Therapeutic Modalities: Electrotherapy
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- [Fawn] Today's course is Therapeutic Modalities: Electrotherapy. Our presenter today is Dr. Scott Cheatham. This is the third part of a three-part series on physical agent modalities. Dr. Scott Cheatham is an Associate Professor in the division of Kinesiology at California State University, Dominguez Hills and Carson, California. He's the owner of Sports Medicine Alliance. He received his Doctor of Physical Therapy and his Doctor of Philosophy in Physical Therapy. He is a Board Certified Orthopedic Physical Therapist and a certified athletic trainer. He also holds several fitness certifications and is a certified ergonomic specialist. He is a national presenter for various organizations and has authored over 100 peer reviewed publications, textbook chapters, and several home study courses on the topics of orthopedics, health and fitness and sports medicine. Dr. Cheatham's professional responsibilities include being an associate editor for the NSCA Strength and Conditioning Journal, Journal of the Canadian Chiropractic Association, and a manuscript reviewer for several other peer reviewed journals. He is an education and research consultant for various health and fitness organizations. His research interests include myofascial interventions and the efficacy of interventions for various musculoskeletal pathologies. His current clinical practice includes sports medicine services, general orthopedics and sports performance training.

- Okay.

- [Fawn] Welcome Scott.

- [Scott] All right. Well, hey, welcome everybody. This is our third presentation in a series: Therapeutic Modalities. And I would love to thank the amazing team at OccupationalTherapy.com for providing me the opportunity to present on these topics, and also just for providing support as a great team for these presentations. So, and I also want to welcome everyone back who's attended the first and second or have heard it, and also everyone new. So, welcome. And so today we're going to be talking

about a very comprehensive subject, but a very valuable subject, right? Electrotherapy. And so I think it's important as we go through to realize I'm going to try and package this comprehensive topic into a two-hour presentation. So just remember, I'm gonna try to give everyone an overview of key points when it comes to electrotherapy and the different types and how do we apply it to different patients or clients, but just remember that there's obviously textbooks out there that go way more in depth. So please consider this more of a evidence-based overview of all the different electrotherapy modalities, okay? So again, I want to thank everybody for having me speak here. Besides all my other stuff that I do, I am an Adjunct Faculty in the MSOT program at California State University, Dominguez Hills. So all what we'll be talking today will be really framed for the occupational therapist, kind of looking at the biopsychosocial model and how we can progress a client's rehabilitation strategy using electrotherapy.

So I want to make sure we kind of promise that all the way. Now, as far as disclosures and stuff, I am receiving a stipend for this presentation, but other than that, I do not have any financial conflicts or any conflicts of interest in this presentation. Everything in this presentation including images and stuff, we've been given permission and copyrights or permissions from the copywriters to use this material. Okay, so for this presentation just like with the other two, we have three main learning objectives. And so by the end of this presentation, I'm hoping that all participants will be able to: Number one, discuss the scientific and physiological principles behind electrotherapy modalities, discuss best practices for administering electrotherapy modalities for different musculoskeletal pathologies, and discuss indications, precautions, contraindications, and potential adverse events for electrotherapy modalities. And as we move on, I'm going to shorten electrotherapy to simply just e-stim, okay? So we'll be using that kind of term just to make it a little bit quicker 'cause we have a lot to cover in the two hours. So, we'll be calling electrotherapy e-stim just as a simple way. Now, when we look at the agenda, module one, we're going to cover the basic

science. So we'll cover kind of the physics behind the e-stim modalities. Module two, we'll cover obviously what they're used for, potential precautions, contraindications and adverse events. Module three, we'll cover the treatment parameters. So basically, how do you program the machine? That's what we're going to be talking about, and that's what you're going to be charting after you use the modality, okay? So module three will be important because we'll go over key aspects. Module four, we're gonna really look at the interface between the e-stim machine and the patient. And that's using electrodes. So we'll talk about electrodes placement and obviously most important these days is patient hygiene.

So we'll talk about that. And then we'll move forward to the application of the different e-stim modalities. Now, just to kind of premise, and if you guys are writing some little notes or whatever, there's really four main categories of e-stim, right? For category one is you're trying to depolarizing motor neuron. So you're trying to get a muscle contraction or number two is you're trying to control pain. Okay, category number three is you're trying to do some type of tissue healing, and number four, you're trying to give some biofeedback. So those are really the four main categories, right? Activate a muscle, decrease pain, okay? Heal tissue and provide some biofeedback. Those are the four main categories. And then basically a bunch of experts over the last, I don't know, century or so have created a lot of different machines that fall in these four categories. So we're going to break it down into more simple categories and what we have to do to get the desired effect within those categories. So that's going to be in module number five. And module number six is obviously going to be an important unit where we're going to be talking about documentation and stuff. And then throughout each of these modules, we will be reflecting on several slides about the current evidence and stuff. And I'll be talking about the evidence-based practice kind of throughout this whole lecture. So on that note, let's move forward and we're gonna go with module one: Basic science.

Now, if we first look at the history of electrotherapy, the first documented form of electrotherapy used for therapeutics was back in 1743, okay, based on what I've read and stuff. Then as we fast forward to 1791, we see that Galvani or the Galvanic came up with the muscle stimulator. Then we see in the 1830s, Faraday came up with the bi-directional current, and then 1905, Lapicque actually found the law of excitation, okay? And then obviously if we move towards all the way to 2020, we can see that many forms of electrotherapy or e-stim are used all over the world for different purposes. So we can see over the last several 100 plus years, we've seen how electrotherapy is being used. And I was able to get this classic picture of how it's used back in the old days as they say. So kind of interesting to see how the history of these modalities have maturated over the years. Now, another important aspect that I start off every presentation on is really for the OT to consider three things: Number one, when is the optimal time to use electrotherapy during a patient's rehabilitation program? And I think that's important, okay? Point number two or things to consider, how will electrotherapy enhance the tissue healing process and the patient's overall recovery? And number three is, what is the optimal sequencing of your interventions including e-stim? How are you considering? Are you gonna do it pre-manual therapy? Are you gonna do it post-exercise? Where does e-stim fit into your rehabilitation strategy? Right? And based on the patient's healing process, based on all the factors that you found in your evaluation, how is e-stim going to be beneficial to them? And I think that that's an important aspect. Now, a lot of times we use e-stim and as you all know we use e-stim for pain control, right? And that's one of our biggest things that we use. We used TENS units, et cetera.

So, I want everyone to, if you have watched the first presentation, I did a nice little concise talk on pain science and affecting let's say the gate there, your pain or the pain neuro-matrix, those of you who may have not seen the first installment, we covered that. So, but I want everyone to kind of keep in mind as I go through this, how are you going to affect your patient? Are you trying to activate a muscle? Are you trying to

control pain and stuff like that? How is this going to facilitate and progress them through it? And I think that's important because in the old days even when I was an aide several years ago, I've been in practice almost 20 years, everyone got e-stim and ultrasound if you remember, and they use it for billable purposes. Now we've progressed from that and we use e-stim modalities to help us with our treatments. Is an adjunct to a comprehensive strategy. So, please make sure that you consider these as we go through the presentation. Okay, so our first kind of clinical question or construct we need to look at is, what is electrotherapy? Well, the basic definition is, it's a group of modalities that use electrical current to induce a physiological effect on the body, okay? It's based on really running a current, right? An electrical current through the body. It's that simple.

So we get electrons and when we combine them all we get ions. And as the electrical current flows through the body, it does create a mechanical effect 'cause we're running a current, but you can also stimulate other tissues like nerves and you can stimulate the central nervous system with opioid responses and stuff, okay? So, the basic setup or the basic foundation is you have a positive and negative, right? Anode and cathode. You have a positive and negative electrode. And so the electricity will either go one way or back and forth between the positive and negative, okay? And that's why when you look at your e-stim machines, we simply have channel one and channel two, right? You have a red wire and a black wire, okay? And so, depending on your modality that you use or your type of e-stim, the electrical current may just go from positive to negative, or it may go back and forth, okay? And so in general we consider the cathode, the negative is the active electrode. And that's the one where you're gonna feel tingling the most. Okay, so when we break it down, it's real simple; either the electrical current is gonna go in one direction or it's gonna bounce back and forth in between the electrodes, okay? And so that's what we're kind of looking at as far as the basic science. Now, when we talk about nomenclature, there's quite a few terms we've heard over the years, right? Direct current, alternating current. So DC current is defined

as a continuous stream of charged particles, okay? And they flow in one direction. And alternating current just like what we get out of our wall, right? We plug it in. An alternating current, AC, is a continuous sinusoidal, bidirectional flow of charged particles. So it goes from positive to negative, but it's continuous, okay? Now, when we look at the frequency or the rate, the speed, it can be described as the number of cycles for AC or the number of pulses for a pulsed current, okay? And so it's typically described in Hertz or pulses per second.

Okay, and we'll cover this later on in the coming slides, but I wanted to kind of plant the seed now for everybody about the basic terminology. Now, amplitude is really the intensity or the strength of the tingling, okay? And so it's typically defined as the magnitude of the current flow, or simply you're turning up the intensity of the machine. Okay, and that's really called the amplitude. And that's typically measured in amps or volts. Depends on what type of unit that you have in your clinic. And then we have two other terms. One's called phase, and that's the period where the electrical current flows in one direction. And then we have pulse, the period where electrical current flows in any direction. So it may include one or more phases. So if we look at charting and we look at how we're documenting our treatments, a lot of times you're gonna document what machine you use, you're gonna document the frequency, the amplitude and the pulses, okay? Those are the two things, 'cause remember, frequency and pulses per second are pretty similar. And we'll see that with some examples based on our later modules. So I just want to kind of get everyone on this terminology because as we go through, we're gonna be using those terms throughout the presentation today.

Okay, a little bit more nomenclature. When we apply electrical current to a person, they're obviously going to have some type of efferent sensations that go up to the brain as we know, right? So there's four typical sensations or stimulation levels that we want to kind of keep in mind as we are talking about these different e-stim modalities,

right? One is sub-sensory where there's no nerve activation, no sensory awareness. And then there's a sensory level where the patient may feel tingling, prickling, pins and needles, and that may be more of a continuous nerve fiber activation. There's also motor where they're gonna feel those paresthesias, but you're gonna get a visible motor contraction. And there's obviously noxious stimulation where it's very painful, okay? So as you know too, over the years and just being in the industry, we know that we have some e-stim modalities, right? E-stim forms that cover all four of those, okay? So, those are just things just to kind of keep in mind as we talk about the different modalities, because most of the time we're gonna be trying to be getting a sensory type of level, right? We want the patient to feel a strong tingling, but we don't want it to be painful, okay? If we're using e-stim to depolarize a motor neuron like alpha motor, then we may want to go into the motor level. So, we'll be talking more and more about that.

Okay, so now let's talk about defining e-stim current, okay? Now remember, current is more of like that continuous flow we talked about. There's three different classifications that the textbooks have and the research. There's a direct current, pulsed and alternating. And we kind of talked about that before, so let's define it. So, when we move forward and we look here on this slide, we can see the direct current, and we know it's defined as a continuous unidirectional flow of particles. It's typically coming from a battery, okay? So, typically if you're going to use a direct current, it's gonna be one of those old portable units like a battery, okay? It's really not often used that much because it's very discomforting because the electrical current flow goes simply from the positive to the negative in a continuous manner. And for some reason, the human body just doesn't feel good, okay? So if we're looking at the diagram below, I want to kind of give everyone kind of a guide to what I'm trying to do here with that. When looking at the... Let me see if I can get the cursor move in here. Okay. Okay, well, when we look down here, there we go. Okay, when we look down here, we can see that we have the amplitude and we have time. And so, with each of these diagrams we look at,

we can see that direct current is a unidirectional. So that means it's just gonna stay on one part and consider the center line as zero and consider the height as the amplitude or the intensity, okay? So if this block here which represents direct current was lower, that means that the intensity or the amplitude is lower, okay? If it's higher, that means you turn the machine up, okay? So this box here on one side of this diagram represents a unidirectional flow of charged particles, okay? So, I just want to premise that because we have several slides that cover this.

Now, our next current is also called pulsed current. Now pulsed current can be both unidirectional or bi-directional. It can be going on both sides. It can be going back and forth between the electrodes. So, instead of just going one way, it can go back and forth between the electrodes. So, instead of going from positive to negative or negative to positive, it can bounce back and forth between those, okay? And typically these devices are battery-powered or they come out of the wall, but pulsed current is defined as an interrupted flow of charged particles in between the pulses. So, basically we have the tingling that comes on, it turns off, it comes on, it turns off, okay? Now, depending on your pulse width, the client may feel it turn off or they may not. It depends on the sensory level what you feel, but the point about pulsed current is it's not a continuous flow, there's a gap or a rest period in between pulses. And I think that that's important to define because a lot of pulsed currents are used and they have some good research behind them. So, I want everyone to understand that the pulsed current is that it could be unidirectional or bi-directional, and there is a rest period or a kind of a latency period in between pulses, okay?

So, we'll go from there. And then we also have our classic alternating current, which as we can see here as we go up and down, it is a continuous sinusoidal which is kind of like a oval bi-directional flow of charges, but it's continuous. It does not stop, okay? Typically these are done out of a wall like a wall unit, but we could see that if you hooked up two electrodes, the electrical current would just bounce back and forth

between negative and positive, okay? Now, a lot of times though too, the patient may not feel the electrical current go back and forth, they may just feel the active electrode called the cathode, okay? So I get a lot of patients that if I do hook this up, they may say, "Oh, I just feel it in one electrode," but if you use an alternating current or some type of like bi-directional current, just understand that the current's going back and forth between those two electrodes. Okay, so now we dig a little bit further where we've defined AC current, pulsed and DC current, right? Those are the big things. But there's also some subtypes of AC currents that we need to understand. So the first one is actually my favorite, is interferential current, and we'll simply call it IFC to be quick. So IFC is interesting because it's considered an alternating current, but IFC is unique where they take the two channels.

If you look at the diagram below, and I'll kind of lay this out, they take one channel which is a positive and negative, and they run let's say, for example, a 5,000 Hertz frequency electrical current through there. Then the interferential requires a second channel: Positive and negative with a different frequency: 5,100 Hertz, okay? So, really if you think about your interferential setup, you're using four electro-pads with two channels, and you crisscross applesauce. I always kind of joke about that, but you crisscross the your target area of pain or whatever you need, okay? Whatever you're going for, you cross the target area with the electrodes. So if you think about this, channel one is going to cross channel two. And then once you turn on the machine, these alternating currents are gonna be sending two different currents going back and forth between channel one and channel two. And when they intersect each other, they're gonna cause a disruption in that area. And the result of those two electrical currents crossing equals a low level stim level of only 100 Hertz. And so speaking in practical sense, over the years I've gotten some really good results with controlling pain with interferential current, especially if I get someone who's postoperative or they're in that acute inflammatory phase, I'll target the area of injury, like let's say like an ankle sprain if I'm doing some orthopedic stuff. And if I cross the area with the two

channels and I turn on the interferential, I create a disruption of the pain fibers. This could be considered the gate theory of pain or whatever philosophy you want to look at as far as pain science. I'm gonna create a disruption in that area and really kind of confuse the nervous system and help it kind of accommodate, right? Accommodation is where the body gets used to it. We're gonna kind of fatigue those nerves and kind of accommodate it through these two waveforms crashing into each other and creating this disruption, okay?

And so I think interferential is a great technology. I prefer it out of all of the electrical currents I've used over the years, okay? I have a portable unit that I use. So they come in many forms, but something to consider if you're looking for really good pain control with that one patient that you need to use it on, okay? And then here's just another diagram here of the two channels. We can see it's an AC waveform, it's continuous, and we can see one's slower and one's faster. Once you cross them together, they're gonna crash into each other, right? And so you develop this interference in the target area, but then your net Hertz is gonna be a lower value. So the patient may not feel it as much. That's what I like about it. Is that you can turn up the intensity and for some reason with interferential and those two channels crossing, they don't feel it as much as let's say like TENS or some of the other units. So just something to think about. And I wanted to spend a little bit of time in interferential because there're some decent research behind it when we look at the evidence-based properties of this a little bit later, okay? Another waveform or another current, another AC current is called pre-modulated. And so that's where it's already set in the machine and the AC current goes through these sequential increases and decreases of amplitude. So that's where the patient's gonna feel the tingling increase, decrease, increase, decrease. So at the sensory level, they're gonna be feeling this modulation or this adjustment in the current flow while the machine's on.

Okay, and then our next and our last AC current is called Russian protocol. And so Russian protocol was created many years ago and it's mainly used for muscle strengthening. So, as you can see here, the frequency is set pretty decent at 5,000 Hertz, and you're gonna get an immediate spike, okay? Immediate increase in amplitude for about 10 seconds and then you're gonna get that rest period it's gonna turn off. It's gonna turn on for 10 seconds, turn off, okay? And so it's gonna be like this burst of electrical current, turn off, electrical current, turn off. And so that is designed to activate the motor neuron, okay? So it's gonna fire the muscle. It's gonna depolarize that motor neuron based on this frequency. So, if you're trying to strengthen a muscle that's been denervated or that's atrophied, the Russian protocol is a great one to use, but over the years I found that it sometimes it can be discomforting because of that burst mode and that break in between pulses as we talked about, okay?

So just something to think about. A lot of your newer combo units that have like eight or 10 waveforms will have this. It's pretty standard with a lot of the new machines. So just something to consider if you're trying to strengthen a muscle. Okay, so now since we discussed the different currents and also the AC sub-currents, now we're gonna move on to another classification called waveforms. So again, we have these big picture kind of classifications of our three currents, right? Direct, AC, and pulsed. Now we go a little bit deeper and we look at the different waveforms. And so, one of the classifications of waveforms is simply a monophasic current. Now, again, this is similar to the direct current, but remember, what is the definition of direct current? A continuous uni-directional. Monophasic has that break in between. Is intermittent. So you have a period or a pulse where you feel the tingling turn on, it may turn off, turn on, turn off. And the patient may or may not feel that depending on how much rest period you give in between. So, if you're using a monophasic current for let's say trying to strengthen the muscle, you might do 15 seconds on, five seconds off. So the client's gonna feel the tingling come on and then feel it come off. And you obviously want them to volitionally contract while they're doing that, okay? So monophasic currents are

typically where the electrical current goes from one electrode to the other, that's it. It doesn't go back and forth. It goes one way, okay? Now we also have a modified monophasic current called hi-voltage, okay? Now hi-voltage is interesting because you have this sudden spike. You have a quick increase in amplitude with a quick drop, a quick amplitude, a quick drop.

Okay, so it goes from let's say zero to 50, all the way down, zero to 50. And again it's intermittent, but hi-voltage has been used for a lot of things as far as strengthening, tissue healing and stuff. So we know it's a pulsed current, and we know that the current goes one way 'cause it's monophasic, but hi-voltage is gonna feel a little bit stronger than some of the different waveforms that are used. So it's something to consider because a lot of times clinicians will kind of shy away from monophasic because it's a little bit more painful sometimes for people and they prefer biphasic 'cause it seems a little bit softer and it gets the same physiological effect. And I think that's important to know. Okay, and then here we have and we let into it a biphasic current, in this waveform, that's where the electrical current goes back and forth between electrodes. So the electrodes are changing polarities. It's kind of moving back and forth, okay, and we have three different subtypes of biphasic currents. We have symmetrical where the electrical current or the waveform on the positive and negative side is very symmetrical. And then we also have a balanced asymmetrical where one pulse may be one shape and then the next pulse might be a shorter one, okay?

And then we also have the third one which is called unbalanced, and that's where one might feel a little bit more intense. And then as it changes to the other, bi-directional, when it goes the other way, it might be a shorter waveform. So a lot of these three waveforms, they all have different physiological effects on the body per se, okay? And so, depending on the protocol that you use, you may program the machine to do a balanced asymmetrical or unbalanced based on your desired physiological effect. Now, the patient in general is not gonna feel these waveforms. They're not gonna feel

like, "Wow, that feels asymmetrical." You know what I mean? So, there the client may just feel the tingling, but depending on the protocols and the research and what your machine can do, what your e-stim machine can do, then you'll program it for that desired effect. But just understand that biphasic has different currents that they found over the years work on the body different ways, okay? So then we're gonna move forward now. So now, in summary we kind of defined what e-stim is. We talked about the different currents. We also talked about the different waveforms. So that's kind of a big picture overview in a two-hour lecture on what this is.

So now let's move into the physiological effects. And kind of like what we discussed before, e-stim really is focusing on depolarizing either the motor nerve, the alpha motor or some type of afferent mechano-receptor or nociceptive pain fiber. It's also used to drive medication, right? Like iontophoresis, we'll talk about that. And that's typically direct current. But as we kind of look here, but as we go around we have to realize that we are sending electrical current into the body, so we are gonna be getting local mechanical effects, we're gonna be getting vibration, we're gonna be getting cellular movement, we're gonna be getting a neuro-endocrine response, we're gonna have chemical changes and stuff. So, we're still gonna have all your basics with all the waveforms, with all the different currents. So, just remember with all the currents and all the waveforms, you're still gonna be impacting the client in different ways, but the angle is, what are you gonna do with that electrical stim modality? Are you trying to activate the muscle? Are you trying to activate the nerve fibers? Are you trying to drive medication? Are you trying to heal? Are you trying just to give biofeedback? So that's what we're looking at, but I want everyone here to consider that you're still making local changes because you're sending a current into the body. And so, I think that that's important to always keep in mind.

Now, when we talked about that, when we talked about a current and stuff, when we look at the top bullet point, we can see in general, okay, that if you're trying to activate

a sensory nerve to let's say decrease pain, you would use a lower amplitude with a shorter pulse duration, okay? And that's really 500 to 100 microseconds, okay? All right, that's where you're looking at. 50 to 100 that you would set the pulse to, okay? And then the amplitude would obviously be lower because you're not gonna turn it up so much that the motor nerves in the area are gonna get turned on. Second bullet point. Now, if you're trying to activate a motor nerve to get a muscle contraction, then obviously you would have a longer pulse duration, but you're gonna turn up the intensity or the amplitude higher, okay? In general, some of the research, evidence-based, talks about if you're going to try to activate very small muscles like in the hand or the face, you would use a 100 to 125 pulse duration, but most muscles are anywhere between 150 to 350.

Now, if you look at the amplitude for motor nerves, you know you're gonna have to turn up the intensity or amplitude higher. So it's not gonna feel as comfy and relaxing as activating a sensory nerve for pain. So you want to consider that with each patient, okay? Because as you turn up the intensity on any machine, you're eventually going to drive so much current into the area, you're gonna depolarize a bunch of nerves including motor and sensory. So, in my opinion, irregardless of what your settings are, if you turn up the intensity high enough, you're still gonna fire everything in the area because the electrical current going from each electrode. You're gonna fire that area. So on that note, there's a term and we're not gonna go into it too much, but I wanted you guys to understand the nomenclature. There's this term called rheobase, and this is down at the bottom in the pink little box here. Rheobase is defined as the minimum amplitude with a long pulse duration to produce an action potential in any tissue, okay? And it's kind of a broad term that talks about the intensity like I just kind of explained. Then there's another term called chronaxie, okay? Chronaxie is the minimum duration it takes to stimulate the tissues at two times the rheobase intensity, okay?

So, again, those two terms are used in all the scientific textbooks and stuff to describe kind of in essence how you activate sensory nerves and motor nerves, okay? And we'll talk more about this in the coming modules, but I want everyone to kind of understand kind of what's the basic settings to activate the two. Probably the two most popular areas would be sensory and motor. Also too, I want you guys to understand that there's an ionic effect, okay? So sometimes we can use a direct current with this iontophoresis to actually drive medication into the skin through a transdermal route, okay? So, basically if you're using let's say Dexamethasone or if you're using lidocain and is positive, you would basically on your iontophoresis machine flip the leads so that the ion flow is positive to positive. So it's gonna repel those ions and push it into the skin, okay? So, basically we're using the basic concept that ion flow, like charges repel, opposite charges attract, okay? So typically your dispersion pad with iontophoresis could be let's say the positive, which has the medication, or sometimes it depends on the machine or the things.

So you take your dispersive pad and then you make sure you set the machine and the lead wire that is going to repel the ions of the medication that's in the dispersive pad. That's gonna push it to the other electrode and it's gonna help drive that medication into the skin and into the myofascial tissues, into the muscle and stuff, okay? So with iontophoresis, remember it's a direct current, it doesn't feel very good, but it's mainly meant to drive medication through that transdermal route, okay? And then just keep in mind too when we talk about the basic science here, a lot of times the physiological effects when we talk about tissue healing and cellular activity, we also like I mentioned before, we do get cell movement called galvanotaxis, we get cell activation so we can affect the mitochondria, et cetera. Some electrical stims have what's called an antimicrobial effect and also we have enhanced circulation, okay?

So, bottom line when it comes to module one: Direct current is typically iontophoresis. This is stuff for you guys to consider. It can also be used for muscle contraction. AC

currents are mainly used for pain control and muscle contraction. Pulsed currents are mainly used for pain, muscle contraction and tissue healing. Now, when we talk about waveforms, okay, that's the other classification, biphasic is the most common because it seems to feel the best. And the symmetrical and asymmetrical are often used the most because it feels good to the patient, okay? So just remember that the treatment goal should determine the desired physiological effect. So you basically need to use the e-stim current or waveform that's gonna help you get that desired effect. Okay, let's move forward to module two. And this is pretty basic, but we've already kind of talked about the indications, right? A lot of times e-stim in general is used for pain modulation, and we're gonna go clockwise in here, okay? Pain modulation, promote tissue healing, improve muscle strength, motor control. We can use it for that transdermal drug delivery and also biofeedback. So those are the big categories. And obviously there's more out there where you can use it like functional electrical stimulation, and you can use it a lot of different ways, but those are the main categories that have been in the research and in the literature, okay?

Now, when we come here and we talk about precautions and contraindications, when we look at the left corner column, the precautions are pretty straightforward, everybody. And we covered this a lot in the first two presentations where a lot of them have very similar ones, right? Cardiac disease, poor sensation for a precaution, malignant tumor, skin irritation, poor mentation, and open wounds, right? Now, specifically though for electrical stim modalities, we need to take a little bit more precaution when we have people with a possible pacemaker. And that's still considered a contraindication. Now, I know if you look at some research, there is studies that have shown that you can use electrical stim with the new kind of insulated, more tech-savvy pacemakers and defibrillators, but in general, most clinicians are considering a pacemaker as a contraindication still, okay? As we go down the column on the right, we can see carotid sinus, nerves, veins, eyes, unstable arrhythmia, thrombophlebitis, pregnancy, impaired sensation and circulation, okay? There's also

been a couple studies that have come out the last couple of years that have showed that maybe during the last couple trimesters, that electrical stim has been used with women who've been pregnant. There is still some controversy around that because there is some professionals that think that it could cause those Braxton Hicks, that it could stimulate those premature contractions and stuff. So there's still some debate around that. So really the big two and the evidence that are kind of debatable is pacemaker and pregnancy, okay? Those are the two big ones, but e-stim has been used during birth to help calm down the pain versus having opiates.

So again, there's some research in both of those areas, but definitely like obviously a pacemaker, I just stay away from it. There's plenty of other modalities I can use to even kind of counteract that. So for me clinically, I just err on the side of caution and I don't try to risk it. So those are just some thoughts that's with what the evidence reflects and also what's happening in current practice, okay? Okay, so this slide is very important. As we go through and I'm gonna use the arrow here, we're gonna go clockwise: Burns, skin reactions, cross contamination, cross infection, okay? Pretty straightforward everybody, pretty obvious, okay? The electrodes should be in good condition if you're looking down at the bullet points. Each patient gets their own electrodes. You need to monitor through the treatment, okay? Besides all my teaching and my research, I do personally do some legal expert work. And two weeks ago, I have a brand new case where a female patient had surgery on her knee. The physical therapist was using electrical stim, EMS, right? Or NMES to get a muscle contraction. The patient said that he used the same electrodes over a month. And so, one of her last sessions, this was about I think six weeks ago it happened, she felt a big burn in her quad and she saw like a red bruise, kind of achy muscles that came over one of the electrodes. She came home and she had a serious amount of pain. And she went to the doctor and they found out that she had a third degree burn in her quad from the electrical stim unit, okay?

So that's one case I'm currently on. We're in discovery, so as I read the notes, I'm learning more and more, but right now at this point, I've come to the professional conclusion as an expert that the standard of care was breached by using outdated old electrodes. And we'll talk about electrodes later, but for some reason that old electrode caused a hot spot in the electrode and that caused a third degree burn. And so basically the patient had to go through surgery where they had to kind of open up the muscle and clean it all up and stuff. So it turned out pretty it's a very negative thing, but these are cases I'm getting through as I mentioned in the other two lectures. As an expert, and I'm also an expert for the PT board of California, so as an expert, I'm getting these cases on a yearly basis. And a lot of times it has to do with the third bullet point, everybody: Monitoring throughout treatment. Such a big point I wanted to drive home to this group especially with electrical stim, okay? In my opinion, sticking them in the room with a hot packer ice for 15 minutes and giving them a bell is not the smartest thing to do these days. I'm getting a least five to six cases a year when it comes to unsupervised, busy clinicians. They hook someone up, something adverse happens, it results in either the licensing board going after them or some type of civil lawsuit, okay? So again, I just want to spend a second driving home this point 'cause it's really important to understand, okay?

Okay, so bottom line, again, you guys make sure you understand your precautions and contraindications, screen the patient please to be safe, okay? If the client finds e-stim to be painful, try a shorter pulse duration and increase the amplitude slowly over time, try using bigger electrodes, okay? And again, if they can't tolerate it, move on. Try to pick something else. Okay, let's go over electrotherapy parameters, okay? We're gonna spend some time. Now remember, with module three, this is an important module because this is how you program the machine, okay? Most machines are preset now as you know, but you need to know what's going on when you set it because most machines give you the simple title, "Oh, it's set for pain, it's set for strengthening, it's sets for this," but we need to know how the electrical waveforms are

programmed in each machine. So when we look at parameters, we kind of discussed this before, we talked about the phase, okay? Remember the phase is a period when the electrical current flows in one direction. So that's going from one electrode to the other, okay? The phase duration is how long it lasts, okay? And so remember, a phase duration could be on either side. It could be monophasic or even biphasic. It could be on both sides. Second term, pulse. And this is really where we're charting pulses per second with our intermittent or we're looking at pulse duration we talked about, right?

Now, really simply, a pulse is where it's a period of time. As you can see down here at the bottom here, it's a period of time that includes the phases, okay? So it doesn't matter where the current flows, it's just the period of time that includes the phases, okay? So, you could have a pulse duration of 100 or 200 and that may include two or three different phases, okay? And so remember, the pulse duration really helps us understand if we're trying to stimulate the different tissues, okay? And as we go back for a second we can see, okay, and we go back to this slide, we can see that the biphasic uses this symmetrical, right? And also two, we can see that we can use a shorter pulse duration to make it more comfortable for people. And so I think it's a big one to hang on to because the pulse duration, shorter or longer, may stimulate different tissues at different times. So I think it's really important to kind of understand that concept. The next one is now is your interpulse interval, okay? When we look at the interpulse interval, that's the latent period or the rest period in between the different pulses, okay?

So maybe you have a pulse that comes on for 10 seconds and then you have an interval of let's say five seconds and then the pulse turns on again, okay? So, just remember the interpulse intervals kind of like your break in between pulses or your spike in the current, okay? And then we have frequency. And I think frequency is important because remember we define it as the number of cycles for AC or the number of pulses for pulsed current, okay? And so most of the time though, we may

chart it as pulses per second, okay? And so again, we can see that if we have these intermittent spikes, one through eight down here at the diagram, we can see if we have those intermittent spikes, we would chart it at that the frequency is set at eight pulses per second, okay? And that means that the waveform is going to have these very rapid increases, decreases, break, increase, break, increase, break all the way through within one second, okay? And depending on your frequency, that's gonna determine your physiological effect. Next, amplitude. Very straightforward. If we look here and we look at the magnitude, it's really set in amps or volts, but if you look at a typical unit, it's typically one through 10, let's say like on a tangent or something simple. So you turn up. I always joke and say you turn up the volume, right? You turn up the intensity, one, two, three, four, and depending on the unit, it could be either amps or volts, okay? And when you're looking at a diagram like this, the higher the column, the higher the intensity, okay? And that's what you're kind of looking at when we talk about that, okay? And then also we have one thing to consider, is your on and off time. This is typically used with your muscle stimulator, right? You're trying to activate the motor neuron and you can't keep it on all the time else you're gonna fatigue the muscle and maybe create a spasm.

So most neuromuscular electrical stimulating units, NMES units, will have a specific on time and then have a specific off time, okay? This is similar for that interpulse period, but this is really a defined on and off period, okay? And a lot of stimulators use that because the off time is when the muscle can rest and regenerate ATP. And then you turn it back on and it spends the energy, then it rests. So just remember that most electrical stimulators have a preset or a custom set of on and off times. And I think that's important, okay? And then we also have what's called the ramp time, okay? The ramp time's important especially with the muscle stimulation because the ramp time means that the intensity and the tingling, let's say what the patient feels is gonna increase to the maximum amount for whatever how many seconds and then it's gonna ramp down and then turn itself off, okay? And so ramp times are a great way to get the

patient during muscle stimulation to actively contract the quad, hold it for that 10 seconds and then relax it, okay? So you should set your ramp time to allow the person to recognize the tingling and to volitionally contract the muscle, hold it at that maximum voluntary contraction, that MVIC, hold it and then start to relax it as the tingling ramps down, and then you give them a break to recover, and then you go through the same cycle of slowly ramping up, holding it to that maximum contraction, and then slowly relaxing, and then another break, okay? To me, I love using ramp up and ramp down times because that doesn't fatigue the patient so much, okay?

Now, if I have a post-op patient, let's say they had ACL repair and we know that they're atrophied in their quads, I love to use electrical muscle stim early on to get them to activate. And once they are able to activate the muscle and they get that motor pattern returned, then I move on and I discontinue the NMES and then I move to more active assist-active motions to really kind of get that motor reeducation going, okay? But I think in the early phases of reeducation, or if you have somebody who has some type of neurological disorder and you're trying to get them to activate, sometimes even post-stroke and stuff, these are very valuable to use. And so the ramp time can be used to your advantage in some conditions in my opinion, okay? So basically bottom line, when we talk about parameters, just remember that all the different units out there have different settings. So if you look at the manufacturers, obviously the manual will give you the settings. And obviously if you work with other professionals, they'll show you what their protocols they use, okay? And so, you need to understand that when you chart, you have to use a lot of these parameters when you set it up, because remember the goal of charting is what? Number one, protect yourself legally. You got to protect yourself. Number two is another clinician should simply pick up your chart or click on your chart in an EMR and be able to replicate it. Okay, so that's why we use all these parameters.

Okay, so then the last thing to consider when we talk about this module and bottom line is accommodation. Just remember that if you're using e-stim on a patient over time, they will get accommodation. That means the nerves in the area, the tissues, they become less responsive. They become used to it. So you may have to change your amplitude, you may have to change the pulses per second, you may have to adjust throughout their treatments because they accommodate. I don't know if you guys have seen this before, but I've had several patients when I'm using interferential or using something for pain, I'll go in and check on them or I'll be within line of sight and I'll come over and say, "Hey, how you doing?" And let's say they're 10 minutes into a 20-minute treatment, they're saying, "Yeah, I don't feel it very much anymore," so then I'll turn up the intensity a little bit or the amplitude, okay? So just remember the body is always going to accommodate to electrical stimulations, so it should be an active monitoring and an active process to make adjustments as you need to, okay? So again, we just want to keep these in mind, especially when it comes to the science behind it and also the parameters and stuff.

Okay, everybody, we are gonna start number four, okay? Now, we're an hour in, so I'm gonna do my customary stretch session. Let's have everyone stand up for me. Yup, get on up. Let's move for a second. We've been sitting for an hour. So, I want everybody to stand in front of their computer. We're gonna go for one minute. I want you to lift your arms above your head. We're gonna do an overhead squat. Open it up. Everyone squat down and give me 10 of them. There's one. I'm doing it. Two. Take a deep breath. Let's shake it out. Good, five. Let's do five more. Keep going. Stretch it out you guys. Okay, take a deep squat, walk around the room a little bit, take a nice little break. Good, I got two more. Stretch it out, move your neck around. Okay, everyone take a deep breath in, you let it out. Use that diaphragm. Get some oxygen to those legs. We've been sitting for an hour, okay? Let's move around a little bit. We've got five more seconds. Good. Good. Move around a little bit. Alright. There's that one little one-minute rest break. All right. All right, let's talk about one of the most important

things too besides parameters, electrodes. Super important like I mentioned before, okay? So, everybody, with module four, it's pretty simple. We know that electrodes is the interface between the patient and the e-stim machine. Well, there's a lot of different electrodes that are out there, okay? And you really get what you pay for. And I'm gonna be honest. Now you can go on Amazon and you can buy the cheap, disposable, flexible ones. If we're looking at the bullet points and I'll kind of use the arrow here, you can also look at the reusable carbon ones, okay? And there's also ones that are permanent. Those are the old-school ones where you have like a conductive fabric and you're putting gel on it and you use it. Those kind of like the old-school stuff, or some type of wound care may use those special ones. And then also you have water immersion, which is not my favorite obviously.

So, again, I had one case where a PT, a therapist used water immersion electrical stim in a metal hydrocollator. So, I don't think I need to go any more into that. So that didn't end up too hot. So, yes. So again, you want to get what you pay for, okay? So, in my opinion I know electrodes can be very expensive in a clinical setting, okay? So, and the insurance doesn't pay for it, but I really think as far as patient safety, you got to buy some good quality, reusable electrodes, okay? And again, that's my humble opinion, but I buy nice ones when I use it. I don't use a ton of e-stim in my practice, but when I do, I use nice electrodes, okay? So I wanna impress upon you guys, you get what you pay for and also note to self, don't use electrical stim in a metal whirlpool. So, just some thoughts there, okay? So, I wish I could talk. I wish I had time to give you the full story, but maybe another time, okay? Alright. So, let's move on.

Okay, electrode hygiene. Pretty simple, right? Everyone gets their own electrodes. So all you do is you punch a couple holes, you stick them in their paper chart or their exercise chart, okay? In my opinion, you renew every month. In my practice, I upsell some other products. Like I'll sell foam rollers, I'll sell stretching straps, I'll sell electrodes. So, and then I also have a couple of little stim machines that I sell. So, if

you can circumvent the cost of electrodes by selling some basic like biofreeze and some basic stuff in your clinic, then you can circumvent the cost. That's how I did it in my practice and it works out pretty good because it covers my costs for like TheraBand and all your basics. So, think about maybe selling some products or even those new Theraguns or whatever. Sometimes you can make a little bit of money to cover all your incidentals, right? And so, electrodes can be expensive, but think about renewing them every single month, okay? Let's go to the next bullet point on this slide here, shelf-life. It's generally recommended that you need to store them on a plastic sheet and seal them in a bag so that the adhesive doesn't dry out, okay? That's real simple. You want to keep it kind of moist, okay? All right, and then when we talk about dried-out electrodes, that's what happened with that legal case that I got two weeks ago, okay? So, the electrode dried out, so the current delivery wasn't uniform through the electrode. It was a two-by-two electrode, okay? It was very small and so the area had a hotspot and that's what I think the cause of third degree burn in the client's calf or excuse me, quad area. So I think that that's important.

So just remember, electrodes are your interface and a lot of people just have the OT or the PT tech put them on, right? But if you're working in an outpatient or you work at an inpatient and your function is an OT, you're very busy, right? If you're in the hospital, you're working with multiple patients on different things, okay? But if you're a certified hand specialist, certified hand therapist, you could be in one room, but you're having two or three patients at a time. So when we're multitasking, we have to control the most important variable and that's patient safety by having good electrodes, okay? And again, that's just my humble opinion, but I'm getting these cases coming through that are simple mistakes, okay? So, here's the other take-home message here is, the shape and size of the electrode definitely plays into your treatment area, okay? So for example, when we talk about if you're gonna be working, if we look at the picture down below, if you look at the quad, you can use your standard two by two, but you might want to use a bigger two by four like the image on the right down here, okay? You

might want to do that because sometimes the larger electrodes as noted in the prior slide can be more comfortable along with adjusting the pulses per second as well as the intensity, right? You can turn it down and make them feel better. So depends on your goal. You could use small two by twos like it's here on this patient's hamstrings or if you're looking at a larger area, you can use this in the back here, okay? And it also depends on your waveform. Like if you're using interferential, then you're gonna crisscross applesauce over an area. If you're using a simple one channel, you may just put it more horizontally, okay?

So it's important to match the electrode type, the electrode size to your desired physiological effect, okay? And again, I want to emphasize this in the short lecture because it's so important, because that's your interface. It's not just setting up the machine, okay? We need to have that effect. Now, here's another important thing if you guys are writing notes: Electrode placement, okay? The distance of the electrode makes a huge impact on the tissues you're going to affect, okay? Here's the rule of thumb: If the electrodes are closer together, the electrical current as we look at the image here is gonna be more superficial, okay? If it's a DC current, it's gonna go one way, okay? If it is an AC current, it's gonna bounce back and forth, but it's going to be more superficial, okay? So if you're working with a very kind of superficial kind of bony area like the ankle or the hand, you may want to put the electrodes close together and you may want to use a smaller two by two, one by one electrode, okay? Now, if you're using a larger area let's say the low back, and let's say you're gonna be trying to impact the thoracolumbar spine and you know based on the anatomy, you have the thoracolumbar fascia, you got the lats, you got the multifidus, you got the QL, you got all this tissue you have to get through, well, guess what you gonna do? You're going to spread out. You're gonna distance the electrodes. And then you may get to use the two by four or a larger electrode. And then the farther they are, the current has to go deeper as it goes back and forth in an AC current or one way in a DC current. So rule of thumb is the farther away the electrodes, the deeper it goes, okay? And I think that

that's important because that's gonna impact the tissues that you pick. And so, now keep in mind though that the electrical current has to travel through multiple tissues, right? We have the integumentary system, we have the myofascia, we have muscle. We also have adipose tissue, we have bone, we have joint. So we have a lot of things. So the distance of your electrodes needs to reflect your desired outcome. You don't just play some over the area of pain and forget about it. You need to think. I encourage all my students when I teach this class to say, "Hey, look, you need to think about why you're using it, when, where, how, why? Where's it gonna fit into your strategy?" But also placement is huge because that's what gets the effect. And the reason I'm emphasizing that is if we look here, when we look at tissue impedance, that's the resistance to current flow, okay?

So if we go back to this slide, if we're working the low back, we know that the electrical current has to travel through multiple tissues. Well, guess what? Different tissue types have different impedance and conduction properties, okay? Here's the rule of thumb for tissue impedance, okay? Tissues with high water content, they decrease resistance and they increase conductivity. So electrical stim modalities, they love the deep skin layers, nerve and muscle, okay? They love those, okay? Tissues with low water content, the resistance is increased and it slows down the connectivity of the current. And that includes bone, fat, tendon, fascia, and the epidermis, okay? The other layer. So you can see you have to consider what is your target tissue, right? What's your desired outcome? And you need to factor in electrode placement, but also tissue impedance, okay? And I think that this is an important take-home when we apply it, because regardless of whatever current you use: Biphasic, monophasic, waveforms, it's not gonna matter unless you properly place the electrodes because that's where the current's gonna be driven into, okay?

So again, if you're gonna go deeper tissue like lumbar, spine or quadricep or whatever, then you're gonna distance the electrodes and understand it's gonna go deeper, okay?

If you're gonna go more official, electrodes are gonna come together and you're gonna realize that you may hit some tissue impedance, okay? So again, these are adjustments that we should be thinking about whenever we apply the modality, and then we can simply put that in the chart or we can draw out a diagram, like with my aides and stuff, I always on my text, I always draw out a diagram and tell them where to put it so that they understand, and then I'll go and check really quick and I'll confirm that that's the distance I want because I know it's gonna hit the target tissue, and I know I'm gonna have the least impedance, okay? So that's what I'm always thinking about when I'm applying this, okay? So, here's some recommendations, okay? So again, you can reduce impedance by doing some other best practices. And again, this is evidence-based too, okay? Is what?

We understand cleaning the skin obviously. There's been definitely case studies that have shown burns and all that. Cleaning the skin, obviously we talked about using proper electrodes, new, fresh electrodes, removing excess hair around the treatment area, and also sometimes warming up the treatment area can reduce impedance because it increases blood flow and all that, okay? The only consideration I want everyone to think about for this two-hour talk is that areas with high adipose tissue, okay? We know that adipose is an insulator, okay? So, if you're targeting the area with a lot of high adipose, you may need to increase the amplitude to create a desired response because we know that adipose is an insulator, okay? It's gonna slow down the electrical current. Okay, so the conductivity is going to be there. You need to make sure that it's not too painful for the patient, okay? If they can't take it, move on and try to pick something else, okay? So that's one just consideration that I've seen in the literature and it's talked about, about that being a tough area and it can be very painful for patients.

Okay, patient hygiene. Here's some best practices that we talk about. Steps one through six. We've used a similar scenario for all the other presentations, but I'm gonna

go through one through five right now. It's everyone's kind of looking at the PowerPoint and let's look at number one. Obviously you got to wash your hands, right? Also you need to wear PPEs if you need to. Number two is you're really prepping the area of the patient's skin. So whenever I apply e-stim to an area, I'll just wipe it off with like an alcohol white pad or I'll do something to clean off their skin. Step three, I'll apply the electrodes, hook up the lead wires that need to be led, program the machine and then adjust the amplitude. Step four, monitor them during the prescribed treatment, okay? If I'm using ice or heat with it, I'm making sure that no water is gonna be there. I'm gonna be checking them, making sure that the ice bag is covered so there's no cross-contamination, right? 'Cause remember, even a ice bag right on the skin can also... I mean, if it's just ice cubes, it's fine, but we're talking about like a gel pack. That can also carry bacteria, right?

So I'm gonna have a cover for that. And then once the treatment's completed, I'm gonna reinspect the area, I'm gonna clean and sanitize and wipe everything off on the patient's skin. If I was using PPEs or whatever, I may wipe off the machine, right? Keep my PPEs, dispose of them when I'm done, okay? So again, these are just general recommendations especially during the COVID, and we're trying to be a little bit more conscious. Just remember, electrode leads, you can simply wipe those off and let them dry. I wouldn't do like the metal part, but just the plastic outer covering. Your machine can be wiped off. And obviously your electrodes, each patient gets their own and you recycle new ones every month, okay? So that's kind of the rule of thumb there. Okay, so bottom line: Just in summary especially for this unit, we understand that electrode distance should match the target depth. And I think that that's super important to consider, okay? Patients get their own electrodes, defective older electrodes can burn, monitor throughout, follow that treatment sequence, okay?

But remember too, I really think the big step in that whole sequence is really wiping off the patient's skin before you apply the electrodes 'cause sometimes if they're working

out in the gym if you have a big clinic, they can sweat, okay? If they're on a hot pack, they're gonna sweat, okay? So I think it's important to wear, like have the aide put on a glove and take a simple alcohol wipe, 70% or higher, wipe off their back, let it dry, then apply the electrodes, okay? To me I think that that's just one very common safe practice to use in this area. And that's kind of what I recommend. And that's what I do with all my patients. I wipe their skin off before and after just to be safe. Okay. All right. Module five: Electrotherapy Application. So let's look at those categories we mentioned in the beginning, right? The first one is, when we talk about e-stim for muscle contraction now, and if we're gonna kind of summarize what we talked about this last hour, we talked about the basic science if you remember, right? What are the currents? What are the waveforms? Then we move forward and we talked about parameters, like, okay, what's a pulse, what's amplitude, how do we set up the machine? That basically. Then we moved forward and we talked about indications, precautions, contraindications, adverse events. And then we related that to electrode placement, how to take care of the electrodes, how to ensure patient hygiene, right?

So now we're gonna move forward and say, "How do we apply the different e-stim to different desired effects?" Well, e-stim for muscle contraction in its essence has several terms. A lot of times people call it NMES, right? Neuromuscular electrical stimulation, or they call it a muscle stimulator. Or if you're doing a functional activity, a lot of times it's just used with somebody who's maybe post-stroke or spinal cord injury. They have those little portable electrical stimulators that actually turn on a muscle in a synchronous fashion, okay? So we have two different main ones that are used in rehabilitation for either OT or PT, whichever, but the goal is you're simply trying to stimulate the motor neuron, the alpha motor neuron you're trying to get in action potential, okay? That's what you're looking for, okay?

Now, when we look at the different waveforms that can be programmed in these machines, a lot of times professionals will use biphasic, pulsed or Russian to build

strength, okay? Now, we understand in the research that strengthening protocols exist, and yes, you can improve someone's isometric strength and their concentric eccentric strength, but there are limitations. Nothing replaces someone actually working out, okay? But if you have somebody who's had surgery or they've been sedentary and they have atrophy and you're trying to strengthen and reeducate, then the preferred waveforms are biphasic or Russian, okay? Biphasic seems to be the most comfortable for a lot of different things, okay? Also though, muscle stimulators are used for as we go down the bullet points, spasm reduction, okay? And again, those same waveforms are used. Also they're used for edema control, okay? And then also if you're gonna look at a denervated muscle, sometimes they do a direct current which is much more powerful and can be much more uncomfortable for patients. So again, you can see the utility of a biphasic current where the...

Remember, the current is going back and forth between the electrodes. So because of that effect, it seems to be more comfortable and have a better efficacy than some of the other currents. And I think that that's important to kind of look at. So, now when we look at specific indications for muscle contractions and here we're looking at the diagram, we're gonna go clockwise, okay? In the research it's being used, okay? Muscle stimulators are being used for muscle contraction, type I or type II muscle fibers, post-ACL reconstruction, post total knee, patellofemoral, sports performance and cardiovascular performance, okay? So those are the main indications for healthy individuals and individuals with musculoskeletal or MSK conditions, okay? Now, muscle stimulators have also been used with cardiac and neurological conditions. And again, as we're looking at the diagram here clockwise, after cardiothoracic surgery, there's been studies that have used this to help strengthen people with cardiopulmonary diseases, post-stroke spinal cord injury, and also cardiovascular performance for people who have had surgery.

So, it's interesting to see how the muscle stimulators or the e-stim for muscle has been used in the early years for a more athletic population. And now it's being used more for cardiac and neurological to help keep the muscles strong and keep the people more functional, more active, and that's where we're getting all this research with all these different diagnoses. So it's pretty interesting, okay? So now when we look at the different devices, again you guys, there's a ton of different devices out there. There's your standard EMS here which only has the two channels, right? Okay, and it's a portable unit. We also have like a large combo unit right here that plugs into the wall. And then we have what's called, and this is a brand called the InTENSity Select Combo. This has like six or 10 different waveforms, okay? So again, I think these manufacturers are trying to get smaller and more portable and use like rechargeable batteries. So, the advantage for us is we can use one portable unit and have access to six or 10 different waveforms, okay? And so I think that that's great.

So a lot of times these combo units will have Russian and NMES settings that you can program for your desired effect for each patient. So I think that's an advantage of the new technology. Now, when we look at this table here, we're not gonna get too much into it. This is more for your reference because of sake of time, but in the literature and in the textbooks and stuff, there's specific protocols. And so, when we look here, and I'm gonna use the green arrow here. When we look here on the left column, we have a protocol for muscle strengthening and also for muscle reeducation. If you're gonna set the machine to strengthen a muscle, in general the researchers and everyone recommends a pulse frequency of 30 to 80 with that same pulse duration we saw before, right? One for small muscles, 125 to 200; large, 200 to 350. Amplitude will be 10% of our maximum contraction, okay? Or an injured muscle will be about 50%. On/off times are set anywhere between six to 10 seconds, okay? The ramp time, remember you need at least a couple seconds. You want to do about a 10 to 20-minute treatment, okay? And then the recommendation is every two to three hours you could do this for a 10 or 20-minute setting, okay? For muscle reeducation, we kind

of follow those similar: 30 to 50, same pulse duration, amplitude is more at the sensory level where you can actually feel it, similar ramp times, and all the way through.

So, these protocols, I've seen the similar ones are very close set in the machines that I use. So, if I set the machine to muscle reeducation, it automatically pops up with the pulse frequency, amp, duration. I set the amplitude, I can set the on and off times or it's preset, and I can set the ramp time, okay? So again, most of the machines have these preset, but when you document your treatment, you need to note all of these parameters, okay? And that's the standard of what everyone's doing. So keep in mind that these protocols are general. They're not all inclusive, but it's meant for you guys to use it to chart, but also to see that there's some standard protocols out there. Now, more than likely, your manufacturer will have a manual that will give you a lot of these protocols based on what they programmed into the machine.

Okay, other protocols here. I'll kind of use a green arrow. We have muscle spasm, reeducation, edema. You can see that a lot of the same parameters are there as you look through, okay? So really, when it comes to muscle stimulation, e-stim for muscle contraction, you're using a lot of similar settings to actually activate the muscle, reeducate, work on muscle spasm reduction, and work on edema because of all those mechanical effects that occur when you run current through the body. Okay, let's look at some evidence, okay? One of the clinical questions I posed was, is NMES effective in healthy individuals and individuals with MSK cardio-respiratory or neurological conditions? Well, as I mentioned at the beginning of this talk, the whole world of e-stim is ginormous, everybody. It's huge, right? We have thousands of studies. So, I did basically a five to eight year lit review for you guys 'cause I wanted to give you the current evidence. So, if you look at the bulk of the current research, we can see from 2015 all the way up to 2020, we have positive benefits for stroke-spasticity, congestive heart failure, post knee surgery, a denervated kind of loose shoulder and stroke, post-TKA, stroke lower extremity function in a couple of studies, dysphagia and stroke,

spinal cord injury, and also COPD. So again, we have all these studies that support it, that NMES has had a positive effect, but please keep in mind that in most of these studies, it was used as an adjunct to a comprehensive program, okay? So, you have to remember that they've been used. Now, the problem with this evidence is that it's all good and handy, but a lot of them didn't report all the parameters that we just discussed. So that's a problem for a researcher or clinician to say, "Hey, wait a second. What was your exact settings?" So that's a gap in the evidence when it comes to e-stim that you should consider, okay? And then there was a 2017 Cochrane review which is very respectable. Said that NMES provides no benefits for patellofemoral syndrome. And those of you who know patellofemoral syndrome, we know that there's a lot of factors in it. So it kind of makes sense that activating the muscle may not be the best approach for PFS, okay? Some clients it could be, but it depends on where they're at in their rehab and stuff, okay?

All right, so let's move on to our next category, right? E-stim for pain control, okay? To me this is probably one of the most widely used categories for e-stim. And they usually break it down into two different categories: Interferential current which uses a AC member, alternating current, but using four electrodes, okay? Transcutaneous electrical nerve stimulation or simply TENS typically uses two electrodes, right? They're both kind of interferential, uses AC so it's continuous, TENS uses like a biphasic current, but you're looking at four pads versus two. So one channel versus two channels. So just kind of consider that. Now, a 2018 study by Almeida et al. was a systematic review and they found that both of these waveforms have the same effects on the body. So, interferential or TENS have similar effects, to decrease pain. And I think that's important because with some individuals, a simple TENS unit using two electrodes is much more efficient than having to hook up the interferential and have them crosscurrents and create that disruption, okay?

So remember, I prefer interferential myself, I love it, but I want to be there when I set it up. If I'm prescribing a pain control e-stim unit for my patients for home use, I'll typically just go with TENS, okay? And so, with the goal, I know that if I'm gonna be using let's say TENS at home, I'm gonna be trying to control the pain level, right? I'm thinking about the neuro-matrix, gate theory, opioid release. I'm thinking of the science behind it and how I'm gonna affect them, okay? All right, if I'm using TENS, I'm gonna be using more of a conventional biphasic current, okay? Or if I'm using interferential, I'm still gonna be using that comfortable biphasic, okay? So again, it's just by choice. And again, you may have to play with the parameters and the waveforms to find that's most comfortable for your client, okay? And I think that that's important to consider, okay? So, when we talk about indications for these types of e-stim modalities for pain control, as we go clockwise, we know it's for acute pain, chronic pain, cancer related pain, stroke, MSK conditions, and also labor pains, okay?

Those have all been used and they're all noted in the research, okay? When we look at units and stuff, we can look at the units here, okay? Again, we have just a portable TENS unit, okay? We also have our combo unit, like we said that plugs into the wall, but then preferably we have our combo unit here that covers six or 10 waveforms. And they're fairly cheap now. If you look on Amazon or whatever, some other manufacturer website, I've actually bought these for patients and just told them, "Oh, go to program number one or whatever and you can preset it." But these newer units are actually very neat. They're pretty slick. I mean, you can actually program them and it's very easy for the patient just to turn them on and off basically, okay? So again, try to use their technology to your advantage, and having a simple, portable combo unit will probably save you a lot of time versus running around looking for the TENS unit, okay?

So, when we talk about pain control, let's talk about the protocols or parameter settings, okay? We typically have three when it comes to either TENS or interferential. We have the high rate conventional, low rate and burst mode. For higher rate, we can

see we have a larger pulses per second, right? So it's gonna come in a lot faster. We have a duration of 50 to 80. We want to produce a tingling, but we don't want to produce a muscle contraction, okay? Remember that. Remember, with any e-stim unit, you can turn up the intensity and you can activate the motor nerve, okay? Very simple. So we want it to be strong and yet comfortable, okay? You can use modulation where it fluctuates up and down to help the patient accommodate, okay? Sometimes they've even recommended, especially with like spinal cord stimulators and all these other stimulators, you can wear them all the time or for 24 hours, okay? And again, the traditional thought is you're doing the gate mechanism of pain, but in the first presentation in this series, I gave you some of the more current pain science theories. So please go back to that and kind of look because this'll feed into your thought process and why you're using e-stim for pain, okay? Now other settings could be low rate, which obviously the parameters are going to be a little bit lower, but now you're gonna produce a visible contraction, okay? So that's another pain control setting, okay? And then you're trying to stimulate the neuroendocrine system by doing an endorphin release, okay?

Now again, I tried the low rate before on people for pain control. Sometimes it doesn't feel good. And then when their muscle is kind of shaking or spasming, they don't like it. So something to consider when you're applying the low rate or the next one would be burst mode, which is a more powerful spike, right? An intermittent spike in the amplitude and the feeling of the tingling, you're gonna turn it up to where they are feeling the tingling, but you're gonna produce a visible contraction in their target area, okay? And again, researchers found out that if you turn it up enough and you set these pulse frequencies and pulse duration, you're gonna stimulate the neuroendocrine, okay? Now that's all great, but I want patients to like the e-stim. So I typically like to go with a conventional setting just to create more comfort 'cause I want them to relax. I don't want them to feel sympathetic when they're feeling uncomfortable, right? And sometimes patients can get freaked out when you put electrical current through them.

And I think that that's important to kind of realize, okay? So, when we look at the research and stuff, we want to consider what the research. When it comes to IFC and TENS and we'll kind of quickly go through this, we did our same lit search and we can see the asterisk or IFC and the other ones are TENS, but we can see that from 2015 to 2020 we have some good evidence that support the efficacy for both e-stim methods, right? So, knee OA, carpal tunnel syndrome, stroke, cancer and labor, they all have good outcomes. Now, when we look at the other evidence, there's a growing group of evidence that's showing no efficacy for TENS, okay? So there is some controversial research ever since from 2015 to 2019 that covers mainly neuropathic, right? So more of your neurological or your musculoskeletal conditions. So, perhaps TENS may not be the best treatment for a standard musculoskeletal condition, okay? Something to think about because we have some mixed evidence. But again though, your best evidence is with your patient. So remember, evidence-based practice is taking the evidence and translating it to your patients in your practice. Just keep in mind that IFC and TENS has mixed research that has occurred in the last five to eight years, okay? Something to think about.

Okay, e-stim for soft tissue healing. We'll continue to move through. We've got a few more minutes here. E-stim for soft tissue healing: High-voltage pulsed current and iontophoresis, okay? Those are two of the main things. The goal is as you know is to either try to modulate pain a little bit too 'cause we get that effect, but we're also trying to stimulate healing, okay? But remember though, I wanted to kind of keep that in there to say you're still working on pain with this stuff because iontophoresis uses an anti-inflammatory, doesn't it? Right? So you're still getting that healing effect, but you're also trying to affect the pain too. So they're used in different ways and so high volts or HVPC uses a pulsed current or an AC, and ionto uses a direct current, okay? Mainly the indications is if we go clockwise, it's gonna be what? Wound healing, edema control, transdermal drug delivery, okay? When we look at the units, again, when we look at ionto, we have like a wired unit, okay? We can see we have a wired

unit that you would use or simply a patch. There was a 2015 study in the Journal of Athletic Training that actually showed that both the patch and the wired iontophoresis has similar benefits, okay? Something to think about. Now, when we talk about high volt, that's also most of the time included in your combo units, okay? So that's just one way to kind of look at the variety. Now, when we look at protocols, we can see we go back to our protocols. And if we're looking at tissue healing by controlling inflammation, facilitating the healing process, we can see that if we're gonna use HVPC, we're gonna use a negative polarity, pulses are gonna be 100 and 105, we usually have a preset duration, we want to produce a comfortable tingling, and we may go for a little bit longer to help kind of calm things down, okay?

Also too, when we talk about tissue healing in the proliferation phase versus inflammatory, we're gonna switch the polarity to positive, pulse frequency, 100, 105, again similar presets from there, okay? These are typically preset protocols, okay? Now we have to remember though too, is that the protocols I'm showing you on this slide are let's say if someone has a sprained ankle and you're working to calm down the ligament, that's when you might want to use HVPC. Now, when you're talking about wound care and open wounds and using electrical stim, that's a whole another presentation on how the electrical stim technology is being used. So please consider that this is mainly in the inflammatory and the proliferation phase, okay? That's one thing I want you to please make sure to consider and stuff, okay? Now, if we're talking about edema control, we have similar settings where we do like a negative polarity. That means you just change the lead wires, okay? Pulse frequency, pulse duration, the amplitude is a little bit higher and you go for 30 minutes, and then again, you go for edema control. Same thing, you're still trying to get the tissues to calm down and heal, okay? You can use more of a biphasic current, okay? You can start using that. And sometimes you can use that for interferential, okay? And then you can use the pulses per second, very similar. A little bit higher pulse duration. And you can go 20 to 30 minutes, okay?

So everyone can see here that these parameters are really for just your reference. There are many of them out there, but they all kind of follow the same kind of categories. Within this two-hour lecture, I just wanted just to kind of give you guys an idea of some of the common protocols out there, okay? Really the last protocol here, iontophoresis. We understand we're using a DC and we changed the leads and we set up the machine to drive the medication trans-dermally into the skin, right? So, if your medication is negative, you would set the machine to repel that into the skin. If it's positive, you would set the lead wires to be positive to drive it into the skin, okay? And that's what we're looking for 'cause we want to push in the skin. And then this slide here, again, my apologies if some of these slides are kind of busy. I wanted to give you guys a reference. Here's the typical ions that are used, okay? And the medications, some of them that are used in iontophoresis, okay? And you can see the polarity and just for some information here. So again, it just mainly for your reference, but I think most of us use either dexamethasone or lidocain, okay? And we know if we look here, dexamethasone is negative.

So, obviously you would switch the machine to be negative to repel it, lidocain is positive. So sometimes professionals will take the dispersive pad, the little pad with the cotton and they'll inject some dexamethasone and lidocain. So let's say for 10 minutes of the treatment, they'll switch the machine to be negative, negative, and push the dexamethasone in. Then they'll switch the machine to be positive, positive, and then to drive the lidocain in, okay? So there's different ways of setting things up clinically, but the goal is you want the ions to repel versus attract, and then that's gonna drive it into the skin, okay? That's kind of the summary for that, okay? So when we look at iontophoresis evidence, we'll quickly go through this. There's not a ton of it the last few years, but some of the studies have shown obviously positive benefits 'cause there's medication. With pain management, lateral epicondylitis, patellar tendinopathy, carpal tunnel syndrome, and wound healing, okay? Most of them use like dexamethasone or

some other type of INSEAD, okay? Cortisone, dexamethasone or the INSEAD family, they use that. But also there's been a couple of studies. I pulled an older study in 2002 that looked at elbow pain and it's kind of older, but even in 2013, a Conchrane review looked at neck pain and found really no major effects. It was kind of weak. So just remember that iontophoresis in my opinion, I love to use it clinically if I need to really calm something down. So it does have its efficacy, but I just want to make sure that you understand that there's some mixed evidence when we talk about evidence-based practice with it, but it really depends on the medications you use, right? So that's why I kind of put an asterisk by it at the top, is that the benefits really depend on the medication you're using, what phase of healing you're going to use it in, and also what's your target tissue?

So, there's a lot of variables that these studies don't flush out that we consider clinically as clinicians for ionto, okay? Now, clinically speaking, ionto is very uncomfortable. I don't know if you guys have ever put it on yourself, but the tingling is very strong and it's very uncomfortable. Patients will accommodate to it, but especially with ionto, because you're driving in medication, it's not uncommon for them to get skin irritation, some little kind of bubbles or blisters at the very interface where that was driven in. So it's important to maybe shave the area and to decrease that tissue impedance as much as you can, clean it off before because again, you're driving in medication. So I've seen people get burned with ionto because it was on too long or if it was too intense. So remember, we're using medication, so you need to be a little bit safer in my humble opinion when you're using it, okay? And my rule of thumb is, I never let a unlicensed person hook it up just to be very careful. So, just something to consider, okay? When we talk about the high volt evidence, 'cause we just talked about ionto, there is a lot of strong evidence for wound healing. And I wanted to keep this slide in here 'cause some of you may do wound care and we know that the high volt pulsed current is used for different things like pain and all that. But specifically though, for diabetic wounds and antibacterial effect, pressure ulcers, wound healing,

chronic wounds, there is in my opinion a strong body of research the last six, eight years from 2014 all the way up to today that support the use of it, okay? So again, HVPC may be a viable option if you are dealing in the wound care area. And again, honestly, it's out of my wheelhouse, but I wanted to put that in there because we have a lot of occupational therapists who carry a lot of hats in their organization. So I wanted to include this just to make sure that we cover all of our evidence-based topics, okay? So please consider that if you're in the realm and again, a lot of you already may be using it. Using that realm. So, important just to know, okay?

Okay, and then our last kind of category that we talked about is simply e-stim for biofeedback. Now, in my humble opinion, biofeedback was popular, gosh, in the eighties and nineties where we simply, if we're looking at the terms, we simply called it biofeedback or EMG biofeedback, but we found out that biofeedback can come in many ways, right? Tactile, visual, auditory. So, I think that the EMG biofeedback has kind of lost a little bit of kind of excitement among clinicians over the years because we found that we can use simpler, quick other modes of biofeedback versus hooking up a machine and having them see the lights or the sound and stuff. But in some cases when you're trying to calm things down or you're trying to reeducate, that's where EMG biofeedback may have it's a good spot. The efficacy may be good in that realm. So, if we're looking here at this second bullet point, we can see that EMG biofeedback, that's where you hook up the electrodes and it measures the activity of the muscle. Very simple. It could be good for reeducation, inhibition and coordination, okay?

Also too, it's precautions or contraindications follow a lot of the same thing, but especially acute inflammatory, pregnancy, bladder, genital infections, because we know that a lot of biofeedback or EMG is used with our women's issues or men's issues when it comes to the lumbal pelvic hip complex, right? When we come to things like incontinence and postpartum stuff, male incontinence and all that, there where a lot of professionals use EMG biofeedback for that. So obviously there'll be some

precautions and contraindications around that. A lot of times too though, it's used in the research for hemiplegia, quadricep strengthening, chronic pain, pelvic floor, TMD disorders, and headache. Some of the research is using it to help people calm their muscles down by cognitively relaxing, okay? So, biofeedback is also used a lot in some of the psychology research to really get people to relax, okay? So, when we look at the evidence, I didn't do note a ton of evidence, but EMG biofeedback has good recent studies for obviously stroke people who maybe have pelvic floor, swallowing disorders, it's been used quite a bit, neck pain, headaches, pelvic floor, and also stroke. So basically from 2019 to 2020, we had a spike in research that shows good benefits, okay?

Now when we're looking at the opposite evidence-based, well, we have a few studies, some Cochrane reviews from 2015 to 2020 showed that it didn't have really any benefit for fibromyalgia or anxiety. So remember, there's some mixed things, but for a lot of your more mechanical stuff or a lot of your neurological stuff, it seems like EMG biofeedback may have some efficacy. So something for everyone here to consider as we're looking at that, okay? And so, the bottom line for this unit is that there are many e-stim modalities in the market. You guys see that. They all have different waveforms, different settings, but I think that the combination unit is a great one to buy and purchase. It's worth it. It's a good expense. The suggested protocols that I noted are really from different textbooks, they're from the research, they're all kind of standard, but just remember, you want to follow guidelines of the device manufacturer's existing evidence. You can also talk to your colleagues and what they're setting, but also too, if you're working with wound care physicians and stuff like that, they know their modalities. So you can collaborate and stuff. And also to just remember, that this talk only covered the main categories of e-stim modalities, okay? There's many other waveforms and currents out there. The three notable ones that I just didn't have time to talk about would be micro-current.

Okay, that's a very low stimulation. H-Wave electrical stimulation and also using ultrasound with e-stim, okay? Those are all kind of options that you guys can consider. I just didn't have a lot of time to discuss that in this two-hour lecture. So again, this is a very comprehensive topic and there's a lot of great textbooks that cover it more in depth. So if you guys need to get some of those references, just send me an email and I'll send you the textbooks that I like to use in my teachings and stuff or some of the research too, okay? Okay, our last unit documentation. We'll finish up pretty quickly here. We can see that we're gonna do the same thing that's discussed in every presentation. You got to note the modality, you got to note the body region, treatment parameters, patient position, and how they respond. Very simple. That protects you and them, okay? We understand that we have different CPT codes, okay? All right, there they haven't changed even though the ICD went to 10. ICD-10 now, okay? Also too, if you look on the OccupationalTherapy.com website, there's actually a good article on billing for modalities, okay? Something to consider if you want to look a little bit more in depth.

Okay, here's some common charting examples. And again, I just adapted this for some examples within some evidence-based textbooks and stuff, and this is similar to how I chart. So again, please consider this is just an idea. Everyone charting is gonna be different especially if you're using EMR, okay? So, if you're gonna do muscle contraction or reeducation, you would simply note the modality, you would describe the pulses you're using, frequency, your on and off time, your ramp time, amplitude, muscle contraction, your treatment time, and then the patient response, okay? So again, pretty obvious, but you can see the protection is in the details. You've got to detail your notes appropriately because again, another clinician should be able to pick it up, okay? Pain control, same thing. You're noting the modality, you're noting the region that was treated, time, electrode placement, the waveform, okay? From there you're also noting pulse's duration, frequency, and amplitude, okay? You can talk about that the patients set it comfortably. This is like in a home unit, and that they

tolerated treatment with a qualifier which could be the pain scale, okay? So, if we look here between neuromuscular reeducation and pain, we can see that we may not have put the waveform here. You could. You could put biphasic, monophasic, whatever, but with TENS, you could put the waveform if you want. So again, these are general examples that are adapted that's in the research and noted, okay? Now, when we're talking about tissue healing, it could be someone who just had an ankle sprain and you're trying to heal them, okay? Just like the first example where you'll talk about high volt. So you're gonna note the polarity, you're going to note the dispersive pad, you're gonna note the amplitude, you're gonna note the treatment and how they tolerated it, okay?

Now again, you can give more details if you want to into the pulse width and all that. If you're gonna use electrical stim with a high volt waveform, you can definitely do like a negative electrode in the wound, okay? That means you just switch the polarity red and green, okay? All right, you can do the dispersive electrodes and give them details. And then obviously if you're using iontophoresis, remember you're using medication, okay? So you need to note the medication, where the active negative electrode was, okay? All right, and also too, you want to note how long you keep the patch on if you're gonna use it and how they tolerated it, okay? So again, these are just some charting examples quickly going over this. And again, you want to put all the parameters you need to to protect yourself. And I think that that's important, okay? So bottom line, remember, you need to document all details, okay? Most injuries occur with poor supervision of modalities in general, and the modalities should be used as an adjunct, okay? So, final thoughts on electrotherapy, okay?

Again, as I keep mentioning throughout the lecture, we want to use it as an adjunct you guys. It's a tool in your toolbox, okay? And the best e-stim parameters may change over time. So you may have to use different waveforms. That's where the combo unit comes in and then proper documentation is always important, okay? And I know we

went a little bit quicker over the documentation, but again, just make sure you hit all the parameters and those examples should help you, okay? All right, everybody. We covered a lot of information in two hours. Thank you so much for hanging in there with me. Here's my email, my university email. Feel free to email me. If you have any personal questions or case questions, we're gonna try and answer a couple of questions here. We'll do our best, but if you think about things later on, just go and email me and I'll do my best to answer as soon as I can within a couple of days, okay? All right, so let's cover a couple of questions if we could, okay?

- [Fawn] Hi, Scott. Thank you so much for a great talk. Let's pull some questions over here. The first, John is asking, "Is a history of cancer a precaution or a contraindication for e-stim use and ultrasound use?"

- [Scott] John, great question. At least right now when I work with the medical doctors and I'm working with my cancer survivors, it's considered a precaution right now. I think in the literature and in the standard of care among professionals and medical doctors, that if there is non-active cancer, that it is only precautionary, okay? Believe it or not, there is some research that has shown that e-stim has been used during active cancer. So that's why you may see it in both categories: Precautions and contraindications. So again, I think it's more on an individual basis, but that's how I approach it. And so hopefully that's something that is helpful for you. Okay.

- [Fawn] Linda, "How often should your machine be calibrated? I'm having trouble finding a company to check our machine. We have one machine and one of the companies I called wants to charge me it says for three, their minimum charge." I'm not sure what that means, but just overall, how would you get your machine checked?

- [Scott] Okay, so 'cause I'm doing more concierge practice, I have my machines calibrated and checked every year, annually, okay? So, they may say... Well, I think

what Linda might be referring to is three or more units. So, you may have to pay extra, but I think once you get that report from them, to me that's a huge protection that the machine was calibrated, because in a legal case, the attorney on the plaintiff's side will ask for your records, okay? And they'll look to make sure that you've been maintaining your equipment, okay? So, I always do a customarily. Every single year I have a report. If I'm using medications and ionto, I have the MSDS sheets and everything, okay? So, I would recommend for everyone to do their due diligence and make sure machines are calibrated annually, you have the report, you also have your MSDS sheets for your medications or any other precautionary stuff because that's defensible documentation, okay? Just some thoughts.

- [Fawn] Perfect. Thank you. Yes, I'm pretty sure that's what she had meant. So, thanks for interpreting that. Another person's asking, "If I have a protocol of several stims per day, does the client take their unit home? And if so, how do I make sure the electrodes are in good shape? How do I monitor this? Do I educate the client to self-monitor?"

- [Scott] Yeah, so Miller, that's a fantastic question. I think when I prescribe a home unit for my clients, I'll give them several electrode packets and I'll number them one, two and three, okay? And I try to educate them on it. They become less sticky. If they start seeing a bunch of hair on them, that they see a bunch of skin on them, to get rid of them, okay? Hopefully you'll be seeing the patient more often, but yes, there's a little bit risk involved when someone's using it at home. So, you try your best and you chart, and you teach them how to program the machine, you teach them how to set up the electrodes, and you teach them how to gently, slowly turn on the amplitude. And then you try to train them as much as you can. And so far so good for me, I mean, the ones I've given the patients, they might zap themselves every so often, but I haven't had any major injuries. So, I think the secret is to number the electrodes and say, "This is the

pack one. In two weeks get rid of it, three weeks get rid of it," like that. So that's something you may want to think about.

- [Fawn] Linda's asking, "When you talk about biofeedback for headaches, does that include migraines?"

- [Scott] Yes, I think and I kind of put that in as a general category. But yes, a lot of the research covers migraines, they cover cervicogenic, they cover all the different classifications of headaches. So yes, definitely migraines because especially tension-type, I think they're using the EMG biofeedback for people to really try to go parasympathetic and relax. So, yes.

- [Fawn] Are there any units or manufacturers you recommend for home care or ones to avoid?

- [Scott] Yeah. So what we'll do is why don't all have everybody email me and I can suggest that. Does that sound good? Because we have different manufacturers and stuff and I want to be respectful. So, if you guys would like to email me, I can definitely respond, okay? I can definitely respond with the companies that I use personally, okay? So let's try to be safe and be fair with everybody on that.

- [Fawn] All right, great. There's another question that came in the queue. We'll also have that person reach out to you. I think that might be a better option. The last question coming in is, "How long is it advisable to use e-stim for Hemi upper extremity without a noticeable increase in strength? I've had good results using e-stim on flacid muscle groups with return of function. However, if there is a minimal to no change, at what point do I stop?"

- [Scott] Well, Melanie, that's a great question and it really depends on the patient and how they're healing. Also too, if it's a Hemi upper extremity, what's the etiological factors, right? Is it a stroke? Is it some other type of neurological condition? Was it a head injury? Stuff like that. So, we have to look at really where the patient's at in their healing process and also too is, how is the e-stim working? How is it gonna open up that neuro motor window? Right? So, great question, very complex. It really depends on the patient, how they heal, any comorbidities, what was the etiological factor, the hemiparesis or whatever that really comes into it. So, really I would have to probably look at the whole case. Look at what's been done, look at the clinical course of treatment, and also the clinical presentation to really be able to give you a strong opinion on that. But also though, there's some good research out there that does talk about that. So, you may want to look at PubMed and do a couple of searches and look at some of the recent research on muscle stim for that. Or talk to maybe a PT and OT who also specializes in neurology. They can also have some opinions. So, hopefully that helps.

- [Fawn] I think we're gonna go ahead and close up the class for today. I want to be mindful of everyone's time. If you have any other questions that come up, please feel free to reach out to him. He's provided his email address. Thank you, Dr. Cheatham for a great talk and a great three-part series.

- [Scott] Yeah, thank you, everybody so much. Have a great week. And please be safe and healthy. And have a good year. And we'll hopefully meet up sometime in the future. Thank you, everybody. Have a great one.

- [Fawn] Thanks everyone. Hope you join us again on OccupationalTherapy.com. Thanks everyone. Have a great day.