years in outpatient settings or should I do something in rehabilitation? Should I do something in working with health psychology? Should I do something in providing brief interventions in a psychiatry clinic? The answer is yes. You should be doing those things. That will prepare you the best and make you the most marketable for the world. Not if I do one more year of neuropsychology, I'm going to get into this internship and this internship is going to pave the way for the rest of my career. I don't think that's the case anymore.

Ryan Van Patten 1:02:08
Right.

John Bellone 1:02:09
Yeah, that was great. Well, Neil, this has been really, really a great discussion. Thank you, again, so much for all your time. This has been so helpful.

Neil Pliskin 1:02:18

It's an honor to be asked to do this. And when it's all said and done, if you could send me a link, I know my colleagues in electrical injury are going to be interested to make fun of me after they hear it.

Ryan Van Patten 1:02:31
[laughs]

Neil Pliskin 1:02:31

You know how it goes. You guys are doing a great thing, and I'm glad to be a part of it. Thank you for asking me.

Ryan Van Patten 1:02:37
Yeah, no problem. Thanks for the time. Appreciate it, Neil.

John Bellone 1:02:40
Yeah.

Neil Pliskin 1:02:41

All right. Take care.

John Bellone 1:02:41
Take care.

Ryan Van Patten 1:02:43
Well, that's it for our discussion with Neil on electrical injury. But before we end this week, John, why don't you announce the winner of the raffle?

John Bellone 1:02:51

Sure. So the winner of an AACN Oxford Workshop series book of her choosing is Rella Cautanen (?). I'm really sorry if I mispronounced that, but congratulations to you. Thanks to everyone who left us a rating. We really appreciate it.

Well, that's all we have today. Thank you so much for listening. Join us next time as we continue to navigate the brain and behavior.

Exit Music 1:03:17

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