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The athletic training profession requires continuing education to maintain the national practice credential. Even with this mandate, there is little evidence on the effectiveness of continuing education in the profession of athletic training. A total of 48 certified athletic trainers, from two samples, with an average of seven years of experience, started this study. A web-based survey assessed educational history, current use, perceived and actual knowledge of electrical stimulation. Participants completed a pre-seminar survey and attended a 1.5-hour presentation. Participants completed a post-seminar survey immediately following the seminar presentation and one-month later. All surveys assessed perceived and actual knowledge, and the post survey included ratings of the seminar. A total of 41 participants completed the post-seminar survey and 30 of those completed the one-month follow-up survey (62.5% response rate). Most (82.9%, n = 34) participants rated the seminar as excellent and 100% rated the presentation as founded in the best available evidence. Nearly all participants indicated that the seminar would improve their competence and practice as an athletic trainer, improve their treatment plans for acute and post-operative pain, aided their learning, and was helpful and appropriate for their experience/skill. This is supported by the findings for perceived and actual knowledge. Following the presentation, participants (n = 41) demonstrated a significant improvement in perceived and actual knowledge scores, $t(40)= 5.08$, $p < .001$. Participants that completed the one-month follow-up survey (n=30) demonstrated a significant increase in perceived knowledge from the pre-seminar to post-seminar survey and remained significantly higher than the pre-seminar at the one-month follow-up survey. These participants also demonstrated a significant increase in actual knowledge from the pre-seminar to post-seminar survey, $t(29)= 3.03$, $p = .003$, and

remained significantly higher than pre-seminar at the one-month follow-up surveys, $t(29)= 3.69$, $p < .001$. These findings suggest that the presentation was effective for improving both perceived and actual knowledge scores in athletic trainers and was well received by the participants.

CONTINUING EDUCATION SEMINAR'S IMPACT ON KNOWLEDGE AND RETENTION AMONG ATHLETIC TRAINERS

by

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Dr. Diane Gill
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DEDICATION

This project is dedicated to my supportive wife, Lynzi, and our children, Nolan and Emma. Also, this project is dedicated to the memory of my mother, Karen Warner.

APPROVAL PAGE

This dissertation written by Brandon J. Warner has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

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CHAPTER I: PROJECT OVERVIEW

According to the Board of Certification (BOC) 2021 Annual Report, there are 58,305 certified athletic trainers all requiring continuing education to maintain their credentials. Healthcare professionals, including athletic trainers, need to possess and maintain their clinical knowledge and skills to provide quality care. Continuing education (CE) is the current post-professional educational method to inform clinicians on best practices, contemporary techniques and skills, and any updates in research beyond their entry level professional education. The BOC requires an athletic trainer to obtain 50 continuing education units (CEUs) every two years to maintain their credential. Despite these CE requirements, healthcare professionals have been shown to have knowledge and skill declines post-continuing education course (Berry & Popp, 2018; Duran et al., 2008; Einspruch et al., 2007; Fischer et al., 2012; Hamilton, 2005; Yang et al., 2012) and professional athletic trainers have demonstrated poor knowledge retention on various therapeutic modalities (Cage et al., 2020a, 2020b, 2020c; Schellhase et al. 2015). As such, continuing education events need to be attended and assessed on an ongoing basis for professionals to maintain contemporary expertise.

Electrical stimulation (ES) is a commonly used modality in the clinical setting and education in its use is foundational in professional athletic training education (Henderson, 2021). ES is a therapeutic agent commonly used for pathologies, such as, postoperative pain, osteoarthritis, rheumatoid arthritis, chronic low back pain, and neck pain (de Almeida et al., 2018). There have been numerous recommendations for the use of ES for pain control and research demonstrating positive outcomes injuries (de Almeida et al., 2018; Feger et al., 2015; Hsu et al, 2019; Johnson et al., 2015). The purpose of this research is to develop and implement a

continuing education seminar on using ES in acute and post-operative pain management and assess ES knowledge gains and retention, ES use and participant feedback post-seminar.

Review of Relevant Literature

Continuing education, in athletic training, is designed to develop knowledge and skills, increase clinical judgement and decision making, and continue/maintain credentials and competence beyond an entry-level of practice (Board of Certification, 2021). The organization that approves CE events and is responsible for maintaining credentials for athletic trainers is the Board of Certification, Inc. (BOC). Every two years, a professional athletic trainer must attend 50 CEU's (Board of Certification, 2022). CEUs require approval from the BOC and undergoes scrutiny to ensure that the highest quality of evidence-based instruction is provided to clinicians. In total, there are four categories of CEUs: Category A, Category B, Category C, and Category D (Board of Certification, 2022). Traditionally, Category A CEUs includes clinical workshops/symposia, seminars, lectures or webinars by approved CEU providers. This category was reported as the most favorable with athletic trainers (Armstrong & Weidner, 2011; Edler & Eberman, 2019).

Continuing Education in Athletic Training

Education of foundational knowledge and skills occurs in professional athletic training programs, with the expectation of maintained competence throughout the individual's career. Education foundationally changes from entry level programs to professional education (Doherty-Restrepo et al., 2009). The basic premise of CE is to ensure the continued safety of the patient and clinician competence, and thus, increase quality of care/patient outcomes and reduce litigation for malpractice (Doherty- Restrepo et al., 2009). To accomplish this task, it is imperative that CE opportunities be founded in current EBP and presented effectively.

Several studies have examined the influences of CE on knowledge skill acquisition. These studies included CE on exertional heat illnesses (EHS), ultrasound, blood-borne pathogens and needles sticks in nursing, EBP in the workplace, and advanced airway management (Schellhase et al., 2015, 2017; Bijana et al., 2018; Andrew & Theiss, 2015; Berry & Popp, 2016). Many of these studies demonstrated increases in knowledge and skill post-educational intervention. In one study, nurses increased in competency and decreased their exposure to needle sticks in the workplace (Bijana et al., 2018). Lastly, another study with nurses explored a learner-centered education seminar for learning about EBP and how to implement it in the workplace. This study used the PICOT (Population, Intervention, Comparison, Outcome, Time) method of questioning for the learner to guide themselves through the process (Andrew & Theiss, 2015). By introducing the PICOT method, implementation of EBP into practice was enhanced (Andrew & Theiss, 2015).

The PICOT format is the same format that is being introduced in athletic training for maintaining certification, however, most of these lectures are constructed using passive learning strategies (Hankemeier & Van Lunen, 2011, 2013). Passive learning is described as methods in which the learners do not have to have physical attention to the lesson or learning material (Magana et al., 2018). The learner is idly watching, reading, or simply listening to the material. Conversely, active learning requires physical engagement and participation during the learning session or with the materials (Magana et al., 2018). Some examples of active learning are summarizing the lecture and identifying questions for the instructor, underlining key words, actively taking notes, or reviewing course videos or audio (Magana et al., 2018). Data suggest that there are knowledge gains when the educational seminar has both active and passive learning components (Bijana et al., 2018). However, it was also suggested that proper assessment

of the CE is needed, and the authors suggested the Kirkpatrick Model for assessment to ensure participant engagement and satisfaction (Bijana et al., 2018).

Though the EBP model has shown promise, it is missing retention of knowledge. For this reason, the Kirkpatrick model for assessment should be employed (Bijiana et al., 2018). The Kirkpatrick model has four levels of assessment, reaction, learning, behavior, results. The first level, reaction, is defined as the degree the participant finds training favorable, engaging, and relevant to their current role and employment (Kirkpatrick & Kirkpatrick, 2016). The second level, learning, is the magnitude of gains in knowledge, skill, attitude, confidence and commitment based on the training seminar (Kirkpatrick & Kirkpatrick, 2016). Both these levels are consistently assessed by CE seminars as a requirement of the Board of Certification. However, the next level, behavior, is very rarely collected. This level is defined as the extent to which the participant uses and applies what they learned in the seminar (Kirkpatrick & Kirkpatrick, 2016). Only a few studies investigated the use and retention of what they learned in the seminar (Andrew & Theiss, 2015; Berry & Popp, 2016; Bijana et al., 2018; Manspeaker & Hankemeier, 2017; Schellhase et al., 2015, 2017). The last level, results, is the degree to which the targeted outcomes occur because of the seminar or technique learned (Kirkpatrick & Kirkpatrick, 2016). For medical professions, this would be positive patient outcomes, reduced injury time, and other key indicators. Admittedly, the last two levels are more difficult to assess, as they occur after they return to their practice setting, which is typically distinct from the learning environment.

As previously noted, assessing the efficacy, knowledge and skill acquisition and retention of CE content are critical for professionals such as athletic trainers who are not required to take re-certification examinations. Adult learning hinges on a few key concepts for the individual

learner: level of satisfaction, addressing their specific needs, type of learner, and type of educational event (hands-on versus didactic) (Doherty-Restrepo et al., 2009). Therefore, the Kirkpatrick model for assessment is ideal for the formal assessment of CE seminars (Kirkpatrick & Kirkpatrick, 2016).

Pain Management

Participation in physical activity and organized sport has an inherent risk of injury and is also associated with a rise in injury-related pain. Athletic trainers regularly manage post-operative patients, and it has been demonstrated that 40% of patients experience moderate to severe pain after surgery, thus making pain management strategies crucial in a post-operative setting (Dahl et al., 2012). It has also been shown that poor pain management of these patients may result in slower progression, poor wound healing, increase clotting risk, and the onset of chronic pain (Dahl et al., 2012). ACL surgeries have been particularly known to generate significant pain post operatively (Williams et al., 2006). In other studies, on pain, patients were reporting moderate to severe pain post-orthopedic foot surgeries at a rate of 21% (Remérand et al., 2014). Adequate management of pain is essential for increased patient outcomes, satisfaction, and quality of life regardless of the activity level of the patient (Bonnet & Marret, 2007; Taylor et al., 2013).

Due to the prevalence of injury-related pain, appropriate pain management strategies must be employed to allow for optimal and safe performance. There are many options for pain management. Most of the data and general practice guidelines recognize a multimodal approach to pain management, incorporating pharmacologic and non-pharmacologic interventions (Chou et al., 2016; Qaseem et al., 2017; U.S. Department of Health and Human Services, 2019). However, current guidelines heavily support the use of pharmacologic intervention over the non-

pharmacologic approaches due to the strength of the current literature. As such, many physicians opt to prescribe pain medication for the management of pain and only recommend non-pharmacological interventions. A study on football players revealed approximately 52% of football players have reported using opioids for pain control at some point in their career (Reardon & Creado, 2014). Of that 52%, approximately 71% reported abuse (Reardon & Creado, 2014). Due to the increased use of these substances, more intentional education on non-pharmacologic pain management strategies is critical.

The current prevalence rates of pain suggest the need for relevant CE offerings to ensure proper management strategies. A national survey was conducted that indicated pain education in prelicensure health professions was minimal across six prelicensure educational programs: medicine, nursing, pharmacy, social work, physician assistants and dentists (Doorenbos et al., 2013). While athletic trainers were not included in this survey, these data suggest that athletic trainers may also need to consider more educational offerings relative to pain management and current techniques used in sports medicine.

Electrical Stimulation in Athletic Training

One technique that non-prescribing providers such as Athletic Trainers use to manage pain is electrical stimulation (ES). ES is a modality that uses electricity to produce predictable physiochemical; and neurological responses to aid in the healing process and is commonly used to mitigate acute or chronic pain clinically. ES can mitigate pain via a few different mechanisms. Primarily, ES will activate sensory nerves that compete with pain receptors and blocks the transmission of pain. ES can also activate the release of endogenous opioids and other chemicals to further block pain. The mechanism is dependent of the form and parameters of ES used. Research on this modality has suggested that ES can reduce the number of opioids used post-

operatively (Astokorki & Mauger, 2017; Lan et al., 2012; Li & Song, 2017; Unterrainer et al., 2010). Studies also suggest that ES can effectively reduce acute and chronic pain as measured by a visual analog scale (Facci et al., 2011; Koca al., 2014; Tugay et al., 2007). One study suggests that ES reduces pre-hospital pain and anxiety when applied by emergency medical services (EMS) on transport when pharmacological analgesia is not feasible due to legislative or logistical restrictions in the EMS system (Simpson et al. 2014). Also, the current pain guidelines indicate that ES should be considered in conjunction with a multimodal approach for pain relief. The American Pain Society, in a joint statement with other agencies, recommended ES for post operative pain as opposed to other modalities, such as acupuncture, massage, cold therapy, and localized heat (Chou et al., 2016). This data should encourage clinicians to use alternative therapies to manage pain to reduce the burden of pain and over-medication.

ES is commonly used to mitigate acute or chronic pain clinically. There is a plethora of ES waveforms, including but not limited to, transcutaneous electrical nerve stimulation (TENS), interferential current (IFC), neuromuscular electrical nerve stimulation (NMES), and hi-volt pulsed stimulation (HVPS). Out of these examples of ES, TENS and IFC are the most frequently used in the management of pain (de Almeida et al., 2018). TENS is a device that can deliver a pulsed current to stimulate tissues. Usually, TENS is used to mitigate chronic pain but has been used for reducing pain in acute injuries (de Almeida et al., 2018; Feger et al., 2015; Johnson et al., 2015). TENS delivers a pulsed current at a pulse duration of 10-300 μsec and a frequency of 1-200 pulses per sec (pps) (de Almeida et al., 2018). Due to their low cost and simplified use, TENS is quite prevalent in the management of pain (U.S. Department of Health and Human Services, 2019; Zeng et al., 2015). IFC is an alternating current that is delivered using a medium frequency that results in a beat frequency between 1-200 Hz (Goats, 1990). The theoretical

foundation in IFC is the premise that the medium frequency of IFC will overcome the impedance of the skin resulting in a more comfortable, tolerable stimulation (de Almeida et al., 2018; Goats, 1990; Johnson & Tabasam, 2003). There has been some controversy in this claim hence why there needs to be more investigation on the potential benefits of IFC and TENS. The current literature does not have a clear consensus on which modality is superior, but both currently work to manage pain (de Almeida et al., 2018; Johnson et al., 2015; Unterrainer et al., 2010; Zeng et al., 2015). Both of these forms of ES have been used for chronic pain syndromes (such as osteoarthritis, total knee arthroplasty [TKA], low back pain, ACL reconstructions, etc.) and post-operative/acute pain syndromes (Astokorki & Mauger, 2017; Boekel et al., 2015; Bonnet & Marret, 2007; Chou et al., 2016; de Almeida et al., 2018; Feger et al., 2015; Johnson et al., 2015; Qaseem et al., 2017; Unterrainer et al., 2010; Zeng et al., 2015).

While electrical stimulation has demonstrated efficacy related to pain mitigation, there are many options clinicians can select for a patient to achieve pain relief. Given the multiple modalities that can be used to control pain, education on appropriate use is critical. Pain is an emerging global health concern due to its prevalence, economic burden and impact on the quality of life, both in the individual and family. Acute pain and acute exacerbation of chronic pain is one of the most common rationales that patients use to seek medical attention (Dahlhamer et al., 2018; Todd, 2017). Approximately 30% of Americans are suffering from either chronic pain or acute pain (Volkow & McLellan, 2016). Therefore, it is critical to develop a management plan to address this need and continuing education providers on best practices in sports medicine. In athletic training, there is little research on the assessment of a CE seminar using the Kirkpatrick Model of assessment. The research is especially limited in the Kirkpatrick model of assessment for level 3, the retention of knowledge and skill, and the level 4 assessments, application, a gap

in the literature surrounding knowledge retention and patient outcomes beyond the CE event. In fact, the strategic alliance, which includes the National Athletic Trainers' Association (NATA), the BOC, and the Commission on the Accreditation of Athletic Training Education (CAATE), developed a research agenda to guide their members. Health professions education, including maintaining competence and clinical expertise, was the third priority in this agenda and is urging athletic trainers to begin researching the quality of CEs (Eberman et al., 2019).

Purpose and Aims

The purpose of this dissertation is to determine the impact of an educational seminar on participant knowledge gain, knowledge retention and reported use of ES for pain management.

Specific Aim #1: To determine the influence of participation in the educational seminar on professional athletic trainers' knowledge of ES.

Specific Aim #2: To determine whether professional athletic trainers' knowledge gains are retained over time.

Specific Aim #3: To determine the influence of participation in the educational seminar on their reported use of electrical stimulation.

Specific Aim #4: To assess participants' evaluations of the content, delivery, and impact of the seminar.

Methods

Using a one-group pre-posttest design, data were collected pre- and post-seminar and one-month post-seminar. The seminar consisted of theoretical foundations of ES and pain management, epidemiology of pain, current barriers in research and limitations, evidence-based guidelines for use, and clinical takeaways and evidence-based parameters. The pre-seminar survey collected initial demographics, perceived and actual knowledge scores, current use of ES

for pain management and previous education using therapeutic modalities and ES. The post-seminar and follow-up surveys collected these same measures, as well as the evaluation of educational seminar.

Participants

Prior to the start of the project, Institutional Review Board (IRB) approval was obtained from the University of North Carolina at Greensboro (UNCG). Participants were recruited by email that clarified the research and eligibility criteria. Individuals that received the initial recruitment email were asked to forward the invitation to other interested athletic trainers. Inclusion criteria included active, current, unencumbered, unrestricted license and certification and currently practicing in a setting defined by the NATA. The NATA's practice settings include College/University, Higher Education, Professional Sports, Secondary Schools, and Emerging Settings. Informed consent was obtained from all participants. A total of 48 certified or licensed athletic trainers, between two samples (seminars), completed the pre-seminar survey (average of 7 years of experience, range from 1 to 33 years). Sample 1 began the seminar in May and 22 participants completed the pre-seminar survey. Sample 2 seminar began in October and 26 participants completed the pre-seminar survey. The post-seminar survey data were analyzed and it was determined that the samples could be pooled. Information regarding pooled data can be found in the results section. Full demographic information is located in Table 1.

Table 1. ***Participant Demographic Information***

Demographic	Categories	Sample 1 Pre-Survey (n=22)	Sample 2 Pre-Survey (n=26)	Pooled Pre-Survey (n=48)
Sex	Male	12	8	20 (41.7%)
	Female	10	18	28 (58.3%)
Age	18-25	6	8	14 (29.2%)
	26-35	13	15	28 (58.3%)

	36-45	1	2	3 (6.3%)
	46-55	2	0	2 (4.2%)
	56-65	0	1	1 (2.1%)
Practice Setting	College/University	10	16	26 (54.2%)
	Professional Sports	0	1	1 (2.1%)
	Secondary School	7	5	12 (25.0%)
	Emerging Settings	2	3	5 (10.4%)
	Higher Education	3	1	4 (8.3%)
Highest Degree Earned	Professional Bachelor's	7	13	20 (41.7%)
	Professional Master's	5	6	11 (22.9%)
	Post-Professional Master's (in AT)	4	2	6 (12.5%)
	Post-Professional Master's (Not in AT)	4	4	8 (16.7%)
	Post-Professional Clinical Doctorate	1	1	2 (4.2%)
	Academic Doctorate	1	0	1 (2.1%)

Measures

Due to lack of literature on ES, no existing assessment measure was available. The surveys used for ES were derived from literature on other therapeutic modalities (Cage et al., 2020a, 2020b, 2020c; Schellhase, 2015, 2017). Using the Kirkpatrick model of assessment, pre-seminar, post-seminar, and one-month follow-up surveys were developed. Apart from the ES questions, the survey questions were used in the previously cited articles (Cage et al., 2020a, 2020b, 2020c). The complete surveys (pre-, post-, and one-month) can be found in Appendix A.

Demographic Information

The demographics section included questions regarding educational background, years of experience, current use of electrical stimulation for acute and post-operative pain, past attendance for continuing education for therapeutic modalities and electrical stimulation, and other relevant demographic (age, gender, etc.).

Perceived Knowledge

The second section measured the participant's perceived knowledge using ES. Perceived knowledge was assessed with nine questions, which were totaled for analysis. Examples of some of the questions regarding perceived knowledge include:

- I can explain the benefits of electrical stimulation to my patient.
- I can assess a patient for indications, contraindications, and precautions for electrical stimulation.
- I can explain the physiological effects and theoretical foundations (mechanisms of action, pain theory, etc.) of electrical stimulation.

All the questions are located in the surveys in Appendix A. Questions in this section were rated on a 5-point Likert scale of Strongly Disagree (0 points) to Strongly Agree (4 points), and totaled to assess participants perceived knowledge and confidence using electrical stimulation, with a possible range from 0-36; the higher the score, the greater the participant's perceived knowledge. The same perceived knowledge questions were included in the pre-seminar, post-seminar and one-month follow-up survey.

Actual Knowledge

The last section measured the participant's actual knowledge using ES, such as, physiological effects, parameters, and pain mitigation. These questions were answered in a traditional multiple-choice format using 5 choices as in a quiz or a test. There was a total of 15 questions including 12 in a traditional multiple-choice format with 5 choices and three true or false statements. Scores were determined right or wrong and totaled for a possible 15 points. Some questions from this section include:

- The primary mechanism through which sensory modalities, for example electrical stimulation, cryotherapy, or superficial heat, target to reduce perceived pain is called what:
    - Radiating pain theory
    - Descending pain modulation
    - Central Biasing
    - Gate control theory
    - Cognitive control

- True/False: It is common and appropriate to see a slight muscle twitch or increased tension with a sensory IFC current, especially over the quadriceps muscle.

All actual knowledge questions can be found in Appendix A.

To develop the knowledge questions, three textbooks (Denegar et al., 2016; Starkey, 2013; Prentice, 2015), currently used on the national certification examination and the continuing education seminar, were used to ensure content correctness and validity. Also, the survey was developed with similar methodology and question design as other studies assessing knowledge of athletic trainers (Cage et al., 2020a, 2020b, 2020c; Schellhase et al., 2015, 2017). The initial survey was sent to four current athletic training educators who provided feedback. Their only recommendations were some grammatical and/or punctuation errors on the first draft.

Participant Assessment of Seminar

The post-seminar survey assessed participant feedback with a traditional conference feedback form (Kirkpatrick & Kirkpatrick, 2016). Ten survey questions used to assess the seminar were scored using a 5-point Likert scale of Strongly Disagree (0 points) to Strongly Agree (4 points). The 10 questions in this section were:

- Overall, how would you rate the quality of this educational seminar?
- This seminar increased my competence (i.e., ability to apply knowledge, skills and judgment in practice).
- This seminar will improve my practice as an Athletic Trainer.
- The seminar materials aided in my learning.

- The presentation style of the instructor helped me learn.
- Course content was appropriate for my experience/skill.
- I plan to apply what I learned in the seminar to my practice.
- The instructor demonstrated subject matter expertise.
- The instructor related the content to the clinical setting.
- Do you feel that the information presented was based on the best available evidence?

Open-ended questions were also used to assess the take-aways and feedback on the seminar. The two questions were:

- What were the main takeaways for you in the seminar?
- What suggestion do you have for improving this seminar?

In the one-month follow-up, two open-ended questions were used to assess what the participant found useful and what information impacted their clinical practice. These questions were:

- Please list 1-3 pieces of knowledge that you remember the most vividly from the presentation.
- Please list 1-3 pieces of knowledge that you feel most impacted your clinical practice from the presentation.

Educational Seminar

A 1.5-hour long online educational seminar was offered on the use of ES for pain management. The seminar was administered via Zoom (Microsoft, Redmond, WA). Reminders were sent to those who responded to the recruitment email one-week prior to the seminar to ensure attendance and ask them to complete the pre-seminar survey. The educational seminar aligned with the Commission on Accreditation of Athletic Training Education (CAATE) 2020

standards, the Board of Certification's Practice Analysis 8, and the NATA educational competencies (5th edition). A lecture, discussion, and traditional question and answer format was used for this seminar. Participants completed the pre-seminar survey prior to the seminar. Once the seminar ended, the participants completed the post-survey questionnaire prior to their departure.

The educational seminar was constructed to encompass EBP and practice-based parameters. The seminar had been previously approved and presented as a BOC EBP lecture at various conferences prior to use in this study. The poll everywhere system was used to assess baseline knowledge and preferences and enhance engagement in line with Knowles' principles of andragogy (Merriam & Bierema, 2018, pg.47). This seminar was designed similar to Schellhase et al. (2017) who designed an educational intervention for best practices for exertional heat stroke. The presentation content outline is in Appendix B. As well as poll everywhere technology, a combination of PowerPoint slides, lecture, and visual content was used in the presentation. At the end of the presentation, time was allotted to complete the post-seminar survey.

Data Collection

A web-based system (Qualtrics Inc., Provo, UT) was used to administer all surveys. An email was sent to the participants inviting them to participate in the study and the pre-seminar survey. Google forms was used to collect participants preferred email. Only IDs were used on surveys to ensure that responses remained confidential. At the end of the seminar, participants were asked to complete the post-seminar survey. One month following the completion of the post-seminar survey, emails were sent asking participants to complete the one-month follow-up survey. Reminders were sent every other day for two weeks to encourage completion.

Data Analysis

Basic descriptive statistics (means, standard deviations, and frequencies) were calculated for all responses and scores. Paired t-tests were used to assess changes over time on knowledge and use scores. Separate analyses on each sample were performed prior to pooling the samples. Independent samples t-testing, with Levene's test for equality of variance and equality of means, was performed to ensure samples could be pooled. Statistics were performed with statistical analysis packages (SPSS, Ver. 29, IBM, Armonk, NY).

Results

Participant's previous education on ES and therapeutic modalities are detailed first. Then, the frequency of use for ES for acute and post operative pain followed by perceived and actual knowledge for ES pre-seminar, post-seminar, and one-month follow-up. The last results presented are the evaluation of the seminar.

Pooling of Samples

To assess the ability to pool the data from both samples, an independent samples test was performed, including Levene's test for equality of variance and a t-test for equality of means. There was homogeneity of variances for perceived knowledge in the pre-seminar survey, p = .390, and the post seminar survey, p = .780, scores. With equal variances assumed, there was no significant difference in the equality of means for the pre-seminar, t(39) = 0.15, p = .879, and post seminar, t(39) = -0.41, p = .687, score. For the actual knowledge scores, there was homogeneity of variances for the pre-seminar survey, p = .948, and the post seminar survey, p = .252, scores. With equal variances assumed, there was no significant difference in the equality of means for the pre-seminar, t(39) = 1.90, p = .065, and post seminar, t(39) = 1.21, p = .235,

scores. These findings support the pooling of samples in the pre- and post-seminar perceived and actual knowledge scores, and the main analyses were performed on pooled samples.

Electrical Stimulation Education

Most participants in both samples reported they had received some education on ES. The majority of athletic trainers reported attending a seminar for any therapeutic modality in the past year (n = 34, 70.9%) as well as ES (n = 25, 52.1%). However, for some participants it was greater than 5 years or do not remember attending a seminar for therapeutic modalities (n = 4, 8.4%) or ES (n = 14, 29.2%). See Table 2 for the detailed information on ES education.

Table 2. ***Education History for Therapeutic Modalities and Electrical Stimulation***

	Pre-Survey Education on Any Modality (n=48)	Pre-Survey Education on ES (n=48)
Less than a year	15	11
1 year	19	14
2 years	5	5
3 years	3	3
4 years	1	0
5 years	1	1
> 5 years	1	5
I do not remember	3	9

Frequency of Electrical Stimulation Use

In the pre-seminar survey (n=48), most participants reported using ES for either acute pain (n = 26, 54.2%) or post-operative pain (n = 32, 66.7%). However, some participants reported never using ES for either acute (n = 22, 45.8%) or post-operative pain (n = 16, 33.3%). Of those that completed the study (n=30), there was a slight increase in use of ES to manage acute pain and post-operative pain. However, the Wilcoxon signed rank test showed no significant difference for the change in using ES for acute pain (Z = -.816, p = .414) or post-

operative pain (Z = -.465, p = .642). Use among participants who completed the follow-up surveys are in Tables 3 and 4.

Table 3. ***Electrical Stimulation Use for Acute Pain Pre-seminar and One-Month Post Seminar***

Frequency	Pre-Seminar (n=30)	One-Month Follow-up (n=30)
Never	10	9
Rarely (Less than once a week)	0	0
Seldom (1-3 patient encounters)	7	10
Occasionally (4-6 patient encounters)	8	7
Frequently (7+ patient encounters)	5	4

Table 4. E*lectrical Stimulation Use for Post-operative Pain Pre-seminar and One-Month Post Seminar*

Frequency	Pre-Seminar (n=30)	One-Month Follow-up (n=30)
Never	14	13
Rarely (Less than once a week)	0	0
Seldom (1-3 patient encounters)	9	14
Occasionally (4-6 patient encounters)	6	1
Frequently (7+ patient encounters)	1	2

Perceived Knowledge

Participants who completed the post-seminar survey (n=41) demonstrated a significant improvement in perceived knowledge scores immediately post-seminar with a large effect size. Those who completed the one-month follow-up survey (n=30) demonstrated a significant increase from the pre-seminar to post-seminar survey. Perceived knowledge scores decreased significantly from the post-seminar to one-month follow-up survey but remained significantly higher than pre-seminar. For descriptive statistics and paired t-tests results, see tables 5 and 6.

Table 5. ***Perceived Knowledge Scores, Descriptive Statistics, and Paired Samples t-test at the Post-Seminar Survey***

Perceived Knowledge	Means and SD		Paired Samples *t-test*			
Pooled (n = 41)	*M*	*SD*	*t*	*df*	*p-value*	*Cohen's d*
Pre-Seminar	28.66	5.71	7.03	40.00	< .001*	1.098
Post-Seminar	33.68	2.79				

*Indicates significant difference (p < .05)

Table 6. ***Perceived Knowledge Scores, Descriptive Statistics, and Paired Samples t-test at the One-Month Follow-up Survey***

Perceived Knowledge	Means and SD		Paired Samples *t-test*			
Pooled (n = 30)	*M*	*SD*	*t*	*df*	*p-value*	*Cohen's d*
Pre-seminar	29.20	5.95	5.11	29.00	< .001*	.934
Post-seminar	33.53	2.97				
Pre-seminar	29.20	5.95	3.13	29.00	.004*	.571
One-Month Follow-up	31.63	3.95				
Post-seminar	33.53	2.97	3.17	29.00	.004*	-.579
One-Month Follow-up	31.63	3.95				

*Indicates significant difference (p < .05)

Actual Knowledge

The participants who completed the post-seminar survey (n=41) demonstrated a statistically significant improvement in actual knowledge immediately post-seminar. The mean sum of correct actual knowledge items in the pre-seminar survey was 7.88 ± 2.77 out of 15. This represented a mean score equivalent to 52.5% ± 18.5%. Following the seminar, the mean sum of actual knowledge items was 9.51 ± 2.19. This represented a mean score equivalent to 63.4% ± 14.6%, indicating an increase in actual knowledge scores of 10.9% The participants who completed the one-month follow-up survey (n=30) also demonstrated a statistically significant increase in actual knowledge from the pre-seminar (8.33 ± 2.88 out of 15; 55.5% ± 19.2%) to the post-seminar survey (9.53 ± 2.30; 63.5% ± 15.3%) and remained significantly higher than the pre-seminar at the one-month follow-up survey (9.73 ± 2.43; 64.9% ± 16.2%). There was no

decrease in actual knowledge scores from the post-seminar to one-month follow-up survey. For specific descriptive statistics and results of the paired t-tests in the pooled data for actual knowledge, refer to tables 7 and 8.

Table 7. ***Actual Knowledge Scores, Descriptive Statistics, and Paired Samples t-test at the Post-Seminar Survey***

Actual Knowledge	Means and SD		Paired Samples *t-test*			
Pooled (n = 41)	*M*	*SD*	*t*	*df*	*p-value*	*Cohen's d*
Pre-seminar	7.88	2.77	5.08	40.00	< .001*	0.438
Post-seminar	9.51	2.19				

*Indicates significant difference (p < .05)

Table 8. ***Actual Knowledge Scores, Descriptive Statistics, and Paired Samples t-test at the One-Month Follow-up Survey***

Actual Knowledge	Means and SD		Paired Samples t-test			
Pooled (n = 30)	*M*	*SD*	*t*	*df*	*p-value*	*Cohen's d*
Pre-seminar	8.33	2.88	3.03	29.00	.005*	.553
Post-seminar	9.53	2.30				
Pre-seminar	8.33	2.88	3.69	29.00	< .001*	.674
One-Month Follow-up	9.73	2.43				
Post-seminar	9.53	2.30	0.73	29.00	.470	.134
One-Month Follow-up	9.73	2.43				

*Indicates significant difference (p < .05)

Assessment of Seminar Presenter and Presentation

The participants on the post-seminar survey were asked to evaluate the seminar and the presenter. Most of the participants rated the seminar as “Excellent” (82.9%, n = 34) and the rest rated the seminar as “Good” (17.1%, n = 7). Overall, the participants were satisfied with the seminar and the presenter as demonstrated in Table 9. Lastly, most of the participants indicated that they plan to use the materials from the seminar in their practice (70.7%, n = 29).

Table 9. ***Assessment of Seminar, Presenter, and Presentation Results Per Question***

Question	**Pooled Responses (n=41)**
Quality of seminar	Excellent = 34 (82.9%) Good = 7 (17.1%) Average = 0 Fair = 0 Poor = 0
Increased my competence	Strongly Agree = 29 (70.7%) Somewhat Agree = 12 (29.3%) Neither Agree nor Disagree = 0 Somewhat Disagree = 0 Strongly Disagree = 0
Will improve my practice	Strongly Agree = 27 (65.9%) Somewhat Agree =11 (26.8%) Neither Agree nor Disagree = 3 (7.3%) Somewhat Disagree = 0 Strongly Disagree = 0
Will improve my patient treatment plans	Strongly Agree = 26 (63.4%) Somewhat Agree = 13 (31.7%) Neither Agree nor Disagree = 2 (4.9%) Somewhat Disagree = 0 Strongly Disagree = 0
Materials aided my learning.	Strongly Agree = 32 (78.0%) Somewhat Agree = 8 (19.5%) Neither Agree nor Disagree = 1 (2.4%) Somewhat Disagree = 0 Strongly Disagree = 0
Instructor's presentation style helped me learn.	Strongly Agree = 33 (80.5%) Somewhat Agree = 6 (14.6%) Neither Agree nor Disagree = 2 (4.9%) Somewhat Disagree = 0 Strongly Disagree = 0
Course content was appropriate for my experience/skill.	Strongly Agree = 35 (85.4%) Somewhat Agree = 5 (12.2%) Neither Agree nor Disagree = 1 (2.4%) Somewhat Disagree = 0 Strongly Disagree = 0

I plan to apply what I learned to my practice.	Strongly Agree = 29 (70.7%) Somewhat Agree = 8 (19.5%) Neither Agree nor Disagree = 3 (7.3%) Somewhat Disagree = 0 Strongly Disagree = 1 (2.4%)
The instructor demonstrated subject matter expertise.	Strongly Agree = 39 (95.1%) Somewhat Agree = 2 (4.9%) Neither Agree nor Disagree = 0 Somewhat Disagree = 0 Strongly Disagree = 0
The instructor related the content to the clinical setting.	Strongly Agree = 38 (92.7%) Somewhat Agree = 3 (7.3%) Neither Agree nor Disagree = 0 Somewhat Disagree = 0 Strongly Disagree = 0
Do you feel that the information presented was based on the best available evidence?	Yes = 41 (100%) No = 0

When asked about the main takeaways of the seminar, the participants commented primarily on the purpose behind the use of ES, how ES mitigates pain, and the parameters for use. Comments from the participants included:

- *Understanding parameters and evidence supporting proper parameters use when utilizing electrical stimulation.*
- *E-stim can be used for a variety of things, so be very intentional with what you'd like to use it for specifically.*
- *Learning in depth about the purpose of e-stim and how to educate patients.*
- *Electrical stimulation is an effective modality to reduce pain.*
- *The main contributing factor to ESTIMs effectiveness is amplitude. TENS and IFC are the most affective wave types in reducing pain.*

- *Clinicians should be diligent and intentional in their application of evidence-based practice. Electrical stimulation is a useful modality for mitigating acute and post-operative pain when properly prescribed and applied.*

When the participants were asked for suggestions for improving the seminar, only a few offered suggestions. Most commented "N/A", "nothing", or offered positive affirmations to the presenter. Other comments included:

- *The PollEverywhere questions were valuable for engaging the audience through the presentation, especially in a virtual format. However, the instructor could have spent more time expanding on why the correct answer was the most correct. Even a few more seconds per question would have been valuable.*
- *Maybe making a handout so people have the information more readily available.*
- *I like this form of interactive seminar compared to the standard way to doing educational seminars.*
- *As a visual learner, more pictures/graphs/or even videos.*
- *Not much! The content was engaging the polleverywhere was a great edition!*

At the 1-month follow-up, participants were asked two questions about the seminar. The first question was what they most vividly remembered about the seminar. Responses to this question from the 1-month survey include:

- *I most vividly remember discussing contraindications but don't remember all of the exceptions.*
- *Pad placement to reach deeper tissues, gate control theory, motor twitch hi-volt.*
- *1. Electrical stim is effective for pain relief when applied properly. 2. Sensory stimulation should not elicit a motor response.*

- *Discussion of different waveforms and uses for treating pain, discussion of selecting correct parameters for treatment.*
- *Different waveforms and theories about how each block pain. Contraindications and electrode placements.*

The second question pertained to pieces of knowledge they felt impacted their clinical practice the most. Comments from the 1-month follow-up include:

- *I do not have any e-stim units available to me at my practice location, so I have not been able to apply this knowledge yet. Trying to get my AD to purchase a unit.*
- *Being in a low-funded secondary-school system, e-stim (specifically tens) is a practical and effective modality for treating post-injury and post-operative pain.*
- *The covering of the basics of E-Stim and reminding myself that it is easy if taken one step at a time.*
- *Selection of parameters and waveforms based on treatment goals per the injury*
- *Really just reinforced how I use e-stim.*
- *None, seldom use electrical stimulation and have not since presentation.*

Discussion

The purpose of this study was to determine the impact of an educational seminar on participant knowledge gain, retention and reported use of ES for pain management. The findings suggest that an educational seminar for athletic trainers may be effective in improving perceived and actual knowledge on ES, but reported use of ES did not change significantly. Given the small sample size and short follow-up timeline, continued research is needed to further assess knowledge gains, retention, and reported use.

An observation that is concerning is the magnitude of the actual knowledge scores. When looking at the pooled data, the pre-seminar scores were 7.88 out of 15 (52.5%). Post-seminar, their scores increased to 9.51 out of 15 (63.4%). In most educational settings, these are not passing scores for quizzes and exams. Unfortunately, there is debate on what is considered competent in athletic training education. Welch-Bacon et al. (2022) indicated that the views and definition of competency varied among AT educators and programs. The recommendations from this study pushed towards developing a consensus for student competence in our educational programs. One project that seeks to define competency is the AT milestones project. The AT milestones project adopted the Institute of Medicine's criteria for Quality Care, which includes "safe, timely, effective, efficient, equitable, and patient-centered care" (Welch-Bacon et al., 2023). However, these milestones are in the preliminary validation stages and not currently used in professional education. This lack of consistency makes it difficult to evaluate the results in this study and may support the need to define competency in athletic training professional education and professional practice.

The low pre-seminar scores in actual and perceived knowledge may be due to the time from their professional education. The range of experience was 1-33 years. Schellhase et al.'s (2015) review of literature demonstrated knowledge decline ranging from 6-months to one year after training. Also, lack of use may result in knowledge degradation over time. Approximately 45.8% of participants did not use ES for acute pain and 33.3% reported never using ES for post-operative pain. The wide range of years of experience, low reported use, and low reported continuing education could explain the lower scores on actual knowledge. However, the actual and perceived knowledge scores significantly improved after post-seminar with only significant

degradation of perceived knowledge scores over a one-month period, showing promise for effectively improving knowledge through continuing education activities.

This study also found only a slight, non-significant, increase in use of ES post-seminar. Approximately 66.7% reported using ES for acute pain and 53.3% for post-operative pain in the pre-seminar survey. In the follow-up survey, approximately 70% reported using ES for acute pain and 56.7% post-operative pain. There was no significant change, but timing may have an effect. In the first sample, the follow-up survey occurred in the summer, when many athletic trainers are not actively practicing. Also, athletic trainers may have interacted with a few post-operative patients in a one-month span; a longer time span may be needed to assess behavioral change in using electrical stimulation.

Overall, participants found the seminar useful, and it was well received. There were high scores for the content, delivery, and impact of the seminar as well as the seminar being founded on the best available evidence. Participants made positive comments on the interactive elements of *polleverywhere* that was used to engage the audience throughout the whole presentation. Participants also commented that the parameters for use and clinical application were well presented and captured during the seminar. These data, as well as the actual and perceived knowledge scores, suggest that the presentation was an effective learning tool for participants. However, the scores for the actual knowledge were still low post-seminar (63.4%) and may not yield clinically meaningful outcomes. Based on suggestions from the audience, even more visual aids would be beneficial, including videos of specific applications in hard-to-treat areas. This information could be used to enhance learning outcomes in future iterations of the seminar.

The education implications of this seminar are important as many professions are investigating virtual offerings (Brooks, 2020; Eusuf et al., 2020; Jordan et al., 2020; Tang et al.,

2020; Welch et al., 2014). With the strategic alliance developing a research agenda to guide their members, the assessment of how continued education is offered and delivered is crucial for maintaining competence and clinical expertise (Eberman et al., 2019). This study demonstrated that a synchronous, online educational seminar was interactive, engaging, and led to increased knowledge acquisition and retention. More seminars that actively engage the participants in this manner are needed to educate athletic trainers and advance the profession.

Limitations and Recommendations

This study would ideally have a larger sample. Sixty-one participants initially signed-up with 48 completing pre-seminar surveys. However, the overall response rates of the post-seminar (41/48, 85.4%) and 1-month follow-up (30/48, 62.5%), were high and congruent with professional educational seminars and earlier studies on athletic trainers (Schellhase, et al, 2017).

This study was performed during the summer for the first sample and in the fall for the second. Reported use of ES might vary depending on time of participation and employment setting. Future studies should be performed either in the fall or spring seasons to ensure that the participants have ample opportunities to use the given modality. Also, the questions could include intent to use ES versus actual use and if they have the resources to use ES to determine whether the participant has the intent or ability to use ES if the situation presents in the clinic.

Lastly, the clinical modalities available at participants' practice settings are remarkably different, which could limit behavior change post-seminar. The writer is unaware of any studies that assess availability and use of ES for athletic trainers. In future studies that assess change in using a therapeutic agent, such as electrical stimulation, questions on access to the modality are needed to exclude participants who lack access and could not use the modality.

Future research should incorporate more interactive elements to increase participant learning. The addition of a laboratory component, whether it is virtual or in-person, could enhance outcomes in regard to actual knowledge scores. If the laboratory component is not feasible, then videos or participant resources could be used to enhance the seminar. Along with the seminar changes, measuring knowledge decline and use of electrical stimulation should take place over a 6-month timespan. This would be congruent with Schellhase et al. (2015) and knowledge decline over a 6–12-month period. Lastly, questions on the availability of the therapeutic modality should be included on the questionnaire. This would allow for a valid measurement of the change in behavior component of the assessment.

Conclusion

With the COVID-19 Pandemic, virtual and online continuing education has become increasingly available for athletic trainers. These formats are becoming standard for organizations and professionals as a form of professional development. In support of virtual educational seminars, participants in this study demonstrated statistically significant increases in actual and perceived knowledge. While actual knowledge scores remained low and did not produce clinically meaningful changes in knowledge and use, further modifications to the learning activities and objective may improve these outcomes in the future. This is supported by the participants positive evaluations of the seminar content, delivery, and interactive elements. Measuring knowledge gains, retention, and use of ES are crucial for assessing learning effectiveness and professional growth. Continued research with similar assessment tools and seminar formats is needed to develop superior continuing education for the maintenance of credentials.

CHAPTER II: DISSEMINATION

After completion of this dissertation, this seminar would be presented at the Arizona Athletic Trainers Association (AzATA) Winter Conference. With the feedback from the participants of this study, the current presentation will be revised to enhance delivery and outcomes. The pre- and post-seminar surveys, actual knowledge only, will be converted to poll everywhere questions and given at the beginning of the presentation. This can show learners how they have increased their competency throughout the seminar. Feedback from this study also suggested more videos demonstrating the application of electrical stimulation and appropriate and safe setup of electrical stimulation. Lastly, a QR code with a participant hand-out will be given to provide the audience with the sources used from the presentation and a reference to the appropriate setup, with parameters, for acute and post-operative pain.

The AzATA was selected as members are certified and licensed athletic trainers that are employed in various settings and community health settings. Also, many of the members present at conferences across the country, and this presentation could encourage current scholars and professionals on effective presentation construction and contemporary practice. The ability to use an effective seminar for the acquisition of new knowledge that is designed for retention is critical for shaping CE in medical professions. As such, the following presentation outline is geared towards this population. The presentation slides are located in Appendix C.

Presentation Outline for Dissemination

Slides 1-7 – Introduction, pre-seminar quiz, learning objectives

This section will administer the pre-seminar survey, introduction to the presentation, disclosure statements, and learning objectives. Learning Objectives include:

- Describe the mechanisms of pain control
- Select the appropriate type of electrical stimulation for acute pain management.
- Design evidence-based decisions for optimal pain relief using electrical stimulation.
- Modify treatment parameters to aid in the reduction of pain.

Slides 8-12 – Evidence-based practice

This section will define Evidence Based Practice and how long it takes for evidence to make current practice. Also, it will describe the role of clinicians and researchers in the body of knowledge for developing and disseminating information and scholarship. This section will also show the athletic training research agenda from 2019 to show participants where healthcare competency and education are as a priority.

Slides 13-17 – PICO question and content introduction

This section will address the content introduction, pain statistics, PICO question and poll everywhere questions to engage the audience on pain statistics. This will set the tone for the presentation by demonstrating how much of a problem pain is in the USA and local to the presentation location (assuming Arizona for the first dissemination). This section will also introduce the PICO question for this presentation. The PICO question is: In subjects suffering from acute and post-operative pain (P) does the use of electrical stimulation during the recovery process (I) reduce the amount of pain and disability experienced (O) compared to conventional treatments (C)?

Slides 18-20 – Current problems with electrical stimulation

Establish the foundation for the lecture on electrical stimulation by describing the current problems using electrical stimulation and its foundations. The problems that currently plague electrical stimulation are a lack of consistency for use and parameters and poor evaluation of outcomes. Anecdotal evidence suggests that ATs also use this as a catch-all for pain when an athlete reports with little direction of what to use next. This is an observed trend in my experience with hundreds of preceptors in the area.

Slides 21-24 – Neuroanatomy and electrical stimulation

This section will explore the nerves activated by electrical stimulation, the order of recruitment, and the types of stimulation levels. This is critical to understand the mechanics for how electrical stimulation can impact the body. This section also defines the various stimulation levels using electrical stimulation, such as, subsensory, sensory, motor, and noxious.

Slides 25-30 – Pain transmission, perception and mechanisms for pain management

This section will include descriptions of pain transmission and mitigation, such as, the gate control theory, endorphinergic inhibition, and central biasing. These are the neural pathways that we are targeting for appropriate pain mitigation in the clinic. There will also be poll everywhere questions in this section to test the audience on this content.

Slides 31-36 – Electrical stimulation terminology and foundations

This section will review the terminology for electrical stimulation parameters, the difference between monophasic and biphasic current, and the types of electrical stimulation used clinically. This will address the consistency issue that we currently have when applying electrical

stimulation for pain relief. Failure to understand the basic terminology could result in poor outcomes in the clinic.

Slides 37-39 – Indications, contraindication, and safety considerations

This section will discuss the indications, contraindications, and safety considerations using electrical stimulation. Knowing when and how to use this modality is important for safe use. Contraindications are the conditions or factors that would preclude the AT from using this on a patient. This section also addressed physical safety concerns, such as, faulty leads and electrodes as well as hydroroom safety and the use of GFI circuits.

Slides 40-43 – Specific parameters for acute and post-operative pain control

This section will provide the parameters for sensory electrical stimulation needed for acute and post operative pain control. This section goes through each spinal level of pain reduction, as well as pain theory (i.e., gate control, descending pain and central biasing).

Slides 44-53 – Current evidence for the use of electrical stimulation

This section will go through evidence-based application, parameters and outcomes using electrical stimulation. Participants will be presented many meta-analyses and systematic reviews that demonstrate the effectiveness and viability as a pain mitigation modality. This will be the foundation for the clinical bottom line and evidence-based suggestions for parameters in the concluding slides.

Slides 54-58 – Clinical bottom line and references

This section is the concluding statements, references, repeat of acknowledgements, question slide and the poll everywhere post-seminar survey to gauge participant learning. The clinical bottom line will discuss how to use electrical stimulation effectively and consistently for acute and post-operative pain.

CHAPTER III: ACTION PLAN

To start, the steps outlined in Chapter II would be performed for immediate dissemination. After the completion of the presentation at AzATA, delivery at other local, regional, and/or national conferences would occur. This will require conferences that target athletic training, kinesiology and other related discipline's educational and clinical programs. Conferences that would be ideal to reach the appropriate educators in Athletic Training and Kinesiology are: The Commission on Accreditation of Athletic Training Education (CAATE) Annual Symposium, National Athletic Trainers' Association (NATA) Conference, Rocky Mountain Athletic Trainers' Association (RMATA) Annual Symposium, and the National Association of Kinesiology in Higher Education (NAKHE) Annual Symposium. The rationale for these conferences is due to the high volume of Athletic Training educators and researchers present. This would assist other professionals how to present material in a method conducive to learning for both professionals and athletic training students.

After the focus of clinical practice, there will be a shift towards best practices for the delivery if content at professional conferences. The information gathered in the dissertation will outline how to construct continuing education seminars to aid in participant learning and knowledge retention. For this dissemination, actions steps include presentations at clinical practice focused conferences. Conferences that may be targeted for this action plan are: Rocky Mountain Athletic Trainers' Association (RMATA) Annual Symposium, NATA Educators Conference, and the American College of Sports Medicine (ACSM) Annual Symposium. There could also be local and state conferences that this information would be presented but the aforementioned symposia will have a greater reach for clinical integration.

Lastly, the principal investigator will conduct further educational and clinical research regarding therapeutic modalities. This research may use various contemporary modalities or foundational skills from athletic training professional programs. Modalities of interest would include, but are not limited to, cryotherapy, thermotherapy, LASER therapy, various manual therapies (massage, instrument assisted soft tissue mobilization, etc.), and rehabilitation protocols. This research could also be applied to the education of student athletic trainers and may be able to help to develop increased competency prior to certification and employment. Understanding how interactive educational presentations could impact pre-professionals could benefit athletic training programs and young professionals tremendously. With higher levels of learning and competency, the potential for delayed knowledge decline in the formative years of a young professional could allow for safe, and more confident practice. As more information is gathered how to education pre-professional students and actively practicing athletic trainers, conferences and educational programs can begin to transform their delivery of education to optimize knowledge gains and retention.

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APPENDIX A – SURVEYS

Electrical Stimulation Educational Seminar Analysis Pre-Seminar Survey

Informed Consent

THE UNIVERSITY OF NORTH CAROLINA AT GREENSBORO

Informed Consent (Online, Anonymous) to Participate in Research

Institutional Review Board #IRB-FY21-260

Approval Date: 12/24/2022

Version: 1.2

Version Date: 12/14/2022

You are being invited to participate in a study about a continuing education seminar's impact on knowledge and retention among athletic trainers by Brandon Warner and Diane Gill (Faculty Advisor).

Your participation is completely voluntary. You have the right to refuse to participate or to withdraw at any time, without penalty. If you do withdraw, it will not affect you in any way. If you choose to withdraw, you may request that any of your data which has been collected be destroyed unless it is in a de-identifiable state. The investigators also have the right to stop your participation at any time. This could be because you have had an unexpected reaction, or have failed to follow instructions, or because the entire study has been stopped.

If you agree to be in this study, this research project will only take about 1.5 hours on a seminar and five surveys that take approximately 15-20 minutes each.

Your data will not be shared with any other parties outside of the investigators. We will do everything possible to make sure that your information is kept confidential. All information obtained in this study is strictly confidential unless disclosure is required by law. We will collect your email and name initially to establish a way to distribute the survey and link for the seminar. Then, you will input the last four digits and first initial for a unique identifier on the surveys to match the data throughout the study. The principal investigator will not see these identifiers and will be removed at the end of the study to protect your identity.

We know of no known risks to this study, other than becoming a little tired of answering the questions, or you may even become a little stressed or distressed when answering some of the questions. You are free to take a break and return to the survey to finish it, or, you can discontinue participation without any problems.

If you need to ask questions about this study, you can contact the principal researcher, Brandon Warner at bjwarner@uncg.edu, or 434-964-6220. If you have any questions regarding your rights as a research participant, please email the UNC-Greensboro Office of Research Integrity at ori@uncg.edu.

- I agree to participate
- I do not agree to participate

The following section is intended to collect demographic information. Please answer the questions to the best of your abilities.

Q1: What is the last four digits of your phone number and your first initial (for example 6220B)?

Q2: What is your identified gender?

- Male
- Female
- I prefer not to answer
- Other: Please Specify

Q3: How many years have you been certified and/or licensed as an athletic trainer (Please round to the nearest year)?

Q4: How old are you currently?

- 18-25
- 26-35
- 36-45
- 46-55
- 56-65
- Above 65

Q5: What racial or ethnic groups describe you? (Select all that apply)

- Hispanic or Latino
- American Indian or Alaskan Native
- Asian
- Native Hawaiian or Other Pacific Islander
- Black or African American
- White
- Other: Please specify

Q6: What professional degree did you attain to be eligible for certification?

- Internship Pathway
- Bachelor of Arts in Athletic Training (Professional Degree)
- Bachelor of Science in Athletic Training (Professional Degree)

- Master of Science in Athletic Training (Professional Degree)

Q7: What is your highest earned degree?

- Professional Bachelors' Degree
- Professional Masters' Degree
- Post-professional Masters' Degree in Athletic Training
- Post-Professional Masters' Degree (Other)
- Academic Doctorate (Ph.D. or Ed.D.)
- Clinical Doctorate (DAT, DPT, DHSc, DHA, etc.)

The following section is intended to collect demographic information. Please answer the questions to the best of your abilities.

Q8: What is your practice setting as defined by the NATA?

1. College/University
2. Higher Education
3. Professional Sports
4. Secondary Schools
5. Emerging Settings (ex. Military, Industrial, Performing Arts)

Q8a: If choice 1 is selected: What division of collegiate athletics best describes your current practice?

- NCAA DI
- NCAA DII
- NCAA DIII
- NAIA
- NJCAA or Two-Year Institution
- University Club Sports

Q8b: If choice 2 is selected: Are you currently instructing in a CAATE accredited athletic training program or similar clinical education program (physical therapy, occupational therapy, chiropractic or medical schools)?

- Yes
- No

Q8c: If choice 4 is selected: What best describes your current practice at your High School?

- Employed by High School
- Employed by the District
- Out-reach from a PT clinic not affiliated with a hospital
- Out-reach from a hospital/physician group

Q8d: If choice 5 is selected: What setting best describes your Emerging Practice Setting?

- PT clinic or Hospital Group (without outreach)

- Club sports (Not associated with a University)
- Military
- Industrial
- Physician's practice/office
- Other Emerging Setting: Specify

The following section is intended to collect demographic information. Please answer the questions to the best of your abilities.

Q9: Approximately how long has it been since you have attended a conference presentation on any therapeutic modality?

- Less than 1 year
- 1 year
- 2 years
- 3 years
- 4 years
- 5 years
- Greater than 5 years
- I do not remember attending any presentation on therapeutic modalities

Q10: Approximately how long has it been since you have attended a conference presentation on electrical stimulation?

- Less than 1 year
- 1 year
- 2 years
- 3 years
- 4 years
- 5 years
- Greater than 5 years
- I do not remember attending any presentation on electrical stimulation

The following section is intended to assess your current usage and understanding of electrical stimulation. Please answer the questions to the best of your abilities.

Q11: In a typical week, how often do you use electrical stimulation for the management of acute pain.

- Never
- Seldom (1-3 patient encounters per week)
- Occasionally (4-6 patient encounters per week)
- Frequently (7 or more patient encounters per week)

Q12: In a typical week, how often do you use electrical stimulation for the management of post-operative pain.

- Never
- Seldom (1-3 patient encounters per week)
- Occasionally (4-6 patient encounters per week)
- Frequently (7 or more patient encounters per week)

The following section is intended to assess your current usage and understanding of electrical stimulation. Please answer the questions to the best of your abilities.

Q13: I can explain the benefits of electrical stimulation to my patient.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q14: I can assess a patient for indications, contraindications, and precautions for electrical stimulation.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q15: I can explain the physiological effects and theoretical foundations (mechanisms of action, pain theory, etc.) of electrical stimulation.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q16: I can inform others of the expected outcomes and adverse reactions to treatment.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q17: I can explain the sensations of electrical stimulation that will be experienced to my patient.

- Strongly agree
- Somewhat agree

- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q18: I can apply the appropriate of parameters that are used for acute and post-operative pain.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q19: I can explain the safety considerations for setting up electrical stimulation.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q20: I have adequate knowledge of the treatment effects of the various waveforms of electrical stimulation (e.g. High Volt Pulse Stimulation, TENS, IFC, etc.).

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q21: I am proficient in the application of electrical stimulation for acute and post-operative pain.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q22: I am interested in improving my proficiency in the application of electrical stimulation.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

The following section is intended to assess your knowledge of electrical stimulation. Please answer the following questions to the best of your ability.

Q23: The primary mechanism through which sensory modalities, for example electrical stimulation, cryotherapy, or superficial heat, target to reduce perceived pain is called what:

A. Radiating pain theory
B. Descending pain modulation
C. Central Biasing
D. Gate control theory
E. Cognitive control

Q24: True/False: It is common and appropriate to see a slight muscle twitch or increased tension with a sensory IFC current, especially over the quadriceps muscle.

Q25: Which of the following pathologies/injuries would benefit from a sensory High-Volt Pulsed Stimulation/Current (HVPS or HVPC)?

A. Chronic Achilles tendinitis
B. Sciatica
C. Sub-acromial impingement syndrome
D. Acute skin abrasion
E. Acute MCL Sprain

Q26: During the treatment, your patient suddenly perceives an increase in intensity under one of the electrodes. What is the most likely cause of this spike of intensity?

A. The electrode is over a motor point in the muscle.
B. The lead is defective and should be replaced.
C. The electrode is damaged and should be discarded.
D. Both the lead and the electrode are damaged and should be replaced.
E. The intensity of the channel may have been accidentally turned up without the athletes prior knowledge.

Q27: Which of the following statements is false in regard to safety considerations for using electrical stimulation?

A. A ground fault interrupter does not need to be used for electrical stimulation devices.
B. The device should be calibrated annually to ensure the proper function of the device
C. Electrical stimulation can be used underwater to target irregular sharped areas that cannot fit an electrode.
D. A clinician needs to inspect the area under the electrodes for burns or adverse reactions to direct or polar currents.
E. Electrodes should only be used on one patient to minimize the risk of communicable diseases.

Q28: To target large diameter nerves for acute and post-operative pain, what transcutaneous electrical nerve stimulation (TENS) should be used?

A. Low frequency (10-40 pps) and a long pulse duration (>300 usec)
B. High frequency (Approximately 100 pps) and a long pulse duration (>300 usec)
C. High frequency (Approximately 100 pps) and a short pulse duration (60-100 usec)

D. Low frequency (10-30 pps) and a short pulse duration (60-100 usec)
E. Studies have shown that there are no specific parameters that will selectively stimulate nerve fibers.

Q29: Which of the following waveforms for electrical stimulation traditionally uses a quad-polar electrode placement?

A. Pre-modulated current
B. Symmetrical biphasic
C. Microcurrent
D. Interferential current/stimulation
E. Quad-polar does not refer to an electrode placement and is a waveform of electrical stimulation

Q30: Which of the following waveforms of electrical stimulation has periods of non-current flow and two equal phases?

A. Asymmetrical biphasic
B. Symmetrical biphasic
C. Microcurrent
D. Monophasic
E. Direct current

Q31: Which of the following injuries would require a monopolar configuration for optimal pain relief?

A. Acute AC joint sprain
B. Sub-acute quadriceps contusion
C. Low grade hamstring strain
D. Posterior rotator cuff strain
E. Erector spinae spasm

Q32: True/False: The primary reason to use pre-modulated current versus true IFC (Quad-polar configuration) is when the location of the injury cannot support four electrodes.

Q33: To targeting deep tissues, how should you place the electrodes on the patient?

A. Farther apart
B. Closer together
C. Perpendicular to the muscle fibers
D. Electrode placement does not affect the depth.

Q34: True/False: It is not safe for the electrical stimulation treatment to cross the spine when treating spinal pathologies.

Q35: Which of the following includes only contraindications for electrical stimulation?

A. Cardiac pathologies, menstruation, edema
B. Obesity, over cancerous lesions, areas of sensory deficit
C. Pacemakers, un-fused epiphyseal plates, tattoos

D. Site of skin infection, unstable fractures, seizure disorder
E. Chronic pain, over exposed metal implants, sensory deficits in treatment area

Q36: Which of the following is the appropriate (best fit) parameters for sensory symmetrical biphasic current?

A. Phase Duration: 150 µsec; Frequency: 2-4 pps; Sensation: Motor; Burst Frequency: 0 bps
B. Phase Duration: 400 µsec; Frequency: 100 pps; Sensation: Noxious; Burst Frequency: 2-4 bps
C. Phase Duration: 100 µsec; Frequency: 200 pps; Sensation: Submotor; Burst Frequency: 2-4 bps
D. Phase Duration: 60 µsec; Frequency: 60 pps; Sensation: Submotor; Burst Frequency: 0 bps
E. Phase Duration: 60 µsec; Frequency: 150 pps; Sensation: Submotor; Burst Frequency: 0 bps

Q37: What is the primary mechanism in which electrical stimulation mitigates acute and/or post-operative pain?

A. All effects are secondary to selective nerve stimulation.
B. Decreases prostaglandin production.
C. Increases inhibitory impulses and decreases excitation impulses.
D. Increases the production of endorphins to manage pain at the spinal cord and central nervous system.
E. Causes vasoconstriction to localize the injury, result in less secondary hypoxic death.

Electrical Stimulation Educational Seminar Analysis Post-Seminar Survey

Q1: What is the last four digits of your phone number and your first initial (for example 6220B)?

Q2: Overall, how would you rate the quality of this educational seminar?

- Excellent
- Good
- Average
- Fair
- Poor

The following section is intended to assess your current usage and understanding of electrical stimulation. Please answer the questions to the best of your abilities.

Q3: I can explain the benefits of electrical stimulation to my patient.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q4: I can assess a patient for indications, contraindications, and precautions for electrical stimulation.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q5: I can explain the physiological effects and theoretical foundations (mechanisms of action, pain theory, etc.) of electrical stimulation.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q6: I can inform others of the expected outcomes and adverse reactions to treatment.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree

- Somewhat disagree
- Strongly disagree

Q7: I can explain the sensations of electrical stimulation that will be experienced to my patient.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q8: I can apply the appropriate of parameters that are used for acute and post-operative pain.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q9: I can explain the safety considerations for setting up electrical stimulation.

- Strongly agree
- Somewhat agree
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C. Microcurrent
D. Interferential current/stimulation
E. Quad-polar does not refer to an electrode placement and is a waveform of electrical stimulation

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B. Symmetrical biphasic
C. Microcurrent
D. Monophasic
E. Direct current

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B. Sub-acute quadriceps contusion
C. Low grade hamstring strain
D. Posterior rotator cuff strain
E. Erector spinae spasm

Q22: True/False: The primary reason to use pre-modulated current versus true IFC (Quad-polar configuration) is when the location of the injury cannot support four electrodes.

Q23: To targeting deep tissues, how should you place the electrodes on the patient?

A. Farther apart
B. Closer together
C. Perpendicular to the muscle fibers
D. Electrode placement does not affect the depth.

Q24: True/False: It is not safe for the electrical stimulation treatment to cross the spine when treating spinal pathologies.

Q25: Which of the following includes only contraindications for electrical stimulation?

A. Cardiac pathologies, menstruation, edema
B. Obesity, over cancerous lesions, areas of sensory deficit
C. Pacemakers, un-fused epiphyseal plates, tattoos

D. Site of skin infection, unstable fractures, seizure disorder
E. Chronic pain, over exposed metal implants, sensory deficits in treatment area

Q26: Which of the following is the appropriate (best fit) parameters for sensory symmetrical biphasic current?

A. Phase Duration: 150 µsec; Frequency: 2-4 pps; Sensation: Motor; Burst Frequency: 0 bps
B. Phase Duration: 400 µsec; Frequency: 100 pps; Sensation: Noxious; Burst Frequency: 2-4 bps
C. Phase Duration: 100 µsec; Frequency: 200 pps; Sensation: Submotor; Burst Frequency: 2-4 bps
D. Phase Duration: 60 µsec; Frequency: 60 pps; Sensation: Submotor; Burst Frequency: 0 bps
E. Phase Duration: 60 µsec; Frequency: 150 pps; Sensation: Submotor; Burst Frequency: 0 bps

Q27: What is the primary mechanism in which electrical stimulation mitigates acute and/or post-operative pain?

A. All effects are secondary to selective nerve stimulation.
B. Decreases prostaglandin production.
C. Increases inhibitory impulses and decreases excitation impulses.
D. Increases the production of endorphins to manage pain at the spinal cord and central nervous system.
E. Causes vasoconstriction to localize the injury, result in less secondary hypoxic death.

The following section is intended to assess your feedback on the seminar and your overall learning. Please answer the following questions to the best of your ability.

Q28: This seminar increased my competence (i.e., ability to apply knowledge, skills and judgment in practice).

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q29: This seminar will improve my practice as an Athletic Trainer.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q30: This seminar will improve my patient treatment plans for acute and post-operative pain.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q31: The seminar materials aided in my learning.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q32: The presentation style of the instructor helped me learn.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q33: Course content was appropriate for my experience/skill.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q34: I plan to apply what I learned in the seminar to my practice.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q35: The instructor demonstrated subject matter expertise.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q36: The instructor related the content to the clinical setting.

- Strongly agree

- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q37: Do you feel that the information presented was based on the best available evidence?

- Yes
- No

Q37a: Display if Q37 is “No”. Why did you feel this presentation was not founded in best evidence?

Q38: What were the main takeaways for you in the seminar?

Q39: What suggestion do you have for improving this seminar?

Electrical Stimulation Educational Seminar Analysis 1-month Follow-up

The following section is intended to collect demographic information. Please answer the questions to the best of your abilities.

Q1: What is the last four digits of your phone number and your first initial (for example 6220B)?

The following section is intended to collect demographic information. Please answer the questions to the best of your abilities.

Q2: What is your practice setting as defined by the NATA?

1. College/University
2. Higher Education
3. Professional Sports
4. Secondary Schools
5. Emerging Settings (ex. Military, Industrial, Performing Arts)

Q2a: If choice 1 is selected: What division of collegiate athletics best describes your current practice?

- NCAA DI
- NCAA DII
- NCAA DIII
- NAIA
- NJCAA or Two-Year Institution
- University Club Sports

Q2b: If choice 2 is selected: Are you currently instructing in a CAATE accredited athletic training program or similar clinical education program (physical therapy, occupational therapy, chiropractic or medical schools)?

- Yes
- No

Q2c: If choice 4 is selected: What best describes your current practice at your High School?

- Employed by High School
- Employed by the District
- Out-reach from a PT clinic not affiliated with a hospital

- Out-reach from a hospital/physician group

Q2d: If choice 5 is selected: What setting best describes your Emerging Practice Setting?

- PT clinic or Hospital Group (without outreach)
- Club sports (Not associated with a University)
- Military
- Industrial
- Physician's practice/office
- Other Emerging Setting: Specify

The following section is intended to collect demographic information. Please answer the questions to the best of your abilities.

Q3: Approximately how long has it been since you have attended a conference presentation on any therapeutic modality?

- Less than 1 year
- 1 year
- 2 years
- 3 years
- 4 years
- 5 years
- Greater than 5 years
- I do not remember attending any presentation on therapeutic modalities

Q4: Approximately how long has it been since you have attended a conference presentation on electrical stimulation?

- Less than 1 year
- 1 year
- 2 years
- 3 years
- 4 years
- 5 years
- Greater than 5 years
- I do not remember attending any presentation on electrical stimulation

The following section is intended to assess your current usage and understanding of electrical stimulation. Please answer the questions to the best of your abilities.

Q5: In a typical week, how often do you use electrical stimulation for the management of acute pain.

- Never

- Seldom (1-3 patient encounters per week)
- Occasionally (4-6 patient encounters per week)
- Frequently (7 or more patient encounters per week)

Q6: In a typical week, how often do you use electrical stimulation for the management of post-operative pain.

- Never
- Seldom (1-3 patient encounters per week)
- Occasionally (4-6 patient encounters per week)
- Frequently (7 or more patient encounters per week)

The following section is intended to assess your current usage and understanding of electrical stimulation. Please answer the questions to the best of your abilities.

Q7: I can explain the benefits of electrical stimulation to my patient.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q8: I can assess a patient for indications, contraindications, and precautions for electrical stimulation.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q9: I can explain the physiological effects and theoretical foundations (mechanisms of action, pain theory, etc.) of electrical stimulation.

- Strongly agree
- Somewhat agree

- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q10: I can inform others of the expected outcomes and adverse reactions to treatment.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q11: I can explain the sensations of electrical stimulation that will be experienced to my patient.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q12: I can apply the appropriate of parameters that are used for acute and post-operative pain.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q13: I can explain the safety considerations for setting up electrical stimulation.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q14: I have adequate knowledge of the treatment effects of the various waveforms of electrical stimulation (e.g. High Volt Pulse Stimulation, TENS, IFC, etc.).

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q15: I am proficient in the application of electrical stimulation for acute and post-operative pain.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q16: I am interested in improving my proficiency in the application of electrical stimulation.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

The following section is intended to assess your knowledge of electrical stimulation. Please answer the following questions to the best of your ability.

Q17: The primary mechanism through which sensory modalities, for example electrical stimulation, cryotherapy, or superficial heat, target to reduce perceived pain is called what:

A. Radiating pain theory
B. Descending pain modulation
C. Central Biasing
D. Gate control theory
E. Cognitive control

Q18: True/False: It is common and appropriate to see a slight muscle twitch or increased tension with a sensory IFC current, especially over the quadriceps muscle.

Q19: Which of the following pathologies/injuries would benefit from a sensory High-Volt Pulsed Stimulation/Current (HVPS or HVPC)?

A. Chronic Achilles tendinitis
B. Sciatica
C. Sub-acromial impingement syndrome
D. Acute skin abrasion
E. Acute MCL Sprain

Q20: During the treatment, your patient suddenly perceives an increase in intensity under one of the electrodes. What is the most likely cause of this spike of intensity?

A. The electrode is over a motor point in the muscle.
B. The lead is defective and should be replaced.
C. The electrode is damaged and should be discarded.
D. Both the lead and the electrode are damaged and should be replaced.
E. The intensity of the channel may have been accidentally turned up without the athletes prior knowledge.

Q21: Which of the following statements is false in regard to safety considerations for using electrical stimulation?

A. A ground fault interrupter does not need to be used for electrical stimulation devices.
B. The device should be calibrated annually to ensure the proper function of the device
C. Electrical stimulation can be used underwater to target irregular sharped areas that cannot fit an electrode.
D. A clinician needs to inspect the area under the electrodes for burns or adverse reactions to direct or polar currents.
E. Electrodes should only be used on one patient to minimize the risk of communicable diseases.

Q22: To target large diameter nerves for acute and post-operative pain, what transcutaneous electrical nerve stimulation (TENS) should be used?

A. Low frequency (10-40 pps) and a long pulse duration (>300 usec)
B. High frequency (Approximately 100 pps) and a long pulse duration (>300 usec)
C. High frequency (Approximately 100 pps) and a short pulse duration (60-100 usec)
D. Low frequency (10-30 pps) and a short pulse duration (60-100 usec)
E. Studies have shown that there are no specific parameters that will selectively stimulate nerve fibers.

Q23: Which of the following waveforms for electrical stimulation traditionally uses a quad-polar electrode placement?

A. Pre-modulated current
B. Symmetrical biphasic
C. Microcurrent
D. Interferential current/stimulation

E. Quad-polar does not refer to an electrode placement and is a waveform of electrical stimulation

Q24: Which of the following waveforms of electrical stimulation has periods of non-current flow and two equal phases?

A. Asymmetrical biphasic
B. Symmetrical biphasic
C. Microcurrent
D. Monophasic
E. Direct current

Q25: Which of the following injuries would require a monopolar configuration for optimal pain relief?

A. Acute AC joint sprain
B. Sub-acute quadriceps contusion
C. Low grade hamstring strain
D. Posterior rotator cuff strain
E. Erector spinae spasm

Q26: True/False: The primary reason to use pre-modulated current versus true IFC (Quad-polar configuration) is when the location of the injury cannot support four electrodes.

Q27: To targeting deep tissues, how should you place the electrodes on the patient?

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E. Causes vasoconstriction to localize the injury, result in less secondary hypoxic death.

The following section is intended to assess your feedback on the seminar and your overall learning. Please answer the following questions to the best of your ability.

Q32: Please list 1-3 pieces of knowledge that you remember the most vividly from the presentation.

Q33: Please list 1-3 pieces of knowledge that you feel most impacted your clinical practice from the presentation.

APPENDIX B – PRESENTATION OUTLINE

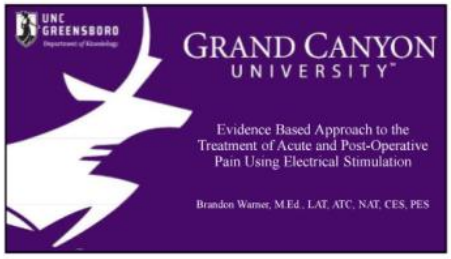
Presentation Outline

- Evidence Based Approach to the Treatment of Acute and Post-Operative Pain Using Electrical Stimulation
    - Brandon Warner, M.Ed., LAT, ATC
- Overview
- Learning Objectives
    - At the conclusion of the program, participants will be able to:
    - Describe the importance of EBP in therapeutic modalities
    - Select the appropriate type of electrical stimulation for acute pain management.
    - Design evidence-based decisions for optimal pain relief using electrical stimulation.
    - Modify treatment parameters to aid in the reduction of pain.
- Evidence-Based Practice
- Evidence-based vs Practice-based?
- Evidence-Based Practice: Defined
- Patient Values
- Perceived Barriers
- Example of Preference and Change
- Introduction
    - Currently, post-operative and acute pain is poorly managed worldwide (Sommer et al., 2010; Boekel et al., 2015)
    - Further evidence suggests that less than half of the patients with post-operative pain have adequate pain relief (Chou et al., 2016)
    - In sports medicine, there is an inherent risk of injuries that may result in surgical interventions.
    - In a recent study, approximately 60% of injuries are related to the knee and 50% of knee injuries, in high schools, are ACL tears (Sayampanathan, 2017)
    - Adequate management of pain is essential for increased patient outcomes and satisfaction (Taylor et al., 2013; Bonnet et al., 2007).
- Opioid Stats Arizona (NIDA)
- Poll Everywhere
- PICO Question
    - In subjects suffering from acute and post-operative pain (P) does the use of electrical stimulation during the recovery process (I) reduce the amount of pain and disability experienced (O) compared to conventional treatments (C)?
    - P – Subjects with acute and/or post-operative pain
    - I – Electrical stimulation
    - C – Reduction of pain
    - O – Conventional therapies

- Electrical Stimulation
- Current Problems with Electrical Stimulation
    - Consistency
    - Too many parameters
    - Inconsistent selection in the evidence
        - (Feger et al., 2015; Johnson et al., 2015; Chou et al., 2016; Chou et al., 2017)
    - Poor evaluation of outcomes
    - Patient rated outcomes measures
    - Adjuvants to electrical stimulation
        - (Feger et al., 2015; Qaseem et al., 2017))
    - Catch-all treatment for every athlete
- What are we trying to accomplish?
- Therapeutic Application Guidelines
    - Primary uses for electrical stimulation:
    - Pain control
    - Edema reduction
    - Reduce spasm
    - Reduce muscle atrophy
    - Neuromuscular re-education
    - Wound healing
- Electrical Stimulation in a "nut shell"
    - Electrical stimulation is an effective modality for stimulating sensory, motor, and pain nerves and, given the proper parameters
    - The nerve stimulated influences the pain relief (Claydon et al., 2011).
- Evidence Behind the Practice
- Key Themes
- Feger et al. 2015
- Johnson et al. 2015
- Chou et al. 2016
- Qaseem et al. 2017
- De Almeida et al. 2018
- Other Notable References
    - Li and Song, 2017
        - Concluded that the use of TENS post-operatively in TKA reduced opioid use.
        - This meta-analysis only pooled 5 RCTs but suggested the potential for use.
    - Unterrainer et al., 2010
        - RCT for patients undergoing spinal surgery
        - Used TENS preincisional and postoperatively.
        - Reduced the need for postoperative opioids

        - Used 100 Hz and 2 Hz with a strong sensory stimulus
    - Simpson et al., 2014
        - High frequency (100 Hz), low intensity (2 mA)
        - Demonstrated significant reduction of pain and anxiety pre-hospital care
        - Concluded that TENS is a viable option for pre-hospital analgesia (EMTs)
- Evidence-based Parameters
    - TENS
        - High frequency, low intensity works best for acute and post-operative pain
        - (Clayton et al., 2011; Yue et al., 2018; Almeida et al., 2018; Samuel & Maiya, 2015)
        - 15-40 mA; 70-150 Hz
    - IFC
        - High frequency and sub-motor
        - (Almeida et al., 2018; Fuentes et al., 2010; Zeng et al., 2015; Samuel & Maiya, 2015)
        - 80-150 Hz (most studies use 100 Hz)
    - HVPS
        - High frequency and sub-motor
        - (Feger et al., 2015; Draper et al., 2012)
        - Pulse duration under 200 usec, High frequency (120 Hz), and sub-motor
- Evidence-based Parameters
    - Its all about the intensity!
    - Clinicians should use an intensity 90% of a visible motor contraction.
    - You can attain this by turning up the stimulation until the twitch is seen and reduce it 10% of the amplitude.
    - Should be a strong, but comfortable, stimulation level absent of a motor contraction.
- Concluding Statements

APPENDIX C – PRESENTATION FOR DISSEMINATION



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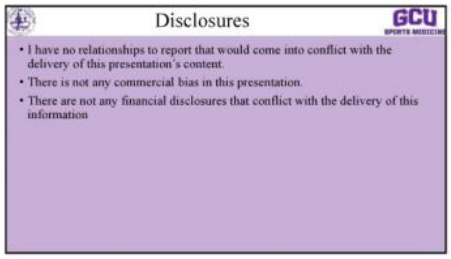

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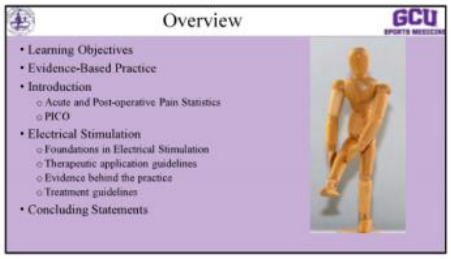

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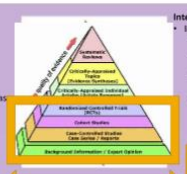
Evidence-Based Practice

7

Evidence-based vs Practice-based?

External Evidence:
- Information Derived from:
  - Case studies
  - Case series
  - RCT
  - Meta-analysis
  - Reviews
- All studies usually encompass:
  - Epidemiology
  - Etiology
  - Diagnosis
  - Prognosis
  - Treatment
  - Prevention



Internal Evidence:
- Information derived from:
  - Clinical experience
  - Foundational classes (anatomy, physiology, etc.)
  - Patient interactions and outcomes
  - Clinical experiences with case patterns or outcomes

Primary role for Clinician's in EBP

8

Evidence-Based Practice: Defined

Best Available Evidence (outcomes) + Patient's Unique Values & Situations + Clinical Expertise = EBP

9

Example of Preference and Change

- It takes approximately **17 years** for research to make clinical practice (Leufer et al., 2009)

Beijing 2008 Olympics

Rio 2016 Olympics

10

Eberman et al., 2019

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Introduction

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Introduction

- Currently, post-operative and acute pain is poorly managed worldwide (Sommer et al., 2010; Boekel et al., 2015)
- Further evidence suggests that less than half of the patients with post-operative pain have adequate pain relief (Chou et al., 2016)
- In sports medicine, there is an inherent risk of injuries that may result in surgical interventions.
- In a recent study, approximately 60% of injuries are related to the knee and 50% of knee injuries, in high schools, are ACL tears (Sayampanathan, 2017)
- Adequate management of pain is essential for increased patient outcomes and satisfaction (Taylor et al., 2013; Bonnet et al., 2007).

So Lets Look at the Stats!

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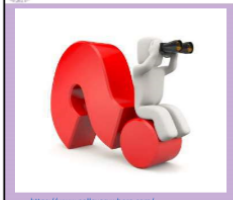
Poll Everywhere



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https://www.polleverywhere.com/

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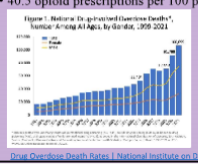
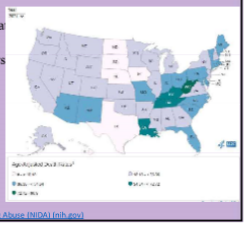
Opioid Stats Arizona (NIDA)

- In 2021, 2730 opioid-related deaths
- In 2021, the rate of opioid related dea
  persons (17/50!)
- 40.5 opioid prescriptions per 100 pers





Drug Overdose Death Rates | National Institute on Drug Abuse (NIDA) (nih.gov)

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PICO Question

- In subjects suffering from acute and post-operative pain (P) does the use of electrical stimulation during the recovery process (I) reduce the amount of pain and disability experienced (O) compared to conventional treatments (C)?
  - P – Subjects with acute and/or post-operative pain
  - I – Electrical stimulation
  - C – Reduction of pain
  - O – Conventional therapies

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Electrical Stimulation Foundations

17

Current Problems with Electrical Stimulation

- Consistency
  - Too many parameters
  - Inconsistent selection in the evidence
    - (Feger et al., 2015; Johnson et al., 2015; Chou et al., 2016; Chou et al., 2017; Thuvarakan, 2020)
- Poor evaluation of outcomes
  - Patient rated outcomes measures
  - Adjuvants to electrical stimulation
    - (Feger et al., 2015; Qaseem et al., 2017)
- Catch-all treatment for every athlete

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What are we trying to accomplish?

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Let's Review!

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In a "Nut Shell"

- A-alpha are considered the traditional "motor nerves"
- A-beta are considered the "sensory nerves"
- A-delta and C fibers are considered the "nociceptors"
- This is an oversimplification of the types of nerves but will conceptually work for this concept

21

Stimulation Levels

- Types of nerves depolarize in a predictable manner depending upon:
  - Diameter
  - Depth
  - Duration of pulse or phase
- Depolarize in this order (A-β > A-α > A-δ > c)
  - Sensory nerves
  - Motor nerves
  - Pain fibers
- Accommodation

22

Stimulation Levels

- Subsensory-level
  - An intensity that is just below what the pt. can sense
- Sensory-level
  - Stimulates only sensory nerves, without any slight muscle twitch
- Motor-level
  - Visible muscle contraction without pain
- Noxious-level
  - Intensity stimulates pain fibers
- Each of these can be associated with specific treatment goals

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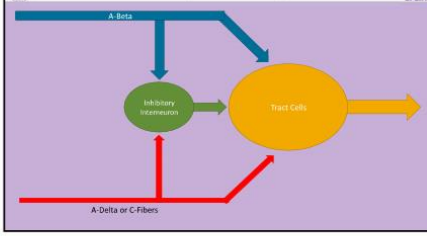
Gate Control Theory – Ascending Mechanism



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Descending Pain Modulation

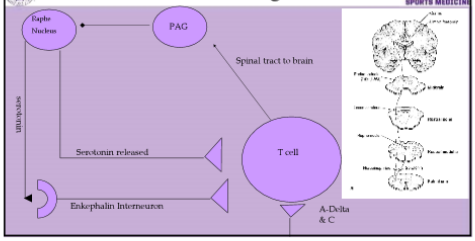
- Not well understood
- Thought that the cerebral cortex can block pain at first synapse
  - Descending pathways are stimulated to block afferent input – "Central Biasing"
  - Endogenous Opioids are released
- This is how social factors/previous experience may be able to influence transmission of pain

25

Central Biasing (Cognitive Control)

26

Central Biasing



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Endorphinergic Inhibition

- Hypothalamus
  - Prolonged INTENSE stimulation
- Pituitary Gland
  - Beta-endorphin
    - Naturally produced opiate
- Beta-endorphin levels increase throughout blood stream
  - Acts on opiate receptors throughout body
  - Causes a decrease in activity of pain systems

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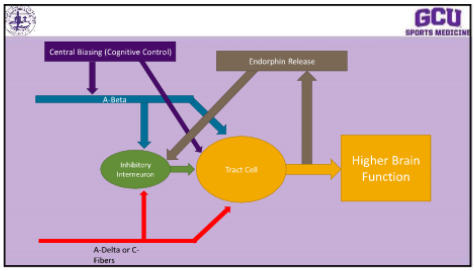

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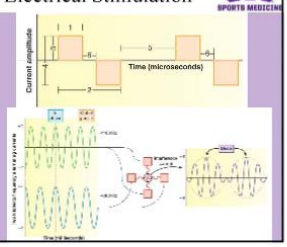
Electrical Stimulation Review

30

Terminology for Electrical Stimulation

- **Phase Duration**
- **Pulse Duration**
- **Frequency**
- **Beat Frequency**
- **Carrier Frequency**
- **Duty Cycle**
- **Intensity (Amplitude)**



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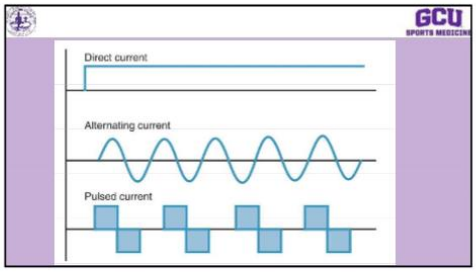

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Monophasic vs. Biphasic

Monophasic

- Has one phase (+ or -)
- Can be used for wound and bone healing, nerve activation, acute or chronic inflammation, and other indications

Biphasic

- Has two phases that comprise the individual pulse (+ and -)
- Used for nerve activation and all effects are secondary to nerve activation

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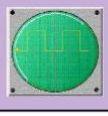
Monophasic vs. Biphasic

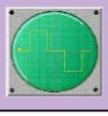
Monophasic

- TENS
- Hi-volt
- Microcurrent



Biphasic

- TENS
- Symmetric Biphasic
- Asymmetrical Biphasic
- VMS (On **Chattanooga Genesys**)



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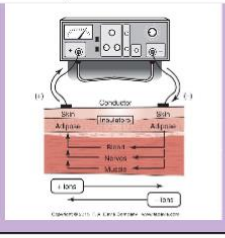
Body as a Circuit



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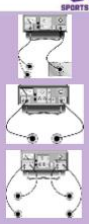
Electrode Placement

- Closer placement = more superficial stimulation
- Monopolar
  - One active & one dispersive
  - Unequal size: dispersive is larger
- Bipolar
  - 2 equal sized electrodes
- Quadpolar
  - 2 sets of electrodes from individual channels
  - Current from each channel intersects



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Therapeutic Uses of Electrical Stimulation

- Pain Control
- Edema reduction
- Inhibit/reduce muscle spasm
- Minimize disuse muscle atrophy
- Muscle strengthening???
- Reduce jt. Contractures
- Facilitate tissue healing
- Facilitate fracture healing
- Aid in muscle re-education

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Contraindications

- Pregnancy (only over abdomen)
- Menstruation (only over abdomen)
- Cancerous lesions
- Pacemakers
- Epilepsy
- Infection/Open wounds
- Cardiac disability
- Areas of sensory deficit
- Areas with skin conditions
- Seizure disorders
- Unstable Fractures
- Over these areas:
  - Carotid sinus
  - Esophagus
  - Larynx, pharynx
  - Near eyes
  - Upper thorax
  - Temporal region
- Metal implants (exposed only)
- Severe Obesity
- Fear of electricity
- Where pain and/or muscle contraction is contraindicated

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Safety

- Ground Fault Interrupter (GFI)
- Lead vs Electrode Damage
- Hydro-room Safety (covers and height from floor)

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Electrical Stimulation in a "nut shell"

- Electrical stimulation is an effective modality for stimulating sensory, motor, and pain nerves and, given the proper parameters
  - The nerve stimulated influences the pain relief (Claydon et al., 2011).

Pain Reduction Strategy	Parameters	Nerves
Gate Mechanism (Ascending Pathways)	Frequency: High Frequency (60-100 Hz) Phase Duration: Approx. 75 usec (60-100 usec)	A-Beta Fibers (Sensory)
Central Biasing (Descending Pathways)	Frequency: High Frequency (100 Hz) Phase Duration: Approx. 1000 usec Burst Frequency: 2-4 bps	C-Fibers (Noxious, Intense Stimulation)
Endorphogenic Inhibition (Descending Mechanism)	Frequency: Low Frequency (Usually <10 Hz) Phase Duration: Approx. 200-400 usec	Motor Fibers (Adelta and Alpha)

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Electrical Parameters Used in Pain Control Approach

Approach	Target Nerves	Phase Duration	Pulse Frequency	Intensity
Sensory	A-beta	<100 µsec	60-100 Hz (pps)	Submotor
Motor	Motor nerves	200-400 µsec	2-4 Hz (pps)	Strong Contraction
			80-120 Hz (pps)	Moderate to strong
Noxious	A-delta C fibers	1-100 msec	Variable	As painful as tolerated

- IFC:
  - Sensory: 80-150 Hz
    - Quadpolar configuration
  - Motor: 2-10 Hz
    - Quadpolar configuration
- Pre-modulated:
  - Sensory: 80-150 Hz
    - Bipolar configuration
  - Motor: 2-10 Hz
    - Bipolar configuration

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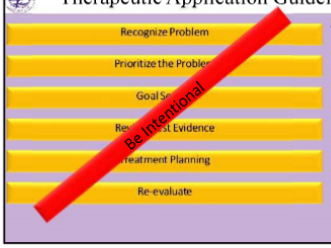
Therapeutic Application Guidelines



- Primary uses for electrical stimulation:
  - Pain control
  - Edema reduction
  - Reduce spasm
  - Reduce muscle atrophy
  - Neuromuscular re-education
  - Wound healing

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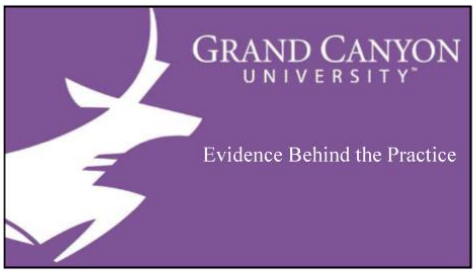

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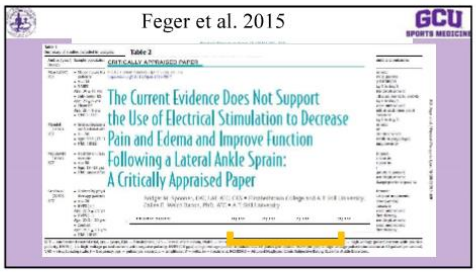

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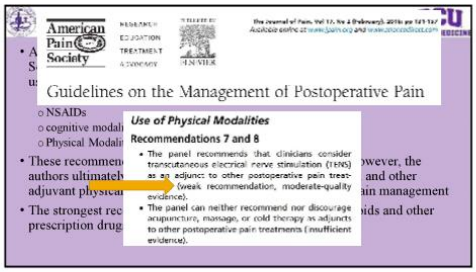

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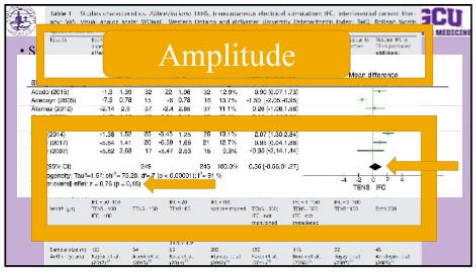

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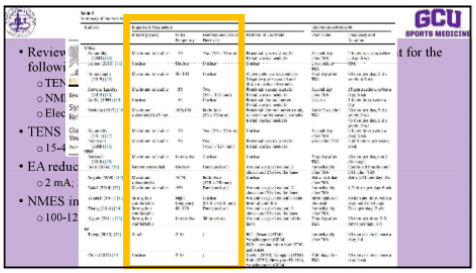

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Other Notable References

- Li and Song, 2017
  - Concluded that the use of TENS post-operatively in TKA reduced opioid use.
  - This meta-analysis only pooled **5 RCTs** but suggested the potential for use.
- Unterrainer et al., 2010
  - RCT for patients undergoing spinal surgery
  - Used TENS preincisional and postoperatively.
  - **Reduced the need for postoperative opioids**
  - Used 100 Hz and 2 Hz with a strong sensory stimulus
- Simpson et al., 2014
  - High frequency (100 Hz), low intensity (2 mA)
  - Demonstrated significant reduction of pain and anxiety pre-hospital care
  - Concluded that TENS is a viable option for pre-hospital analgesia (EMTs)
- Thuvarakan, 2020
  - **26 RCTS** and a total of **3348 pooled participants**
  - High frequency (100 Hz); Variable Intensity
  - Small but statistically significant pain reduction in labor pain

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Evidence-based Parameters

- TENS
  - High frequency, low intensity works best for acute and post-operative pain
    - (Clayton et al., 2011; Yue et al., 2018; Almeida et al., 2018; Samuel & Maiya, 2015)
  - 15-40 mA; 70-150 Hz
- IFC
  - High frequency and sub-motor
    - (Almeida et al., 2018; Fuentes et al., 2010; Zeng et al., 2015; Samuel & Maiya, 2015)
  - 80-150 Hz (most studies use 100 Hz)
- HVPS
  - High frequency and sub-motor
    - (Feger et al., 2015; Draper et al., 2012)
  - Pulse duration under 200 usec, High frequency (120 Hz), and sub-motor

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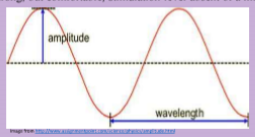
Evidence-based Parameters

- Its all about the intensity!
  - Clinicians should use an intensity 90% of a visible motor contraction.
    - You can attain this by turning up the stimulation until the twitch is seen and reduce it 10% of the amplitude.
  - Should be a strong, but comfortable, stimulation level absent of a motor contraction.



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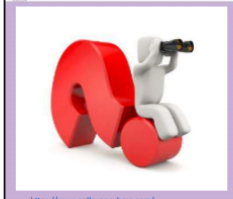
Pop Quiz!



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https://www.polleverywhere.com/

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Concluding Statements

- Electrical stimulation has some great potential benefits
  - However, it has a plethora of conflicting data and parameters
- Use your knowledge to better yourself in the clinic on most up-to-date evidence
  - Electrical stimulation has a decent amount of evidence out there and available but thoroughly appraise evidence due to poor construction and bias
- Parameters are important for nerve stimulation
  - ALL effects are secondary to a nervous system response (except DC)
  - What tissue are you stimulating?
  - What are you trying to accomplish?
- We need more higher quality and consistent evidence to substantiate the use and be able to make better more informed clinical decisions!

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спасибо
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sukriya
go raibh maith agat
merci
terima kasih

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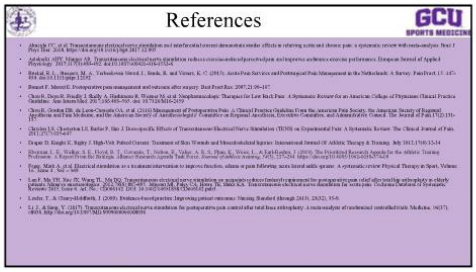
References
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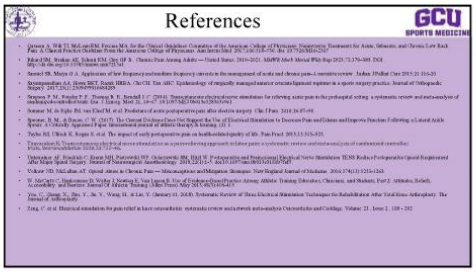
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