Transcutaneous Electrical Acupoint Stimulation to Decrease Opiate Utilization in Surgical Patients: An Evidence Based Education Module

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Transcutaneous Electrical Acupoint Stimulation to Decrease Opiate Utilization in Surgical Patients: An Evidence Based Education Module

A DNP Project Presented to the Faculty of the Nicole Wertheim College of Nursing and Health Sciences
Florida International University

In partial fulfillment of the requirements For the Degree of Doctor of Nursing Practice

By

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Approval Acknowledged: __________________________, DNA Program Director
Date: ________________________________

Approval Acknowledged: __________________________, DNP Program Director
Date: ________________________________
Dedicated to my father, who was a strong proponent of alternative therapies,

Louis Henry Luth, III

I wish you could have seen me graduate in person, but I know you are shining down on me from up above.
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ABSTRACT

**Impact Statement:** Improve provider knowledge on the use of transcutaneous electrical acupoint stimulation (TEAS) as an adjunct to anesthesia to decrease levels of pain and opiate usage in patients.

**Background:** A non-pharmaceutical method of analgesia can decrease the amount of opioid analgesia required during the perioperative period. TEAS is noninvasive, affords no risk of infection, and is inexpensive. Disposable electrodes are placed on acupoints on the body and stimulated with an electrical current. TEAS has been shown to decrease perioperative opioid use and pain in surgical patients. The purpose of this evidence-based project was to answer the following clinical question: (P) For surgical patients in the perioperative period (I) does an educational module on transcutaneous electrical acupoint stimulation (C) compared to no educational module (O) increase the anesthesia provider’s knowledge in decreasing perioperative analgesia, nausea, vomiting, post-operative recovery time, pain, and increase patient satisfaction?

**Methods:** After receiving IRB exemption, anesthesia providers at Mt. Sinai Medical Center, Miami Beach, FL were invited to participate in the study. An evidence based educational narrated video PowerPoint module and a pre- and post-test were created and distributed via email to potential participants. Responses and demographic data was collected via Qualtrics software.

**Results:** A total of seven certified registered nurse anesthetists (CRNA) participated in the study. Results from the pre- and post-tests show that there was an average of 25.7% increase in test scores after viewing the evidence based educational module. There was also an improvement in providers’ attitudes towards TEAS.
Conclusion: An evidence-based educational module discussing TEAS increases anesthesia providers’ knowledge in decreasing perioperative analgesia, nausea, vomiting, post-operative recovery time, pain, and increasing patient satisfaction through the use of TEAS.

INTRODUCTION

Problem Statement

Throughout the past decade opioid addiction has come to the forefront of national policy and politics in the United States. Opioid addiction is now referred to as a “crisis.” It is estimated that 2 million Americans are addicted to opioids. In 2018, 47,000 people died due to an opioid overdose in the United States. Opioid addiction has cost the justice system $8 billion, which is far less than estimates of what the opioid crisis has cost the American economy. The opioid crisis costs an estimated half a trillion dollars, or 2% of gross domestic product every year. In addition, people addicted to opioids have a greater tendency to become homeless, jobless, and catch preventable communicable diseases such as hepatitis C. Opioids are often ordered for post-operative pain. It is estimated that between 21-29% of patients prescribed opioids will misuse them, and 8-12% will develop an addiction. One way to combat the opioid crisis is through the use of non-pharmacological methods of analgesia. Transcutaneous electrical acupoint stimulation (TEAS) is one therapy that has shown success in decreasing perioperative opioids and improving patients’ postoperative pain level.

Delivering analgesia is a standard of care for the anesthesia provider. Opioid analgesics are an important part of the anesthetic regimen. Opioids provide powerful analgesia, block the sympathetic response of laryngoscopy and surgical incision, provide a synergistic effect, and reduce the anesthetic gas and other pharmacological requirements. However, studies have
shown that even the limited use of opioids during the perioperative period increases the risk that patients will experience addiction. The cost of not fixing the opioid problem is a continuation of the opioid crisis that has caused tens of thousands of deaths and trillions of dollars in economic losses. Incorporating non-pharmacological complimentary therapies into anesthetic practice can decrease the amount of opioid and non-opioid drugs used in the perioperative period.

Utilizing a non-pharmaceutical method of analgesia can potentially decrease the amount of pharmaceutical analgesia required. Acupuncture is a non-pharmacological analgesic technique that has been used for over 2,000 years in Asia and has been used in conjunction with anesthesia since the 1950’s. Acupuncture is based on the traditional theory that the body’s physiological functions are regulated by 12 bilateral Yin and Yang channels on the body and 2 midline channels, one located posteriorly and the other inferiorly. Flowing in these channels is “Qi”, a force that regulates the functions of the body. Pain and illness are caused by the blockage of the flow of Qi. Insertion of filiform needles into acupoints on the body can unblock this flow, relieving pain and illness.

The location of acupoints and their selection is based on Traditional Chinese Medicine (TCM), and cannot necessarily be explained by modern medical science. The stimulated acupoint must lie on the same meridian as the target organ. Occasionally, meridians follow the pathway of peripheral nerves. Some of the acupoints that are frequently stimulated to provide perioperative analgesia happen to lie over key nerve pathways. These acupoints include Neiguan (PC6), Hegu (LI4), and Zusanli (ST36), which follow the median nerve, deep branches of the median nerve, and the deep peroneal nerve respectively. Though the theory of meridians and Qi has yet to be proved by modern science, research supports the physiologic effectiveness of acupuncture and its numerous forms.
Studies have shown that acupuncture increases endogenous opioid-like substances in the cerebral spinal fluid. These neuropeptides act on the same mu, kappa, and delta opioid receptors that synthetic opiates like morphine and fentanyl act on, producing analgesia, respiratory depression and cardiovascular homeostasis. Research on rats has shown that all three opioid receptors play a role in the analgesia that electroacupuncture provides. A study by Han et al. performed on humans found that peripheral electrical stimulation with a frequency of 2 Hz produces a significant increase in enkephalin-like immunoreactivity (IR) but not dynorphin IR. A frequency of 100 Hz does the opposite; it increases dynorphin IR but not enkephalin IR. It is thought that this release of endogenous opioid peptides, including beta-endorphin and endomorphin, are responsible for the analgesia provided by acupuncture. Laser acupuncture has shown to increase beta-endorphin and decrease substance P, a pain-inducing neuropeptide. Tu, et al. showed that patients receiving transcutaneous electrical acupoint stimulation (TEAS) had lower blood levels of the algogenic substances 5-HT and substance P than the control group.

There are several different methods to stimulate acupuncture points beyond the well-known traditional form that uses filiform needles. Electroacupuncture adds electrical stimulation to the needles. Moxibustion is a form of acupuncture that involves heating the needles with dried mugwort that is called moxa. Acupressure involves stimulating acupoints not with needles, but through sustained pressure. Acupoints on the auricle of the ear correspond to all areas of the body and auricular acupuncture seeks to provide its benefits through the stimulation of these acupoints. Laser acupuncture utilizes lasers for its acupoint stimulation. Transcutaneous electrical acupoint stimulation (TEAS) is a variation of electroacupuncture that has shown great promise in providing non-pharmacological perioperative analgesia.
TEAS is noninvasive, affords no risk of infection, and is inexpensive. Disposable electrodes are placed on acupoints on the body and stimulated with an electrical current. Generally, an alternating dense and disperse frequency of 2/100 Hz is utilized, with an intensity of 5-10 mA, though higher can be used. Stimulation for 30 minutes has been found to yield the best results. TEAS is very similar to transcutaneous electrical nerve stimulation (TENS). The difference is TEAS specifically targets acupoints, TENS does not. In fact, some studies refer to TEAS as “TENS performed on acupoints.” Unlike traditional acupuncture, which should be performed by a trained acupuncturist with years of training, TEAS can be performed with nominal training by anesthesia providers and nurses.

TEAS has been shown through randomized control trials to decrease perioperative opioid use and postoperative pain in surgical patients who underwent a variety of procedures. TEAS decreased pain and shortened the length of time in the post-anesthesia care unit (PACU) for patients undergoing laparoscopic gynecological surgery. Patients undergoing a sinusotomy who received TEAS required 39% less intraoperative remifentanil than those in the control group. The patients took less time to extubate and had fewer opioid related side effects, such as nausea and vomiting. Intraoperative sufentanil was also successfully decreased through the use of TEAS during video-assisted thoracic surgical lobectomy. Patients undergoing a thyroidectomy who did not receive TEAS required an average of 3.5 doses of postoperative morphine compared to those in the TEAS group who only required an average of one dose. Patients who underwent a hip arthroplasty and received TEAS required less postoperative fentanyl than those in the control group.

In several studies, patients given a patient controlled analgesia (PCA) pump for postoperative pain utilized the PCA less when they received TEAS. Wang et al. found that
TEAS decreased PCA hydromorphone usage by 65% from the control group in patients who underwent lower abdominal surgery.\textsuperscript{27} Chen \textit{et al.} found that TEAS significantly decreased PCA hydromorphone in patients who had undergone lower abdominal gynecological surgery.\textsuperscript{20} Another study found that TEAS significantly decreased PCA tramadol usage in patients who underwent abdominal surgery requiring a midline incision.\textsuperscript{28} The benefits of TEAS go beyond pain and decreased opioid usage. It has been shown that TEAS consistently decreases the postoperative side effects of opioids such as nausea and vomiting,\textsuperscript{16,20,25,26,29} dizziness,\textsuperscript{25,26,29} and pruritis.\textsuperscript{29} TEAS has also been shown to improve patient satisfaction.\textsuperscript{19} Additionally, TEAS has been used in the intensive care unit (ICU) to decrease pain and opioid analgesia in mechanically ventilated patients with a diagnosis of pneumonia.\textsuperscript{30} There are several areas in the research on TEAS that still need validation.

There is no consensus on exact anatomical location of the electrodes for the implementation of TEAS.\textsuperscript{20,28} Neither is there consensus on how often the patient should be stimulated or which part of the perioperative period the patient should be stimulated.\textsuperscript{16,19,31} These are knowledge gaps that must be further researched. Additionally, there is a gap in the knowledge of anesthesia providers in the utilization and benefits of TEAS for the surgical patient in the perioperative period.

Anesthesia provider awareness of the dangers and benefits of opioids can lead to less prescribing of opioids.\textsuperscript{32} Many physicians receive little, if any, direct training regarding opioid usage.\textsuperscript{33} In fact, only five states require all physicians to receive opioid-related continuing education.\textsuperscript{33} Structured continuing education programs can make a positive change in the way anesthesia providers utilize and prescribe opioids.\textsuperscript{1} Providing education about non-
pharmacological methods of analgesia, including TEAS in opioid continuing education programs, would help increase provider knowledge about TEAS.

The opioid crisis has cost the United States tens of thousands of lives and billions of dollars.\textsuperscript{2} Given the great volume of opioids anesthesia providers utilize every day, reducing the amount of opioids in anesthesia can help curb what has become an opiate addiction crisis in the United States.\textsuperscript{1} Though there is some discussion about how to specifically administer TEAS,\textsuperscript{16,19,20,28,31} it has emerged as a viable non-pharmacological, noninvasive technique for reducing perioperative pharmacological analgesic use.\textsuperscript{5} TEAS is a cost-effective treatment that has been shown to reduce perioperative opioid use.\textsuperscript{5} Additionally, anesthesia providers can be trained to administer TEAS with little instruction.\textsuperscript{5,21} Improving anesthesia provider knowledge about opioid administration could help increase the use of non-pharmacological methods of analgesia,\textsuperscript{1} including TEAS.

**PICO Question**

(P) For surgical patients in the perioperative period (I) does an educational module on transcutaneous electrical acupoint stimulation (C) compared to no educational module (O) increase the anesthesia provider’s knowledge and attitude in decreasing perioperative analgesia, nausea, vomiting, post-operative recovery time, pain, and increase patient satisfaction? The primary objective of this quality improvement project is to understand the effectiveness of TEAS in providing perioperative analgesia. The secondary objective is to reduce the reliance on opioid and other pharmacological analgesia by utilizing a nonpharmacological technique to provide analgesia in the perioperative period. Tertiary objectives are to understand TEAS’ effect on postoperative pain, nausea, vomiting, PACU time, and patient satisfaction.
METHODOLOGY

Information Sources and Search Strategy

A review of the literature was conducted to identify studies that answered the PICO question. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist was used (Figure 1). Quality improvement projects are important resources for healthcare professionals who make clinical practice decisions.34 Quality improvement projects provide sound data on what interventions are effective or ineffective and which ones are associated with improved health outcomes.34 The PRISMA checklist is meant to be a reporting guideline that is used to improve the clarity as to how quality improvement projects are presented.34

In this literature review, three databases and were utilized for the initial search: Cumulative Index of Nursing and Allied Health Literature (CINAHL), PubMed, and Medline (ProQuest), in addition to Google Scholar. The PICO question was used to direct the search, using key words (Table 1). Boolean operators were used to specify the limits of the search and truncation was used to catch all variations of search terms. All database searches were limited to research involving humans and the English language. There was no limit on dates published.

<table>
<thead>
<tr>
<th>Concepts/Topics</th>
<th>Acupuncture</th>
<th>Pain</th>
<th>Anesthesia</th>
<th>Analgesia</th>
<th>Surgery</th>
<th>Filters Applied / Results</th>
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<tr>
<td>CINAHL</td>
<td>Acup* OR TEAS OR TENS OR “transcutaneous electrical nerve stimulation” OR needl*</td>
<td>Pain* OR ache* OR aching OR discomfort* OR irrita* OR sore* OR sting* OR throb*</td>
<td>Anesth* OR Analgesia</td>
<td>Analges*</td>
<td>Surg* OR operat* OR preop* OR postop* OR intraop*</td>
<td>Research on humans English language 658 Results</td>
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<tr>
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<td>Results</td>
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<tr>
<td>PubMed</td>
<td>Acup* OR TEAS OR TENS OR “transcutaneous electrical nerve stimulation” OR needl*</td>
<td>Pain* OR ache* OR aching OR discomfort* OR irriTA* OR sore* OR sting* OR throb* OR periop* OR postop* OR intraop* OR preop* OR surg* OR operaT* OR anesthES* OR analges*</td>
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<tr>
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<td>Pain* OR ache* OR aching OR discomfort* OR irriTA* OR sore* OR sting* OR throb* OR periop* OR postop* OR intraop* OR preop* OR surg* OR operaT* OR anesthES* OR analges*</td>
<td>633</td>
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**Study Selection and Screening Method with Inclusion/Exclusion Criteria**

A total of 2,033 articles were retrieved in the three databases. The article citations were uploaded to EndNote where 196 duplicates were eliminated, leaving 1,837 articles. Inclusion and exclusion criteria were applied to each article (Table 2). The titles of the articles were then
appraised following the inclusion criteria and it was determined what type of research the article was. Appropriate classifications of studies included randomized control trials (RCT), systematic reviews, and meta-analyses. Dissertations/theses, questionnaires, and RCT protocols for prospective studies were excluded. If the type of study was appropriate, it was then determined who and what the study was researching. Inclusion criteria included patients undergoing a surgical procedure or patients that were mechanically ventilated. Furthermore, studies involved the use of TEAS for pain of a surgical or acute critical care nature. TEAS for the use of chronic pain was excluded. Older studies refer to TEAS as “transcutaneous electrical nerve stimulation (TENS) applied to acupoints.” Studies that involved any of the following were excluded: TENS not administered in conjunction with TEAS, traditional acupuncture, electroacupuncture, acupressure, and TEAS not used for the purpose of analgesia. Appraising the title for further exclusion eliminated 1,806 articles. Inclusion and exclusion criteria that could not be gleaned from the titles was then garnered by reading the abstracts of the remaining 31 articles.

<table>
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<th>Table 2. Inclusion and Exclusion Criteria</th>
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<td><strong>Inclusion</strong></td>
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<td>Population:</td>
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<tr>
<td>• Patients undergoing a surgical procedure</td>
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<tr>
<td>• Patients who were mechanically ventilated</td>
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<tr>
<td>Intervention:</td>
</tr>
<tr>
<td>• TEAS used for the purpose of analgesia</td>
</tr>
<tr>
<td>Outcomes:</td>
</tr>
<tr>
<td>• Decreased opiate usage in the perioperative period or while on mechanical ventilation (MV)</td>
</tr>
<tr>
<td>• Decreased pain in the perioperative period or while on MV</td>
</tr>
<tr>
<td>• Any outcome measured in addition to decreased opiate usage and/or pain in the perioperative period or while on MV</td>
</tr>
<tr>
<td>Type of study:</td>
</tr>
<tr>
<td>• Randomized control trials (RCT)</td>
</tr>
<tr>
<td>• English language</td>
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<tr>
<td>• Systematic reviews/meta-analyses</td>
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Studies included for this quality improvement project and aligning with the PICO question showed: decreased opiate usage in the perioperative period or while on mechanical ventilation (MV), decreased pain in the perioperative period, or decreased opiate usage and/or pain in the perioperative period. Studies that only had measures that did not include opiate usage and/or pain in the perioperative period or while on MV were excluded.

This literature search included 16 articles for full text review. Google Scholar was then searched using the search terms: “transcutaneous electrical acupoint stimulation”, “decrease opioid”, “pain”, and “surgery”. The search elicited 3,260 results. Two hundred results were searched for relevant titles. If a title was relevant and was not a duplicate, then the researcher read the abstract and determined if the article should be included in the full-text review using the same inclusion and exclusion criteria. An additional 13 articles were found for full-text review in this manner, bringing the total articles for full-text review to 29. After full-text review 14 articles were excluded and 15 included in the final review.
Figure 1. PRISMA Flow Diagram

- **Identification**
  - Records found in the three databases \((n = 2,033)\)
  - Records found through other sources \((n = 0)\)

- **Screening**
  - Records after duplicates removed \((n = 1,837)\)
    - Titles screened \((n = 1,837)\)
    - Records excluded \((n = 1,806)\)

- **Eligibility**
  - Full-text articles assessed for eligibility from databases and Google Scholar \((n = 29)\)
    - Full-text articles excluded \((n = 14)\)

- **Included**
  - Studies included in the literature review \((n = 15)\)
Collection, Analysis, and Data Items

Rating scales are used to determine the strength of information. Quantitative evidence is ranked on a tiered scale that has three Levels: I, II, and III. Level I evidence makes the strongest quantitative case for the question a study is trying to answer. Meta-analyses, experimental studies and RCTs are considered Level I evidence. Research designs such as quasi-experimental studies are Level II and nonexperimental studies are classified as Level III, among other types of studies. Articles for this literature review were not excluded according to their Level of evidence, as all articles encountered were RCTs, and classified as Level I evidence. After determining the Level of evidence, the articles were graded according to their quality of research evidence.

Quality is classified as A-High, B-Good, and C-Low/Major flaw. High Quality research is consistent and has generalizable results. It includes a sufficient sample size with appropriate control, has definitive conclusions and includes consistent recommendations. Good Quality research has reasonably consistent results with a sufficient sample size and has some control. Conclusions are fairly definitive, and the recommendations are reasonably consistent. Low Quality research contains scant evidence with results that are inconsistent. Sample size is insufficient for the study design and conclusions cannot be drawn. Articles that were Low Quality were eliminated from the literature review.

A matrix of all the articles was compiled to organize the evidence (Appendix A). The matrix included information that included the design/method, sample/setting, major variables studied, measurement/data analysis, finding, results, conclusions and appraisal. The matrix was used to assist in evaluating the Level of the study and the Quality of the research.
RESULTS

Pain & Opioid Usage

A double-blind, placebo controlled randomized control trial (RCT) by Chen, et al in 2020, performed transcutaneous electrical acupoint stimulation (TEAS) on 80 patients aged 18-64 undergoing minimally invasive lung cancer surgery. Patients in the experimental group (TEAS group) received TEAS at 10-15 mA for 30 minutes prior to anesthetic induction, continuous stimulation throughout the surgery at 30 mA, and intermittent stimulations at 10-15 mA for 30 minutes each at 6, 24, and 48 hours postoperatively. Patients in the sham-TEAS group received 4 mA stimulation in the same manner as the experimental group preoperatively and postoperatively. The control group received no electrical stimulation during the perioperative period. The threshold at which one can perceive electrical stimulation is 5 mA. Acupoints stimulated were bilateral Hegu (LI 4), Neiguan (PC 6), Houxi (SI 3) and Zhigou (TE 6) at a frequency of 2/100 Hz. At 30 minutes prior to procedure end 10μg sufentanil was given for analgesia during emergence. A patient-controlled analgesia (PCA) pump was connected with sufentanil 1.5μg/mL. The TEAS group consumed significantly less sufentanil using the PCA pump than the sham-TEAS group at 6, 24, and 48 hours. At 48 hours the consumption for the TEAS group was 118.52 ± 9.77μg versus the sham-TEAS group’s 140.15 ± 7.87μg, \( P<0.001 \). This amounted to an almost 16% decrease in postoperative sufentanil consumption. The mean total number of both PCA attempts, \( P<0.001 \), and effective PCA attempts, \( P<0.001 \), was also significantly lower in the TEAS group than the sham-TEAS group. The visual analog scale (VAS) pain scores of the TEAS group at 6, 24, and 48 hours postoperatively were significantly lower than those in the sham-TEAS group, \( P<0.01 \). One month after the operation the VAS scores of the TEAS group were still significantly lower than those of the sham group, \( P<0.001 \).
In 2015, Yao et al. found that patients who received TEAS prior to gynecological laparoscopic surgery reported significantly lower postoperative pain scores than the control group. The double blind, placebo RCT involved 71 patients between the ages of 18-60 undergoing an elective gynecological laparoscopic surgery. TEAS was applied to four acupoints: bilateral Hegu (LI4), Neiguan (PC6), Zusanli (ST36), and Sanyinjiao (SP6). A dense-disperse frequency of 2/10 Hz and an intensity of 6-9 mA for 30 minutes was used. Optimal intensity was fine-tuned to achieve a slight twitching of the regional muscles up to the maximum tolerance level of the patient. Patients in the control group were connected to the stimulator but stimulation was not applied. Postoperative pain was measured through a VAS. If the pain score was greater than 4, the patient received a rescue dose of intravenous sufentanil 0.05µg/kg. Patients in the TEAS group had lower VAS scores than the control group at hour 0.5, 1, 2, 4, 8 and 24 postoperatively, $P<0.05$. Patients in the control group requested rescue analgesia more quickly than those in the TEAS group. The average time to first request for rescue analgesia in the control group was 47 minutes versus 59 minutes for the control group. This was significantly longer, $P=0.039$. Additionally, the cumulative number of rescue doses administered for the TEAS group was significantly less than the control group at 1 dose versus 3.5 doses, $P=0.004$.

A 2019 double blind placebo RCT by Tu, et al. of 120 patients age 18 to 70 years old undergoing ureteroscopic lithotripsy found that patients receiving TEAS, Group T, consumed less total tramadol after 48 hours postoperatively than patients in the control group, Group C, which received sham TEAS ($127.14 \pm 28.46$mg vs. $415.27 \pm 86.37$mg), $P<0.01$. Upon arrival in the postoperative recovery area patients in Group T received TEAS on bilateral Shenfu (BL23) and SP9 acupoints. The acupoints were stimulated at 0h, 4h, 8h and 12h postoperatively. TEAS was also implemented on the 2 days following surgery three times each day at 0700, 1100,
and 1500. Each stimulation session was 30 minutes with a dilatational wave with a frequency of 2/100 Hz. Intensity was set at the highest tolerable level for the patient, between 5-30 mA.

Patients in Group T were also given placebo medication in the same color and shape as tramadol hydrochloride tablets twice a day at 0800 and 2000. If TEAS failed to produce adequate pain relief, patients were given actual tramadol 100mg. Upon arrival in the postoperative recovery area patients in Group C were given actual tramadol hydrochloride 100mg at 0800 and 2000 for postoperative pain relief. Electrodes were applied in the same manner as Group T but were not stimulated. If VAS pain scores were greater than 3, an extra dose of tramadol 100mg was administered. The dosing limit was less than 600mg in a 24-hour period. VAS scores of Group T were significantly lower than Group C at 4h, \( P=0.01 \), 12h, \( P=0.03 \), and 24h, \( P<0.01 \). Total tramadol consumption was recorded as the amount of extra analgesia received, that is, in addition to the twice a day scheduled 200mg doses. Group T consumed significantly less tramadol than Group C for the 48 hours it was measured, consuming 127 ± 28.46mg versus 415.27 ± 86.37mg, \( P<0.01 \). The amount consumed at 24h was also significantly less in Group T, \( P<0.01 \).

A unique aspect of the Tu et al study is that the algogenic blood plasma concentrations of serotonin (5-HT) and substance P (SP) were taken via venous blood samples from every patient at 5 different intervals during the hospital stay. Plasma concentrations of 5-HT were significantly less in Group T at 4h, \( P=0.03 \), 12h, \( P<0.01 \), and 48h, \( P=0.04 \), than in Group C. Plasma concentrations of SP were significantly less in Group T at 4h, \( P<0.01 \), 12h, \( P=0.02 \), 24h, \( P=0.04 \), and 48h, \( P=0.02 \). At time 0h the levels were essentially equal.

A 2015 double blind placebo RCT by Chen et al of 83 adult female patients age 18-60 years old undergoing elective thyroidectomy also found that patients receiving TEAS requested less analgesia postoperatively. Patients in the experimental group, Group TEAS, received
TEAS bilaterally on the Hegu (LI 4) and Neiguan (PC 6) acupoints. TEAS was performed prior to induction with a disperse-dense frequency of 2/10 Hz and an intensity of 6-9 mA for 30 minutes. The intensity was adjusted according to the patient’s maximum tolerance level, enough to produce a slight twitching of the muscles. Patients in the control group, Group C, were connected to the apparatus, but electronic stimulation was not applied. A VAS was used to measure pain on a scale of 0 to 10, where 0 was no pain and 10 was the worst pain ever. Postoperative pain was measured at hours 1, 2, 4, 8 and 24. Morphine 2mg intravenous was administered as a rescue analgesia if VAS was greater than 4. Patients in Group TEAS performed significantly better in every variable measured. The average pain score of the experimental group was 2.6 versus the control group’s average pain score of 3.9, \( P=0.013 \). The maximum pain scores were 5 and 6, respectively, \( P=0.021 \). Group TEAS waited an average of 69 minutes before requesting their first dose of rescue analgesia. This is contrasted with the average of 37 minutes it took Group C to request analgesia, \( P<0.001 \). The average cumulative number of rescue doses for Group TEAS was 1, whereas the average cumulative number of rescue doses was 3.5 for Group C, \( P=0.004 \).25

A 2012 study by Lan et al involved a double blind, placebo RCT of 60 patients over the age of 65 undergoing total hip arthroplasty: 30 in the control group, known as Group Sham, and 30 in the experimental group, known as Group Acu.26 Prior to surgery six acupoints were stimulated in Group Acu: P6 and L14 bilaterally, and ST36 and GB31 ipsilateral to the surgical site. The sites were stimulated in the dense and disperse mode at a frequency of 2/100 Hz and intensity of 9-20 mA, depending on the patient’s tolerance. Acupoints were stimulated 30 minutes prior to surgery and at four time points after surgery: 2h, 4h, 20h and 44h. Patients in Group Sham had the electrodes and device hooked up to them, but the intensity was set at 0 mA.
Every patient was connected to an intravenous PCA pump at the finish of surgery. The pump was primed with fentanyl 10µg/mL and patients were given an initial bolus of 20µg. The basal rate was set to 20µg/hour. The PCA pump was connected to the patients for 2 days. There was no difference in the amount of pain at rest nor pain with activity between the two groups at time points 8h, 24h, and 48h. The amount of postoperative fentanyl consumed by Group Acu was significantly less than that of Group Sham. The amount consumed by Group Acu was significantly lower than Group Sham at 24h (mean ± SD; 360 ± 117µg vs. 572 ± 132µg), \( P<0.001 \) and at 48h (mean ± SD; 712 ± 184µg vs. 1022 ± 197µg), \( P<0.001 \). The number of patients in Group Acu who required rescue doses of analgesia was also significantly fewer: 4 patients versus 11 patients in Group Sham, \( P<0.05 \).

A 2017 study by Huang, et al investigated the effect of administering TEAS at different frequencies for the control of perioperative pain in 80 patients undergoing a selective video-assisted thoracic surgical lobectomy. The study was a double blind placebo RCT of 80 patients: 20 in the control group known as Con group; 20 in the first experimental group that received TEAS at a frequency of 2/100Hz, known as the 2/100Hz group, 20 in the second experimental group that received TEAS at a frequency of 2Hz, known as the 2Hz group; 20 in the third experimental group that received TEAS at a frequency of 100Hz, known as the 100Hz group. Each patient was connected to a PCA pump of sufentanil 1µg/mL and flurbiprofen 1.2mg/mL. A basal rate was set at 2mL/hr, with a demand bolus dose of 3mL, and lockout time of 15 minutes. The acupoints stimulated were Neiguan (PC6), Hegu (LI4), Lieque (LU7), and Quchi (LI11) on the ipsilateral surgery side. Intensity was set at the highest tolerable level that did not cause discomfort to the patient. The frequency was set at 2/100Hz, 2Hz, or 100Hz depending on the group. In the control group the patients were hooked up to the stimulator and the indicator light
was lit up as if it was functioning, however, no current flowed through the electrodes. All patients received TEAS or sham TEAS for 30 minutes prior to induction, during the entire surgery, and for 30 minutes at 24 and 48 hours after surgery. Intraoperative sufentanil dosages were converted into the equivalent remifentanil dosage for standard comparison. Total intraoperative opioid dosage was significantly lower in the 2/100Hz group than the other three groups, \( P<0.001 \). The 2/100Hz group consumed 0.1128µg/kg/min compared to the Con group, 0.1451µg/kg/min, the 2Hz group, 0.1718µg/kg/min, and the 100Hz group, 0.1451µg/kg/min. TEAS performed at a frequency of 2/100Hz decreased intraoperative opioid consumption by 33.5% compared to the control group.

In 2014, Zhang et al found that preoperative TEAS decreased intraoperative remifentanil usage by almost 35%. The study was a blind, placebo RCT of 65 female patients, ASA I and ASA II, undergoing elective cosmetic breast surgery: 33 in the experimental group and 32 patients in the control group. Patients in the experimental group received preoperative TEAS 30 minutes before induction of anesthesia using a dense-disperse frequency of 2/10 Hz with an intensity of 6-9 mA. Electrodes were placed on three pairs of bilateral acupoints: Hegu (LI4), Neiguan (PC6), and Zusanli (ST36). Patients in the control group received sham TEAS in which they were connected to the instrument, but electronic stimulation was not applied. Anesthesia was maintained using propofol and remifentanil infusions, titrated according to hemodynamics and bispectral index. Remifentanil use in the TEAS group was significantly less at 0.06µg/kg/min compared to 0.09µg/kg/min, \( P=0.01 \) in the sham group. Postoperative VAS pain scores were significantly less in the TEAS group than in the sham group at every time interval measured: 0h, \( P<0.05 \), 4h, \( P<0.05 \), 8h, \( P<0.05 \), and 24h, \( P<0.05 \). A very similar study in 2014 by Wang et al found that in patients undergoing sinusotomy, TEAS decreased intraoperative
remifentanil by 39% compared to patients in the control group, 0.051µg/kg versus 0.0907µg/kg, 
\(P<0.001\).\textsuperscript{23}

Two early studies in 1997\textsuperscript{27} and 1998\textsuperscript{20} are often cited by subsequent studies. In 1997 Wang et al established that higher intensity TEAS was more successful in reducing analgesic requirements than lower intensity TEAS.\textsuperscript{27} The researchers conducted a single blind, placebo RCT of 100 female gynecological patients undergoing elective lower abdominal surgery. All patients received a hydromorphone PCA pump postoperatively. The study compared the effect of sham TEAS, low intensity TEAS at an intensity of 4-5mA, and high intensity TEAS at an intensity of 9-12mA on perioperative pain and opioid usage. A fourth group was the control group and was only given the PCA pump for pain control. The amount of hydromorphone delivered after 24 hours to the high TEAS group was significantly less than all other groups. Total hydromorphone use in the high TEAS group was 65\%, \(P<0.001\), 55\%, \(P<0.01\), and 46\%, \(P<0.01\) less than the PCA pump-only, sham TEAS, and low TEAS groups respectively.\textsuperscript{27} The 1998 study by Chen et al helped establish that alleviation of pain depends on placement of TEAS electrodes.\textsuperscript{20}

The Chen study compared 100 female patients undergoing total abdominal hysterectomy or myomectomy. The patients were divided evenly into four groups. The control group, Group I, received sham TEAS. Group II received nonacupoint TENS stimulation bilaterally on the deltoid aspect of the shoulders. Group III received dermatomal TENS on either side of the surgical incision. Group IV received acupoint TEAS at the bilateral Zusanli acupoints. The frequency was set at the dense and disperse mode at 2/100Hz. The intensity was set at 0mA for the control group and between 9-12mA for patients in Groups II, III, and IV depending on the patient’s ability to tolerate it. All patients received a hydromorphone PCA pump postoperatively. The
average dose of hydromorphone delivered in 24 hours to Groups III, \( P<0.05 \), and IV, \( P<0.05 \), was significantly less than Groups I and II. Groups III and IV consumed 6.8mg and 6.5mg of hydromorphone respectively, versus 10.7mg and 10.5mg for Group I and II, respectively.\(^{20}\) A similar study in 2019 by Oztas and Iyigun correlated the original results from Chen et al, that either TENS adjacent to the surgical incision or TEAS are superior to no electrical stimulation at all.\(^{28}\)

TEAS has also been shown to reduce postoperative pain in women undergoing surgical abortion,\(^{36}\) and reduce pain and postoperative morphine requirements in patients undergoing surgery to correct nontraumatic lumbar spine injuries under general anesthesia.\(^{5}\) A 2017 study by Sun et al found that patients administered TEAS both before and after laparoscopic cholecystectomy or laparoscopic gynecological surgery had less pain than patients who were administered TEAS only preoperatively or not at all.\(^{19}\) Additionally, TEAS has not only been found to reduce pain in surgical patients, but has also been used to reduce pain and opioid analgesia in mechanically ventilated patients in the intensive care unit.\(^{30}\)

**Postoperative Nausea and Vomiting (PONV)**

Research indicates that an added benefit of TEAS to the surgical patient is reduced incidences of PONV. The study by Zhang et al that performed TEAS on patients undergoing ambulatory elective cosmetic breast surgery found that postoperatively, 15 participants in the sham group experienced nausea, compared to 7 in the TEAS group, \( P=0.03 \). In the sham group 11 participants experienced vomiting, compared to 4 in the TEAS group, \( P=0.03 \). Patients received preoperative TEAS on the bilateral acupoints: Hegu (LI4), Neiguan (PC6), and Zusanli (ST36).\(^{29}\)
The Chen et al study in 2020 found that TEAS performed on patients undergoing minimally invasive lung surgery during all perioperative periods, including up to 48 hours postoperatively, on bilateral Hegu (LI 4), Neiguan (PC 6), Houxi (SI 3) and Zhigou (TE 6), reduced nausea and vomiting. Compared to the sham group, the TEAS group experienced significantly lower incidences of nausea at 0h, 6h, 24h, and 48h postoperatively. They experienced less vomiting at 0h, 6h, and 24h postoperatively. The 2015 Yao et al study involving participants undergoing elective gynecological laparoscopic surgery who received TEAS preoperatively, also resulted in significantly fewer incidences of nausea, vomiting, and dizziness, in the TEAS group compared to the control group. In this study, bilateral Hegu (LI4), Neiguan (PC6), Zusanli (ST36), and Sanyinjiao (SP6) were stimulated.

In the 2019 Tu et al study involving patients undergoing ureteroscopic lithotripsy TEAS was performed postoperatively at 0h, 4h, 8h and 12h on bilateral Shenyu (BL23) and SP9 acupoints. It was also implemented on the 2 days following surgery three times each day at 0700, 1100, and 1500. Researchers found that compared to the control group, patients in the TEAS group experienced significantly fewer incidences of vertigo. Patients in the TEAS group also experienced fewer incidences of nausea or vomiting.

In the Chen et al study involving patients undergoing elective thyroidectomy, TEAS was performed prior to induction bilaterally on the Hegu (LI 4) and Neiguan (PC 6) acupoints. Only 10 patients in Group TEAS experienced PONV. This was compared to 26 patients in the control group. Twelve TEAS patients and 27 control patients experienced dizziness.
The 2012 study by Lan et al on elderly patients undergoing total hip arthroplasty also found that TEAS decreased PONV. Prior to surgery, six acupoints were stimulated in the TEAS group: PC6 and L14 bilaterally, and ST36 and GB31 ipsilateral to the surgical site. Only 5 patients in the TEAS group compared to 14 in the control group experienced nausea, $P<0.05$. Three patients in the TEAS group compared to 10 in the control group experienced vomiting, $P<0.05$. Two patients in the TEAS group compared to 8 in the control group experienced dizziness, $P<0.05$.26

**Time Spent in the Post-anesthesia Care Unit (PACU)**

Several studies included in their investigations the effect TEAS had on time required in the PACU. Factors such as uncontrolled pain and PONV can prolong a patient’s stay in the PACU.29 Adverse effects of opioid administration such as nausea, respiratory depression, and excess sedation can also prolong PACU time.29 In the 2014 study conducted by Zhang et al, in which researchers studied the effect of TEAS on the recovery of patients who underwent ambulatory elective cosmetic breast surgery, readiness for discharge was assessed by the PACU nurse using the modified Aldrete score every 10 minutes. Patients were ready for discharge when the modified Aldrete score was 10 and the pain score was less then 5. The length of time spent in the PACU was significantly less in the TEAS group than the sham group. The length of time in the PACU was 35.6 min in the TEAS group versus 48.3 minutes in the sham group, $P=0.01$.29

In the 2015 Yao et al study, in which patients who underwent a gynecological laparoscopic surgery received TEAS 30 minutes prior to induction, the duration of stay in the PACU was shorter for the TEAS group than for the control group: 27.8 minutes versus 35.7 minutes, $P=0.039$.22 Chen et al found that after a thyroidectomy, patients who received pre-
induction TEAS stayed an average of 11 minutes less in the PACU: 26 minutes versus 37 min, $P<0.001$.\textsuperscript{25}

**Quality of Recovery & Patient Satisfaction**

TEAS has been shown to increase patient satisfaction. In their 2015 study, Yao et al assessed the quality of recovery (QoR) of patients who had undergone gynecological laparoscopic surgery and received preoperative TEAS.\textsuperscript{22} QoR was assessed the day before the operation and 24 hours after using a 40-item questionnaire known as a QoR-40. Scores on the questionnaire ranged from 40 to 200. A score of 40 was considered very poor and a score of 200 was considered excellent. Patient satisfaction was measured 24 hours after the surgery with a 10-point scale. A score of 10 was excellent, a score of 1 was horrible. A score of greater than 8 represented a satisfied patient.\textsuperscript{22}

The TEAS patients scored their experiences significantly higher than did the control group in four categories: emotional state, $P=0.013$, physical comfort, $P<0.001$, psychological support, $P=0.029$, and postoperative pain, $P=0.001$. There was no significant difference in a fifth category, physical independence, $P=0.152$. The global QoR scores for the patients in the TEAS group were significantly greater than those in the control group, $P<0.001$. The average global score and standard deviation for the TEAS group was 176.5 ± 10.2 respectively. The average global score and standard deviation for the control group was 164.8 ± 14.7. Patients in the TEAS group gave an average satisfaction score of 8, versus an average satisfaction score of 6 for the control group, $P=0.002$.\textsuperscript{22}

The Chen et al study that utilized TEAS on patients undergoing a thyroidectomy also measured the effects of TEAS on QoR-40 scores which were assessed the day prior to surgery and 24 hours after.\textsuperscript{25} The survey used five metrics to analyze a patient’s satisfaction: emotional
state, physical comfort, psychological support, physical independence, and pain. Each item was graded with a five-point score. The lowest score possible was 40, representing an extremely poor recovery. The highest score was 200, representing an excellent recovery. Patients in the TEAS group ranked their quality of recovery significantly greater than those in the control group in three metrics: emotional state, $P=0.023$, physical comfort, $P<0.001$, and pain, $P<0.001$. There was no difference in the metrics of psychological support and physical independence. The global QoR median score was also significantly greater in Group TEAS than in the control group: 183 versus 168 respectively, $P<0.001$. In this same study, patients measured their satisfaction 24 hours postoperatively using a 10-point scale, 10 being excellent and 1 being horrible. The TEAS patients reported an average satisfaction score of 8, versus an average satisfaction score of 6 for the control group, $P=0.002$.

Patient satisfaction was studied in the 2017 study by Sun et al, in which study participants undergoing laparoscopic cholecystectomy or laparoscopic gynecological surgery were divided into four study groups, one that received sham TEAS, one that received only preoperative TEAS, one that received pre- and intraoperative TEAS, and the fourth group that received pre- and postoperative TEAS. The satisfaction rates of both the pre- and intraoperative TEAS group, and the pre- and postoperative TEAS group was 100%. The satisfaction rate of the preoperative TEAS group was 98.9%. All three of these findings were significantly higher than the 88.9% satisfaction rate of the control group who only received sham treatment, $P<0.05$.

The 1998 study by Chen et al found that according to the global pain assessment questionnaire participants completed, 88-96% of patients stated that their pain was adequately treated. Approximately 60% of patients in Group III, the group that received electrical stimulation at the incision site, and 68% of patients in Group IV, the group that received TEAS,
thought that TEAS decreased their pain. This was opposed to only 20% of the patients in Group I, the sham group, and 32% of patients in Group II, who received electrical stimulation on the bilateral deltoids, who thought that TEAS decreased their pain. Interestingly, this study asked participants if they would be willing to use TEAS again for a future procedure. Researchers found that all the patients except one, including the participants in the sham group, declared that they would use the TEAS device again for a future surgery if given the opportunity. Over half the participants were so satisfied they stated they would be willing to pay extra to have TEAS therapy for a future operation.20

**DISCUSSION**

**Summary of Evidence**

Fifteen RCTs with a total of 1,511 patients were included in this quality improvement project. Several studies were excluded, which had measures that did not include opiate usage and/or pain in the perioperative period or while on mechanical ventilation, studies that did not utilize TEAS, and studies in which TEAS was not utilized for the purpose of analgesia. All fifteen studies met the criteria for Level 1 evidence. Of the fifteen articles found, twelve were rated as high quality, and three were rated of a good quality based on the Johns Hopkins’ appraisal scale.

Of the fifteen articles analyzed, TEAS was found useful as a non-pharmacological method to decrease perioperative pain and/or analgesia usage. TEAS is cited as effective, non-invasive, and easy to use. An advantage is that it can be applied by any healthcare provider with nominal training.29 There is little risk to the patient beyond a low incidence of procedural pain and contamination.25 TEAS was also shown to be effective in reducing pain and opioid use in not only surgical patients, but mechanically intubated patients in the intensive care unit.30
The studies reviewed utilized a variety of acupoints (Table 3 and Figure 2). The two most commonly used acupoints were Hegu (LI4) and Neiguan (PC6). Hegu was utilized in eleven of the fifteen studies. Hegu is located on the large intestine meridian and is used for its analgesic and sedative effects.\(^2\) Hegu’s anatomical location is on the dorsum of the hand, on the webbing between the thumb and index finger.\(^3\)

Neiguan (PC6) was utilized in 10 of the fifteen studies. Neiguan has powerful anti-nausea effects and is located on the hand-Jueyin pericardium meridian.\(^2\) Neiguan is located on the palmar side of the forearm, 2 cun above the crease of the wrist approximately over where the median nerve lies.\(^3\) Of the six studies that found that TEAS decreased PONV, five of them utilized the PC6 acupoint.

The third most commonly used acupoint was Zusanli (ST36). Zusanli is located at the conjunction point of the stomach channel and the foot-Yangming and is also helpful in attenuating lower abdominal pain.\(^2\) Anatomically, Zusanli is located 3 cun below Dubi (S35), one finger breadth from the anterior crest of the tibia on the lateral aspect of the lower leg.\(^3\) The other acupoints utilized were specific to the type and anatomical location of the surgery. Two studies compared the stimulation of acupoints versus non-acupoints.
### Table 3. Descriptions of Selected Acupoints

<table>
<thead>
<tr>
<th><strong>Acupoint</strong></th>
<th><strong>Meridian/Target Organs</strong></th>
<th><strong>Clinical Effect</strong></th>
<th><strong>Anatomic Location</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hegu (LI4)</td>
<td>Large Intestine Meridian²²</td>
<td>Analgesic &amp; sedative effects²²</td>
<td>Dorsum of hand, between first and second metacarpal bones, in the middle of the second metacarpal bone on the radial side²³</td>
</tr>
<tr>
<td>Neiguan (PC6)</td>
<td>Hand-Jueyin pericardium meridian²²</td>
<td>Mitigates PONV²²</td>
<td>Palmar side of the forearm, 2 cun above the crease of the wrist, on the line that connects Quze (PC3) and Daling (PC7)²³</td>
</tr>
<tr>
<td>Zusanli (ST36)</td>
<td>Conjunction point of the stomach channel and the Foot-Yangming²²</td>
<td>Relives lower abdominal pain²⁰</td>
<td>3 cun below Dubi (S35), one finger breadth from the anterior crest of the tibia on the lateral aspect of the lower leg²³</td>
</tr>
<tr>
<td>Sanyinjiao (SP6)</td>
<td>On the spleen meridian, marks the conjunction of the spleen, liver, and kidney channels³⁷</td>
<td>Relieves labor pain, dysmenorrhea, and other female ailments³⁷</td>
<td>Medial aspect of the lower leg, four finger-widths above the highest prominence of the medial malleolus, behind the posterior edge of the tibia³⁷</td>
</tr>
</tbody>
</table>

Chen et al demonstrated the importance of the site of electrical stimulation. Researchers concluded that acupoint stimulation produced superior analgesia and a decrease in postoperative hydromorphone administration compared to stimulation of non-acupoints. However, dermatomal stimulation of the incisional site was as effective as the acupoint stimulation.²⁰ Oztas and Iyigun conducted a very similar study with a similar conclusion.²⁸ Another important variable in the administration of TEAS is the intensity of the stimulation.

Wang et al compared low intensity TEAS administered at 4-5mA to high intensity TEAS, administered at 9-12mA. Researchers established that when TEAS was used in conjunction with a PCA, it produced a significant decrease in analgesic requirement, which was related to the strength of electrical stimulation. High intensity TEAS also decreased opioid-related side effects. These researchers also concluded that the placebo effect plays a role in the analgesic power of TEAS, given that 35% of the participants who received sham TEAS thought it decreased their pain.²⁷ Another major variable that differed amongst the studies was the time period chosen to
utilize TEAS stimulation, in the pre-, intra-, or postoperative time periods or a combination of the three.

Eight of the fourteen studies that involved surgical patients chose only one of these time periods. Four utilized only preoperative TEAS and four utilized only postoperative TEAS. No studies utilized only intraoperative TEAS. Six studies utilized a combination of either preoperative, intraoperative, or postoperative TEAS. Sun et al compared TEAS at different perioperative times. Researchers concluded that preoperative TEAS with intraoperative or postoperative TEAS, as opposed to preoperative TEAS alone, offered an alternative or adjunct treatment for pain relief following laparoscopic surgery.19 The Feng et al study involving surgical abortion also compared the effects of TEAS at different perioperative times. Researchers concluded that it was better to perform TEAS prior to surgery to achieve post-procedure analgesia.36 Studies utilizing only preoperative or only postoperative TEAS, however, both found TEAS to be effective.

The study by Zhang et al, which studied patients receiving ambulatory breast surgery, found that preoperative TEAS significantly decreased intraoperative remifentanil usage. Researchers declared that TEAS should be used more often after surgery of an ambulatory nature. This was after further studies identified the most beneficial combination of time, frequency, and intensity of stimulation.29 These same researchers replicated these results in Wang et al, a study involving patients undergoing sinusotomy, finding that preoperative TEAS can significantly decrease intraoperative remifentanil administration.23 Tu et al declared that TEAS can ease postoperative pain and reduce the use of postoperative analgesic drugs after finding that postoperative TEAS significantly decreased postoperative tramadol administration to patients who underwent lithotripsy.16 Chen et al made a similar conclusion, finding that TEAS
administered in the preoperative, intraoperative and postoperative periods significantly decreased sufentanil administration.\textsuperscript{31} Chen et al recommended TEAS for perioperative analgesia.\textsuperscript{31} Tu et al found laboratory evidence of decreased pain.\textsuperscript{16}

Tu et al drew bloodwork that measured 5-HT and substance P from study participants at five different times during the course of their hospital stay. Researchers concluded that TEAS may block the production of these algogenic substances in the body, blocking not only the conduction of pain, but its generation too.\textsuperscript{16} Zhang et al measured blood levels of the stress markers adrenaline, noradrenaline, adrenocorticotropic hormone, glucose, and cortisol at four time points of patients undergoing ambulatory breast surgery. The lack of differentiation in intraoperative catecholamine and hormone levels suggested no difference in the level of intraoperative stress each patient endured.\textsuperscript{29} These results were replicated in their study on patients undergoing sinusotomy.\textsuperscript{23}

**Limitations of the Quality of the Systematic Review**

Overall, the studies included in this quality improvement project were of high quality. All fifteen studies met the criteria for Level 1 evidence. Of the fifteen articles found, twelve were rated as high quality, and three were rated as a good quality based on the Johns Hopkins' appraisal scale. A limiting factor with every study is that all of the studies were conducted at single facilities. Due to similar patient population demographics, similar equipment, and similar healthcare providers, conducting a study at a single facility limits its reproducibility. Additionally, most of the studies were small in size, ranging from 47 to 361 participants. Studies with more participants would increase the strength of the results, giving them more depth and credence. Another limitation is the inability to blind the patients.
The threshold for feeling the electrical stimulation of TEAS is 5 mA. Surpassing this threshold is necessary to receive the full benefits of TEAS. Therefore, when stimulating a patient with greater than 5 mA, the patient will know that they are receiving the electrical stimulation and possible TEAS treatment. This prevents the patient from being totally blinded to the study, except for TEAS that is utilized intraoperatively, when the patient is anesthetized and undergoing a surgical procedure. Knowing that they are receiving some form of stimulation could affect the patient’s perception of their treatment and might even induce a placebo effect, potentially affecting the outcomes of the study. However, although patients might have known they are being stimulated, they were still blinded as to whether they were receiving TEAS or non-TEAS stimulation. Another limitation is that most of the studies were conducted in East Asia.

Eleven of the fifteen studies were conducted in either China or Taiwan. Since acupuncture and related techniques such as TEAS are traditional practices in Chinese culture, there could have been a psychological effect of increased acceptance to TEAS as an acceptable form of analgesia. This could have created higher positive results than of patients from a different ethnic population. In general, it has been found that Chinese patients request and receive small amounts of postoperative analgesia. The prospect of opioid addiction and social stigma concerns most Chinese patients. A final limitation is the heavy participation of female study participants.

Seven of the fifteen studies enlisted only female or mostly female participants due to the gynecological nature of the procedures they were undergoing. This represents 855 of the 1,511 or 56.5% of participants. None of the other studies specified how many of their participants were male or female. However, if half of the remaining 656 participants were female, as represented in
the general population, this would mean that approximately 78% of participants across the 15 studies were female. Including more men in the research studies would be more representative of the general population.

**Recommendations for Future Research**

Broader research needs to be conducted at multiple facilities with a larger and more diverse patient population\(^{31}\) that includes more male participants.\(^{19}\) This will give more depth and credence to results. Furthermore, additional studies need to be conducted to pinpoint the exact combination of perioperative time periods, preoperative, intraoperative, or postoperative, that yield the greatest analgesic effect. None of the studies conducted utilized children in their research designs. It will eventually have to be determined whether children and infants receive the same benefit from TEAS as adults.

Finally, there are many acupoints on the human body, and a myriad of combinations in which they could be stimulated. The most effective combinations of acupoints for specific surgeries, that yield the greatest analgesia should be pinpointed. A more rigorous TEAS protocol for specific surgeries would be beneficial for understanding which interventions produce the best patient outcomes.

**Recommendations for Practice**

TEAS can be implemented as an adjunct form of non-pharmacological, non-invasive analgesia. The evidence suggests that any perioperative combination of TEAS can result in positive patient outcomes. However, if TEAS is not implemented in the preoperative or intraoperative period, it is impossible for the patient to receive intraoperative benefit. For this reason, it is recommended that TEAS be initiated 30 minutes prior to surgery. TEAS should be
administered at a dense and disperse frequency of 2/100 Hz for a duration of 30-40 minutes. The intensity should be set above 5 mA.

There are a myriad of acupoint combinations that could potentially be utilized. Hegu (LI4) is specifically used for its generalized analgesic and sedative effects. Neiguan (PC6) alleviates nausea. Located on the hand and on the wrist, these two acupoints are easy for healthcare providers to access and identify. For these reasons, Hegu (LI4) and Neiguan (PC6) at a minimum are the acupoints that should be stimulated. Stimulation should be bilateral. Since every surgery involves the potential for pain and for nausea, and Hegu (LI4) and Neiguan (PC6) have generalized effects, they can be stimulated with any surgical procedure. As no studies to date have been performed on infants and children, TEAS should only be performed on adults at this time.

**Conclusion**

TEAS is a nonpharmacological, noninvasive analgesic technique that has been shown to decrease postoperative pain, perioperative opioid use, PONV, recovery time, and improve patient satisfaction. Though there are many different acupoints on the human body, the stimulation of Hegu (LI4) and Neiguan (PC6) has consistently shown to decrease perioperative opioid use and decrease PONV. Future studies need to be performed to determine the usefulness of stimulating other acupoints on the body. Additionally, broader studies conducted at multiple healthcare sites with a larger and more diverse patient population will serve to validate the existing research on TEAS. In current clinical practice, TEAS shows promise as a simple, economical, nonpharmacological, noninvasive adjunct to existing perioperative analgesic regimens that can be easily administered by any healthcare provider with minimal training in implementing evidence based medicine. TEAS can further be useful for patients suffering from major organ
system diseases or who have a contraindication to opioid drugs. The non-pharmacological and non-invasive nature of TEAS lends itself useful to such patients.16

IMPLEMENTATION

Setting and Participants

The setting for this educational module was an online survey and PowerPoint educational module. Members of the Department of Anesthesia from Miami Beach Anesthesiology Associates at Mount Sinai Medical Center, Miami Beach, Florida were invited to participate. The invitees included both anesthesiologists and Certified Registered Nurse Anesthetists (CRNAs). The participation was based on individuals who were within the email list provided by Mount Sinai Medical Center. The anesthesia providers were asked to provide feedback regarding the educational module's anesthesia providers' experience. The anticipated sample size was between 10-15 participants.

Recruitment

The target population consisted of CRNAs and anesthesiologists who had taken care of patients in the perioperative period. Participants were identified through an email list provided by Mount Sinai Medical Center. The anesthesia providers within the email list were emailed an invitation to participate in the educational module.

Description of Approach and Project Procedures

The primary methodology of the proposed project was to administer an online educational module that included a PowerPoint video to providers that discussed TEAS and its benefits. The project was implemented by conducting an online pre-assessment test that assessed the anesthesia provider’s knowledge about TEAS. The existing knowledge and understanding of
the anesthesia provider was defined using a pre-evaluation tool that influenced the intervention's information and determined the content or subject matter of the intervention.

The second phase included a voiceover video PowerPoint with information regarding TEAS. This acted as the primary means of learning. It is essential to bridge existing gaps in knowledge and support the need for non-pharmacological analgesic interventions by educating anesthesia providers. The delivery of the presentation offered insight for providers regarding TEAS, including a background on acupuncture and Traditional Chinese Medicine, what TEAS is, how TEAS works, the benefits of TEAS, and how best to administer TEAS.

The third phase of the project involved an online post-assessment test to identify the anesthesia provider’s learned knowledge and perception to the intervention and the contents that were delivered. This information provided greater feedback regarding the impact of the educational intervention and helped determine how to best move forward in increasing the usage of TEAS.

Protection of Human Subjects

Anesthesia providers participating in the survey remained anonymous and the data was secured by using unique code identifiers. The digital data collected from the pre-test and post-test were protected by a laptop password and spyware; this ensured the safety of the data. There were no perceived risks to participating in this study as it only required the time spent on it, which was anticipated to be 20 minutes or less.

Data Collection and Analysis

The primary instruments for the study were preassessment and post-assessment testing applications to determine the effectiveness of the educational module. Both tests were conducted via surveys utilizing Qualtrics software. The survey was first comprised of six demographic
questions. The pre-test consisted of 13 questions that focused on basic knowledge and implementation of TEAS. The pre-test was meant to ascertain the participant’s baseline knowledge of TEAS. Two questions included at the end of the pre-test were meant to determine the provider’s attitude toward alternative therapies in medicine, and their likelihood of using TEAS in the future in their anesthesia practice. Following the pre-test, the participant viewed the TEAS video educational module. After viewing, the participant took the post-test. The post-test questions consisted of the same questions as the pre-test, administered in the same order. This was the best way to determine if knowledge had been gained upon completion of the educational module. The data collected was confidential, and no subject identifiers were recorded during any component of the study.

**Data Management and Measure**

The investigator for this project is the DNP student who created the pre- and post-tests and the TEAS educational module. Each question was measured, and the responses recorded to identify the knowledge base before and after the educational module. No personal identifiers were recorded for each of the study participants so that confidentiality was protected. The impact of the educational module was based upon the results of the pre-and post-test surveys. Through statistical analysis, the study results identified were able to determine the effectiveness of the educational module by improving anesthesia providers' knowledge. The data collected was stored in a password-protected laptop computer.
IMPLEMENTATION RESULTS

Demographics

The demographics are shown in Table 4, shown below.

Table 4. Participant Demographics

<table>
<thead>
<tr>
<th>Demographic</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Participants</td>
<td>7 (100%)</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>3 (42.86%)</td>
</tr>
<tr>
<td>Female</td>
<td>4 (57.14%)</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
</tr>
<tr>
<td>25-34</td>
<td>3 (42.86%)</td>
</tr>
<tr>
<td>35-44</td>
<td>3 (42.86%)</td>
</tr>
<tr>
<td>45-54</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>&gt;55</td>
<td>1 (14.29%)</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>4 (57.14%)</td>
</tr>
<tr>
<td>Caucasian</td>
<td>1 (14.29%)</td>
</tr>
<tr>
<td>African American</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Asian/Pacific Islander</td>
<td>2 (28.57%)</td>
</tr>
<tr>
<td>Other</td>
<td>0 (0%)</td>
</tr>
<tr>
<td><strong>Position/Title</strong></td>
<td></td>
</tr>
<tr>
<td>CRNA</td>
<td>7 (100%)</td>
</tr>
<tr>
<td>MD/DO</td>
<td>0 (0%)</td>
</tr>
<tr>
<td><strong>Level of Education</strong></td>
<td></td>
</tr>
<tr>
<td>Associates</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Bachelors</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Masters</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>MD/DNP/PhD</td>
<td>7 (100%)</td>
</tr>
<tr>
<td><strong>Years of Experience</strong></td>
<td></td>
</tr>
<tr>
<td>Less than 1 year</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>1 to 5 years</td>
<td>5 (71.43%)</td>
</tr>
<tr>
<td>6 to 10 years</td>
<td>1 (14.29%)</td>
</tr>
<tr>
<td>More than 10 years</td>
<td>1 (14.29%)</td>
</tr>
</tbody>
</table>

There were 7 participants in the pre-test demographics. Slightly more participants identified as female (n=4, 57.14%) than male (n=3, 42.86%). The majority of participants identified themselves as Hispanic (n=4, 57.14%). Two participants identified themselves as
Asian/Pacific Islander (n=2, 28.57%), and one participant identified as Caucasian (n=1, 14.29%). The vast majority of participants were under 44 years of age (n=6, 85.71%), and one participant was greater than 55 years old (n=1, 14.29%). All participants identified their role as an anesthesia provider as a CRNA (n=7, 100%), and all identified their level of education as MD/DNP/PhD (n=7, 100%). In terms of experience, 5 participants had 1-5 years of experience (n=5, 71.43%), one had 6-10 years (n=1, 14.29%), and one had more than 10 years (n=1, 14.29%).

Comparison of Pre-test and Post-test Results

The pre-test consisted of 13 questions regarding basic information about TEAS, its administration, and how it works. It was expected that this would be the first time many participants learned about TEAS, so pre-test scores were expected to be low. The average pre-test score was 48% (Figure 3). Following the pre-test, participants were asked to view a PowerPoint video that was less than 10 minutes in length. The educational video covered all the questions in the pre-test. Following the video, a post-test was administered. This post-test consisted of the same questions that were in the pre-test, administered in the same order. The average post-test score was 74%. Every participant except one increased their score on the post-test compared to the pre-test. This resulted in an average 25.7% increase in test scores after participants watched the educational video. This increase in test scores indicates that learning was achieved, and that the TEAS education module was successful in its aim to disseminate knowledge and educate anesthesia providers about TEAS.
Figure 3. Knowledge

Following the PowerPoint educational video, average scores on almost every individual question improved from the pre-test to the post-test. There was neither improvement nor regression on questions 10 and 11, (Table 5) as the scores stayed the same. Question 5 was the only question in which more participants answered it incorrectly in the post-test than in the pre-test. This may reflect a flaw in the way the subject matter was presented in the video, the way the question was posed, or both.

Table 5. Difference in Pre- and Post-Test Knowledge

<table>
<thead>
<tr>
<th>Questions</th>
<th>Percent Correct: Pre-test</th>
<th>Percent Correct: Post-test</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. It is estimated that what percentage of patients who are prescribed opioids will develop an addiction?</td>
<td>28.57%</td>
<td>71.43%</td>
<td>42.86%</td>
</tr>
<tr>
<td>2. Which of the following statements reflects accurate beliefs in Traditional Chinese Medicine?</td>
<td>42.86%</td>
<td>85.71%</td>
<td>42.85%</td>
</tr>
<tr>
<td>3. What is Transcutaneous Electrical Acupoint Stimulation (TEAS)?</td>
<td>28.57%</td>
<td>85.71%</td>
<td>57.14%</td>
</tr>
<tr>
<td>4. What is the difference between Transcutaneous Electrical Acupoint Stimulation (TEAS) and Transcutaneous Electrical Nerve Stimulation (TENS)?</td>
<td>71.43%</td>
<td>100%</td>
<td>28.57%</td>
</tr>
<tr>
<td>5. How does TEAS decrease pain?</td>
<td>85.71%</td>
<td>28.57%</td>
<td>-57.14%</td>
</tr>
</tbody>
</table>
Pre-Test and Post-test Attitudes Toward Nonpharmacological Interventions and TEAS

At the end of the pre-test but before the educational video, participants were questioned about their attitude toward nonpharmacological interventions and alternative therapies and their likelihood to implement TEAS in the future. Five participants (n=5, 71.43%) had a very positive attitude, one had a positive attitude (n=1, 14.29%), and one had a neutral attitude (n=1, 14.29%) (Table 6). One person was very likely to implement TEAS in their anesthesia practice (n=1, 14.29%), four people were likely (n=4, 57.14%), one person was unsure (n=1, 14.29%), and one person was unlikely (n=1, 14.29%). The same questions were posed to participants at the end of the post-test to analyze how attitudes changed after receiving education about TEAS. After receiving the education, all participants had a very positive attitude toward nonpharmacological interventions and alternative therapies (n=7, 100%). Participants also indicated that they were more likely to implement TEAS into their anesthesia practice following the education. Three participants said they were very likely (n=3, 42.86%), two said they were likely (n=2, 28.57%), and two said they were unsure (n=2, 28.57%) (Figure 4).
<table>
<thead>
<tr>
<th>What is your attitude toward nonpharmacological interventions and alternative therapies?</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very positive</td>
<td>71.43%</td>
<td>100%</td>
<td>28.57%</td>
</tr>
<tr>
<td>Positive</td>
<td>14.29%</td>
<td>0%</td>
<td>-14.29%</td>
</tr>
<tr>
<td>Neutral</td>
<td>14.29%</td>
<td>0%</td>
<td>-14.39%</td>
</tr>
<tr>
<td>Negative</td>
<td>0%</td>
<td>0%</td>
<td>-14.39%</td>
</tr>
<tr>
<td>Very negative</td>
<td>0%</td>
<td>0%</td>
<td>-14.39%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How likely are you to implement TEAS into your anesthesia practice?</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very likely</td>
<td>14.29%</td>
<td>42.86%</td>
<td>28.57%</td>
</tr>
<tr>
<td>Likely</td>
<td>57.14%</td>
<td>28.57%</td>
<td>-28.57%</td>
</tr>
<tr>
<td>Unsure</td>
<td>14.29%</td>
<td>28.57%</td>
<td>14.29%</td>
</tr>
<tr>
<td>Unlikely</td>
<td>14.29%</td>
<td>0%</td>
<td>-14.29%</td>
</tr>
<tr>
<td>Very unlikely</td>
<td>0%</td>
<td>0%</td>
<td>-14.29%</td>
</tr>
</tbody>
</table>

**Table 6. Attitude & Likelihood to Implement TEAS**

**Figure 4:** How likely are you to implement TEAS in your anesthesia practice? (Post-test)

It is easier to change one’s attitude or feeling toward an intervention than it is to change one’s practice. Whereas changing one’s attitude simply entails evolving feelings about a subject matter, changing practice involves practical decisions such as obtaining equipment, patient consents, and staff training. For this reason, it was not an unexpected result that not every participant would indicate that they were very likely to implement TEAS in their anesthesia practice. However, due to an increase in participants’ likelihood of implementing TEAS, it can be inferred that following the education, participants have a better understanding of TEAS and feel more confident about implementation.
Summary

Overall, the results reflected an improvement in knowledge and attitude based on the pre-test and post-test scores. Knowledge showed an average gain of 25.7%. In addition, the post-test demonstrated that participant attitudes about nonpharmacological and alternative therapies remained high following the educational video. Likelihood to implement TEAS in their anesthesia practice increased following the educational video.

IMPLEMENTATION DISCUSSION

Limitations

Limitations of the study include a small sample size; the survey was emailed to the members of the Department of Anesthesia at Mount Sinai Medical Center, Miami Beach, Florida. There were 32 emails on the list; however, only seven people completed the survey. A larger sample size would be preferred to enhance the study's findings. The survey link, which included a pre-test, a narrated PowerPoint presentation, and a post-test, was available online for two weeks. Extending the time frame may have resulted in more replies. Finally, the project was completed entirely online, preventing it from being delivered through other means.

Future Implications for Anesthesia Practice

The literature shows that TEAS can decrease perioperative opioid utilization, pain, postoperative nausea and vomiting, recovery time, and increase patient satisfaction. Educating anesthesia providers about TEAS first makes them aware of this nonpharmacological, noninvasive analgesic technique, and secondly, teaches them how to utilize it. It is estimated that 8-12% of patients who are prescribed opioids will develop an addiction. By decreasing their use of perioperative opioids, anesthesia providers can help decrease the number of people who suffer from opioid use disorder. Researchers found that barriers to nursing use of nonpharmacological
analgesia included lack of education. \textsuperscript{38} Educational modules, such as the one used in this study, can help eliminate at least one barrier to nonpharmacological interventions.
REFERENCES


22. Yao Y, Zhao Q, Gong C, et al. Transcutaneous electrical acupoint stimulation improves the postoperative quality of recovery and analgesia after gynecological laparoscopic


28. Oztas B, Iyigun E. The effects of two different electrical stimulation methods on the pain intensity of the patients who had undergone abdominal surgery with a midline incision:


### APPENDIX

**Appendix A: Abbreviated Article Matrix Table**

<table>
<thead>
<tr>
<th>Author (Year), Level of evidence</th>
<th>Study, participants, Intervention</th>
<th>TEAS performed on experimental group</th>
<th>Outcome on opioid usage</th>
<th>Other outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chen et al (2020)</strong>&lt;br&gt;Level I, Quality B</td>
<td>80 patients (ASA I &amp; II) undergoing minimally invasive lung cancer surgery. 40 in the experimental group received TEAS. 40 in the control group received sham TEAS that stimulated at 4 mA. All patients were provided a patient controlled analgesia (PCA) pump postoperatively with sufentanil.</td>
<td><strong>When:</strong> 30 min. prior to induction, intraoperatively, and at 6h, 24h &amp; 48h postoperatively.&lt;br&gt;<strong>Duration:</strong> 30 min. each session, except intraoperatively, which was continuous for the surgery.&lt;br&gt;<strong>Frequency:</strong> 2/100Hz&lt;br&gt;<strong>Intensity:</strong> 30mA intraoperatively, 10-15 mA all other times.&lt;br&gt;<strong>Acupoints:</strong> bilateral Hegu (LI 4), Neiguan (PC 6), Houxi (SI 3) and Zhigou (TE 6)</td>
<td>Decreased postoperative sufentanil by almost 16% (P&lt;0.01)&lt;br&gt;TEAS resulted in decreased pain (P&lt;0.001), lower bispectral index score (BIS) (P&lt;0.001), fewer PCA demand attempts (P&lt;0.001), fewer successful demand attempts (P&lt;0.001), and fewer incidences of postoperative nausea (P&lt;0.001) and vomiting (P=0.03-0.001).</td>
<td></td>
</tr>
<tr>
<td><strong>Oztas &amp; Iyigun (2019)</strong>&lt;br&gt;Level I, Quality B</td>
<td>47 patients undergoing elective abdominal surgery: 16 in the control group who received no intervention, 16 in the experimental TENS group, 15 in the experimental TEAS group. All patients were given a tramadol PCA to control postoperative pain.</td>
<td><strong>When:</strong> 0.5h, 2h, 18h, 22h, 42h, and 46h postoperatively&lt;br&gt;<strong>Duration:</strong> 30 min.&lt;br&gt;<strong>Frequency:</strong> 2/100Hz&lt;br&gt;<strong>Intensity:</strong> up to 12mA, highest patient could tolerate&lt;br&gt;<strong>Acupoints:</strong> ST25, Neiguan (P6), Zusanli (ST36), Hegu (LI4)&lt;br&gt;<strong>Non-acupoints:</strong> lateral to the incision</td>
<td>TEAS group consumed less tramadol (228.40mg) than the control group (357.81mg) in first 24 hours (P&lt;0.05), and less in the second 24 hours, 164.46mg versus 265.65mg respectively, (P&lt;0.05).&lt;br&gt;Both intervention groups had significantly decreased postoperative pain (P=0.001).</td>
<td></td>
</tr>
<tr>
<td><strong>Tu et al (2019)</strong>&lt;br&gt;Level I, Quality A</td>
<td>120 patients (ASA I &amp; II) undergoing ureteroscopic holmium laser lithotripsy. 60 patients in the experimental group who received TEAS. 60 in the</td>
<td><strong>When:</strong> 0h 4h, 8h &amp; 12h postoperatively on the day of the surgery. And at 07:00, 11:00, and 15:00 on postop days 1 and 2.&lt;br&gt;<strong>Duration:</strong> 30 min.&lt;br&gt;<strong>Frequency:</strong> 2/100Hz</td>
<td>Patients who received TEAS consumed less total tramadol after 48h postoperatively than did those in the control group (127.14 ± 28.46mg vs. 415.27 ±&lt;br&gt;TEAS decreased postoperative VAS scores at 4h (P&lt;0.01), 12h (P&lt;0.03), and 24h (P&lt;0.01) and incidences of vertigo (P&lt;0.05),</td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Level</td>
<td>Quality</td>
<td>Participants</td>
<td>Intervention Details</td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
<td>---------</td>
<td>--------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>AminiSaman et al (2018)</td>
<td>Level I</td>
<td>Quality A</td>
<td>50 patients who had been admitted to the intensive care unit (ICU) less than 48 hours prior and were on mechanical ventilation (MV) with a diagnosis of pneumonia: 25 in the control group who received sham TEAS; 25 in the experimental group who received TEAS.</td>
<td><strong>Intensity:</strong> 5-30mA, highest patient could tolerate</td>
</tr>
<tr>
<td>Huang et al (2017)</td>
<td>Level I</td>
<td>Quality A</td>
<td>80 patients (ASA I-III) undergoing video-assisted thoracoscopic surgery (VATS) lobectomy: 20 in control group who received sham TEAS with no stimulation, 20 in 2/100Hz TEAS group, 20 in 2Hz TEAS group, 20 in 100Hz TEAS group. Each patient was connected to a sufentanil PCA for postoperative analgesia.</td>
<td><strong>When:</strong> 4 times over the course of 24 hours <strong>Duration:</strong> 30 min. <strong>Frequency:</strong> 1-10Hz <strong>Intensity:</strong> 5-10mA, the highest the patient could tolerate</td>
</tr>
<tr>
<td>Sun et al (2017)</td>
<td>Level I</td>
<td>Quality A</td>
<td>361 patients schedule for laparoscopic cholecystectomy or gynecological</td>
<td><strong>When:</strong> Pre-, intra-, or postoperatively depending on experimental group. <strong>Duration:</strong> 30 min.</td>
</tr>
<tr>
<td><strong>Level I, Quality B</strong></td>
<td><strong>Level I, Quality A</strong></td>
<td><strong>Level I, Quality A</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td>------------------------</td>
<td>------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>140 nulliparous female patients (ASA I &amp; II) requesting pregnancy termination with intravenous anesthesia. 35 in control group with no intervention, 35 in the first experimental group (pre-op); 35 in the second experimental group (post-op); 35 in the third experimental group (comb-op)</td>
<td>83 patients (ASA I &amp; II), 42 in the control group undergoing elective thyroidectomy. 41 in the experimental group; 42 in the control group.</td>
<td>71 female patients (ASA I &amp; II) undergoing elective gynecological laparoscopic surgery. 35 in the experimental group who received</td>
<td></td>
<td></td>
</tr>
<tr>
<td>When: 30 min. prior to procedure, after procedure, or a both (depending on experimental group) Duration: 30 min. Frequency: 2/100Hz Intensity: 0-30mA, the highest intensity the patient could tolerate Acupoints: bilateral Diji (SP8), Sanyinjiao (SP6)</td>
<td>When: One time, prior to induction Duration: 30 min. Frequency: 2/100Hz Intensity: 6-9mA Acupoints: bilateral Hegu (LI4), Neiguan (PC6)</td>
<td>When: One time, 30 min. prior to induction Duration: 30 min. Frequency: 2/10Hz Intensity: 6-9mA Acupoints: bilateral Hegu (LI4),</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No opioids were given during this RCT.</td>
<td>Patients in the control group required 3.5 doses of postoperative rescue analgesia morphine, compared to 1 dose in the TEAS group (P=0.004).</td>
<td>Patients in the TEAS group required an average of 1 postoperative rescue dose of sufentanil versus 3.5 doses for the control group (P=0.004)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decreased pain (P&lt;0.001) and PONV (P&lt;0.05)</td>
<td>TEAS decreased pain (P=0.013), the time to first request for rescue analgesia (P&lt;0.001), PONV (P=0.001), dizziness (P=0.001), duration of PACU stay (P&lt;0.001), and increased patient satisfaction (P=0.002)</td>
<td>TEAS increased Quality of Recovery scores (QoR) (P&lt;0.001), and patient satisfaction score (P=0.002), decreased postoperative pain</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TEAS. 36 in the control group who received sham TEAS with no stimulation.

Neiguan (PC6), Zusanli (ST36), and Sanyinjiao (SP6)

(P<0.05), PACU stay (P<0.001), and incidences of nausea (P=0.041), vomiting (P=0.004) & dizziness (P=0.001). TEAS increased the time to first request for rescue analgesia postoperatively (P=0.039)

**Wang et al (2014)**  
Level I, Quality A  
60 patients (ASA I & II) undergoing elective sinusotomy. 30 in the experimental group that received TEAS. 30 in the control group that received sham TEAS with no stimulation

When: One time, 30 min. prior to induction  
Duration: 30 min.  
Frequency: 2/10Hz  
Intensity: 6-9mA  
Acupoints: bilateral Hegu (LI4), Neiguan (PC6), Zusanli (ST36)

Decreased intraoperative use of remifentanil by 39% (P<0.001).

TEAS decreased time to extubation (P=0.01) and recall (P=0.007) the number of patients experiencing dizziness (P=0.010) and pruritis (P=0.020).

**Zhang et al (2014)**  
Level I, Quality A  
65 female patients (ASA I & II) undergoing elective cosmetic breast surgery. Randomly divided into 2 groups: 33 in the experimental group that received TEAS; 31 in control group that received sham TEAS with no stimulation

When: One time, 30 min. prior to induction  
Duration: 30 min.  
Frequency: 2/10Hz  
Intensity: 6-9mA  
Acupoints: Hegu (LI4), Neiguan (PC6), Zusanli (ST36)

Decreased intraoperative remifentanil by almost 35% (P=0.01)

TEAS significantly decreased time in the post anesthesia care unit (PACU) (P=0.01), time to removal of laryngeal mask airway (LMA) (P=0.01), time to reorientation (P=0.01), postoperative pain (P<0.05), dizziness (P=0.01), nausea (P=0.03), vomiting (P=0.03), and pruritis (P=0.03).

**Lan et al (2012)**  
Level I, Quality A  
60 patients (ASA I & II) undergoing total hip arthroscopy: 30 in control group that received sham TEAS with no stimulation, 30 in the experimental group that received TEAS. All patients received a fentanyl PCA for postoperative pain.

When: 30 min. prior to induction and at 2h, 4h, 20h, and 44h postoperatively  
Duration: 30 min.  
Frequency: 2/100Hz  
Intensity: 9-20mA, highest intensity patient could tolerate  
Acupoints: Neiguan (P6) and Hegu (L14) bilaterally, and Zusanli (ST36)

Decreased PCA fentanyl at postoperative 24h (P<0.001) and 48h (P<0.001). Fewer patients required postoperative rescue analgesia (P<0.05).

Decreased nausea (P<0.05), vomiting (P<0.05), and dizziness (P<0.05).
<table>
<thead>
<tr>
<th>Study</th>
<th>Level</th>
<th>Quality</th>
<th>Design</th>
<th>Intervention Details</th>
<th>Outcome Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yeh et al (2010)</td>
<td>Level I</td>
<td>Quality A</td>
<td>94 patients (ASA I &amp; II) undergoing surgery to correct nontraumatic lumbar injuries: 31 in control group who received no intervention, 33 in experimental group who received TEAS, 30 in experimental group who received sham TEAS which received the same stimulation as the TEAS group except electrodes were placed 2cm away from the acupoints. All patients received a morphine epidural PCA for postoperative pain control.</td>
<td><strong>When:</strong> 1 hour prior to induction and at 1h and 2h postoperatively. <strong>Duration:</strong> 20 min. <strong>Frequency:</strong> 2/100Hz <strong>Intensity:</strong> 4-7 mA depending on patient’s body weight. <strong>Acupoints:</strong> bilaterally to Weizhong (BL40), Yanglingquan (GB34), Shenmen (HT7), and Neiguan (P6).</td>
<td>Decreased morphine consumption (18.6 ± 9.7mg) compared to the control group (27.2 ± 12.5mg) ((P=0.02)). Decreased pain ((P=0.01)) and number of PCA demands ((P&lt;0.001)).</td>
</tr>
<tr>
<td>Chen, et al. (1998)</td>
<td>Level I</td>
<td>Quality A</td>
<td>100 female patients (ASA I &amp; II) undergoing total abdominal hysterectomy or myomectomy surgery: 25 in control group who received sham TEAS with no stimulation (Group I), 25 in experimental group who received TENS on the deltoid aspect of the shoulder (Group II), 25 in experimental group who received TENS on either side of the surgical incision (Group III), 25 in experimental group who received TEAS on acupoints (Group IV).</td>
<td><strong>When:</strong> Immediately postoperatively, and every 2-3 hours thereafter while awake, at bedtime, and upon waking up in the morning. Controlled by patient. <strong>Duration:</strong> automatically shut off after 30 min. <strong>Frequency:</strong> 2/100Hz <strong>Intensity:</strong> 9-12mA <strong>Acupoints:</strong> bilateral Zusanli (ST36) <strong>Non-acupoints:</strong> bilateral deltoid aspects of shoulders; either side of the surgical incision</td>
<td>Groups III and IV consumed less opioids respectively than Group I &amp; II ((all P values&lt;0.05)). Decreased duration of PCA use ((P&lt;0.05)), PCA demands ((P&lt;0.05)), nausea ((P&lt;0.05)), dizziness ((P&lt;0.05)), and sedation ((P&lt;0.05)). Improved patient satisfaction ((P&lt;0.05)).</td>
</tr>
<tr>
<td>Wang, et al. (1997) Level I, Quality A</td>
<td>PCA for postoperative pain. 100 female gynecological patients (ASA I &amp; II) undergoing elective lower abdominal surgery. 25 in the control group who did not receive any form of TEAS, 25 who received sham TEAS without stimulation, 25 who received low intensity TEAS, and 25 who received high intensity TEAS. All patients received a PCA postoperatively with hydromorphone.</td>
<td>When: Immediately postoperatively and for every 2 hours afterward during awake hours until discontinued. <strong>Duration</strong>: 30 min. <strong>Frequency</strong>: 2/10Hz <strong>Intensity</strong>: low-TEAS: 4-5 mA; high-TEAS: 9-12 mA <strong>Acupoints</strong>: Hegu (LI4) of non-dominant hand <strong>Non-acupoints</strong>: either side of the incision</td>
<td>Total hydromorphone use in the high TEAS group was 65% ($P&lt;0.001$) 55% ($P&lt;0.01$) and 46% ($P&lt;0.01$) less than the PCA-only, sham TEAS, and low TEAS groups respectively.</td>
<td>Number of PCA demands was significantly lower in both the high ($P&lt;0.001$) and low ($P&lt;0.05$) TEAS groups compared to the control. High-TEAS group required the PCA for less time ($P&lt;0.05$). High-TEAS significantly decreased nausea ($P&lt;0.05$), dizziness ($P&lt;0.05$), pruritis ($P&lt;0.05$), sedation score ($P&lt;0.05$).</td>
<td></td>
</tr>
</tbody>
</table>
Appendix B: IRB Exemption

MEMORANDUM

To: Dr. Yasmine Campbell
CC: David Luth
From: Elizabeth Juhasz, Ph.D., IRB Coordinator
Date: April 8, 2021
Protocol Title: "Transcutaneous Electrical Acupoint Stimulation to Decrease Opiate Utilization in Surgical Patients: An Evidence Based Educational Module"

The Florida International University Office of Research Integrity has reviewed your research study for the use of human subjects and deemed it Exempt via the Exempt Review process.

IRB Protocol Exemption #: IRB-21-0150
IRB Exemption Date: 04/08/21
TOPAZ Reference #: 110234

As a requirement of IRB Exemption you are required to:

1) Submit an IRB Exempt Amendment Form for all proposed additions or changes in the procedures involving human subjects. All additions and changes must be reviewed and approved prior to implementation.
2) Promptly submit an IRB Exempt Event Report Form for every serious or unusual or unanticipated adverse event, problems with the rights or welfare of the human subjects, and/or deviations from the approved protocol.
3) Submit an IRB Exempt Project Completion Report Form when the study is finished or discontinued.

Special Conditions: N/A

For further information, you may visit the IRB website at http://research.fiu.edu/irb.

EJ
March 1, 2021

Ann B. Miller, DNP, CRNA, APRN
Interim Assistant Chair
Clinical Associate Professor
Department of Nurse Anesthetist Practice
Florida International University

Dear Dr. Miller,

Thank you for inviting Mount Sinai Medical Center to participate in Doctor of Nursing Practice (DNP) project conducted by David Luth entitled “Transcutaneous Electrical Acupoint Stimulation to Decrease Opiate Utilization in Surgical Patients: An Evidence Based Educational Module” in the Nicole Warheim College of Nursing and Health Sciences, Department of Nurse Anesthetist Practice at Florida International University. I have warranted Mr. Luth permission to conduct the project using our providers.

Evidence-based practice’s primary aim is to yield the best outcomes for patients by selecting interventions supported by the evidence. This proposed quality improvement project seeks to investigate and synthesize the latest evidence regarding transcutaneous electrical acupoint stimulation to decrease opiate utilization.

We understand that participation in the study is voluntary and carries no overt risk. All Anesthesiology providers are free to participate or withdraw from the study at any time. The educational intervention will be conveyed by a 15-minute virtual PowerPoint presentation, with a pretest and posttest questionnaire delivered by a URL link electronically via Quatrics, an online survey product. Responses to pretest and posttest surveys are not linked to any participant. The collected information is reported as an aggregate, and there is no monetary compensation for participation. All collected material will be kept confidential, stored in a password-encrypted digital cloud, and only be accessible to the investigators of this study: David Luth and Dr. Ann Miller.

Once the Institutional Review Board’s approval is achieved, this scholarly project’s execution will occur over two weeks. David Luth will behave professionally, follow standards of care, and not impede hospital performance. We support the participation of our Anesthesiology providers in this project and look forward to working with you.

Respectfully,

Jampierre (J.P.) Mato, DNP, CRNA, APRN
Executive CRNA Director
SRNA Coordinator/Supervisor
Electronic Mail: Jampierre@bellsouth.net
Mobile Phone: 954-688-6080

4300 Alton Road, Suite 2454, Miami Beach, Fl. 33140
Office (305) 674-2742 • Facsimile (305) 674-9723
Appendix C: Recruitment Letter

Transcutaneous Electrical Acupoint Stimulation to Decrease Opiate Utilization in Surgical Patients: An Evidence Based Educational Module

Dear Mount Sinai Medical Center Anesthesia Provider:

My name is David Luth and I am a student from the Anesthesiology Nursing Program Department of Nurse Anesthetist Practice at Florida International University. I am writing to invite you to participate in my quality improvement project. The goal of this project is to improve health care provider knowledge on the uses of Transcutaneous Electrical Acupoint Stimulation as an adjunct to anesthesia to decrease levels of pain and opiate usage in patients during the perioperative period. You are eligible to take part in this project because you are a member of the Anesthesia Department for Mount Sinai Medical Center.

If you decide to participate in this project, you will be asked to complete and sign a consent form for participation. Next, you will complete a pre-test questionnaire, which is expected to take approximately 5 minutes. You will then be asked to view an approximately 15 minute long educational presentation online. After watching the video, you will be asked to complete the post-test questionnaire, which is expected to take approximately 5 minutes. *No compensation will be provided.*

Remember, this is completely voluntary. You can choose to be in the study or not. If you'd like to participate or have any questions about the study, please email or contact me dkram013@fiu.edu or 954-305-1353.

Thank you very much.

Sincerely,

David Luth, SRNA, BSN
Appendix D: Informed Consent

CONSENT TO PARTICIPATE IN A QUALITY IMPROVEMENT PROJECT

“Transcutaneous Electrical Acupoint Stimulation to Decrease Opiate Utilization in Surgical Patients: An Evidence Based Educational Module”

PURPOSE OF THE PROJECT
You are being asked to be in a quality improvement project. The goal of this project is to increase anesthesia providers’ knowledge about transcutaneous electrical acupoint stimulation as an adjunct, nonpharmacological therapy to decrease perioperative pain and opiate utilization in surgical patients.

DURATION OF THE PROJECT
Your participation will require about 20 minutes of your time.

PROCEDURES
If you agree to be in the project, we will ask you to do the following things:

RISKS AND/OR DISCOMFORTS
There are no foreseeable risks with you for participating in this project.

BENEFITS
The following benefits may be associated with your participation in this project: An increase in knowledge about the utility, delivery, and benefits of transcutaneous electrical acupoint stimulation as an adjunct, nonpharmacological intervention used to decrease perioperative pain and opiate utilization in the surgical patient. The overall objective of the program is to increase the quality of healthcare delivery, improving the health indicator of our patients, and increase patient engagement.

ALTERNATIVES
There are no known alternatives available to you other than not taking part in this project. However, if you like to receive the educational material given to the participants in this project, it will be provided to you at no cost.

CONFIDENTIALITY
The records of this project will be kept private and will be protected to the fullest extent provided by law. If, in any sort of report, we might publish, we will not include any information that will
make it possible to identify you as a participant. Records will be stored securely, and only the project team will have access to the records.

COMPENSATION & COSTS
There is no cost or payment to you for receiving the health education and/or participating in this project.

RIGHT TO DECLINE OR WITHDRAW
Your participation in this project is voluntary. You are free to participate in the project or withdraw your consent at any time during the project. Your withdrawal or lack of participation will not affect any benefits to which you are otherwise entitled. The investigator reserves the right to remove you without your consent at such time that they feel it is in the best interest.

RESEARCHER CONTACT INFORMATION
If you have any questions about the purpose, procedures, or any other issues relating to this research project, you may contact David Luth. at 954-305-1353, dkram013@fiu.edu or Dr. Ann Miller at 305-348-4871, anmille@fiu.edu

IRB CONTACT INFORMATION
If you would like to talk with someone about your rights of being a subject in this project or about ethical issues with this project, you may contact the FIU Office of Research Integrity by phone at 305-348-2494 or by email at ori@fiu.edu

PARTICIPANT AGREEMENT
I consent by participating in the survey. I have read the information in this consent form and agree to participate in this project.
Appendix E: Pre-test and Post-test Questionnaire

Pretest and Posttest Questionnaire:

Transcutaneous Electrical Acupoint Stimulation (TEAS)

INTRODUCTION

The primary aim of this quality improvement project is to improve the knowledge of Transcutaneous Electrical Acupoint Stimulation usage as a nonpharmacological adjunct to decrease pain and opiate utilization in the perioperative period in the surgical patient.

Please answer the questions below to the best of your ability. The questions are in multiple choice format. These questions are meant to measure knowledge and perceptions on Transcutaneous Electrical Acupoint Stimulation (TEAS).

PERSONAL INFORMATION

1. **Gender:** Male Female Other

2. **Age:** ______

3. **Ethnicity:**

   Hispanic Caucasian African American Asian Other

4. **Position/Title:** ____________________________

5. **Level of Education:** Associates Bachelors Masters PhD/MD/DNP

6. **Years of experience:** Less than 1 year 1 to 5 6 to 10 More than 10 years

QUESTIONNAIRE
1. It is estimated that what percentage of patients who are prescribed opioids will develop an addiction?
   a. 1-7%
   b. 8-12%
   c. 13-20%
   d. 21-33%

2. Which of the following statements reflects accurate beliefs in Traditional Chinese Medicine?
   a. “Qi” is a force that regulates the function of the body and flows through meridians. Blockage of Qi causes ailments.
   b. The body’s physiological functions are regulated by Yin and Yang channels called meridians that flow through the body.
   c. The location of acupoints and their selection based on Traditional Chinese Medicine cannot necessarily be explained by modern medical science.
   d. Acupoints are located on meridians throughout the body and stimulation can of these points can unblock Qi.
   e. All of the above

3. What is Transcutaneous Electrical Acupoint Stimulation (TEAS)?
   a. Electrical stimulation of acupoints on the body via electrodes placed on the skin
   b. Electrical stimulation of acupoints on the body via electrified acupuncture needles
   c. Electrical stimulation of nerve pathways in the body via electrodes placed on the skin
   d. Stimulation of the brain, which sends electrical impulses to acupoints on the body

4. What is the difference between Transcutaneous Electrical Acupoint Stimulation (TEAS) and Transcutaneous Electrical Nerve Stimulation (TENS)?
   a. They are different names for the same thing
b. TEAS stimulates acupoints, whereas TENS stimulates nerves

c. TEAS stimulates at a higher intensity than TENS

d. TEAS is only utilized when TENS does not produce effective results

5. How does TEAS decrease pain?

a. Electrical stimulation releases endogenous opioid-like substances including enkephalins, dynorphin, beta-endorphin, and endomorphin, inducing natural analgesia

b. TEAS has a placebo effect on the patient

c. TEAS has been shown to decrease the algogenic substances 5-HT and substance P

d. All of the above

6. TEAS should be administered for how long?

a. 10 minutes

b. 30 minutes

c. 1 hour

d. 2 hours

7. To achieve the best results the intensity of TEAS stimulation must be:

a. 5mA or less

b. A minimum of 6-10mA

c. Greater than 30mA

d. Intensity of the stimulation does not affect analgesia

8. The Hegu (LI4) acupoint is located where and has what effect?

a. Two inches to the right of the umbilicus; used for soothing gastrointestinal ailments

b. On the deltoid; has analgesic effects
c. Anterior to the earlobe, just superior to the mastoid process; used for the prevention of nausea and vomiting

d. Between the base of the thumb and index finger; has analgesic effects

9. Why is an alternating frequency of 2/100Hz the most common frequency used during TEAS?

a. This frequency has been chosen by default; there is no specific reason for this frequency choice.

b. Stimulation with 2Hz primes the receptors for stimulation with the more powerful 100Hz, preventing injury to the cell wall integrity resulting from electrical stimulation.

c. A frequency of 2Hz has been shown to produce significant increases of enkephalin, but not dynorphin. A frequency of 100Hz has been shown to increase dynorphin, but not enkephalin; using an alternating frequency increases both.

d. A frequency 2/100Hz keeps the pain receptors confused, thus negating their ability to send pain signals.

10. TEAS has been shown to:

I. Decrease postoperative morphine use

II. Decrease postoperative hydromorphone delivered by a patient-controlled analgesia (PCA) pump

III. Decrease intraoperative remifentanil use

IV. Decreased postoperative tramadol delivered by a patient-controlled analgesia (PCA) pump

a. II & III

b. I, II, III

c. I & II

d. I, II, II, IV
11. In addition to decreasing pain and opioid usage in surgical patients during the perioperative period, TEAS has been shown to:

   a. Decrease postoperative nausea and vomiting

   b. Improve patient satisfaction

   c. Decrease postoperative recovery time

   d. All of the above

12. Select the statements regarding patient satisfaction that are true:

   a. TEAS increases patient satisfaction, but only in those who received actual TEAS

   b. TEAS increases patient satisfaction not only in those who received actual TEAS, but those that received sham TEAS

   c. Some patients stated that TEAS decreased their pain, but they felt like they were missing out by not receiving more pharmacologic analgesia

   d. TEAS has not been shown to increase patient satisfaction

13. What are some advantages to using TEAS?

   I. Nonpharmacological

   II. It can be administered by healthcare providers with minimal training

   III. Noninvasive

   IV. It can be used in lieu of pharmacological analgesics

   V. Inexpensive

   a. I, III, V

   b. I, III, IV, V

   c. I, II, III, IV, V

   d. I, II, III, V

14. What is your attitude toward nonpharmacological interventions and alternative therapies?
a. Very positive
b. Positive
c. Neutral
d. Negative
e. Very negative

15. **How likely are you to implement TEAS into your anesthesia practice?**

a. Very likely
b. Likely
c. Unsure
d. Unlikely
e. Very unlikely

**ANSWER KEY:**

1. B  
2. E  
3. A  
4. B  
5. D  
6. B  
7. B  
8. D  
9. C  
10. D  
11. D  
12. B  
13. D
Appendix F: PowerPoint Educational Module Slides
Appendix G: AANA Abstract

Title

Transcutaneous Electrical Acupoint Stimulation to Decrease Opiate Utilization in Surgical Patients: An Evidence Based Education Module

Impact Statement

Improve provider knowledge on the use of transcutaneous electrical acupoint stimulation (TEAS) as an adjunct to anesthesia to decrease levels of pain and opiate usage in patients.

Background/Purpose/Question

An estimated 2 million Americans are addicted to opioids. A non-pharmaceutical method of analgesia can decrease the amount of opioid analgesia required during the perioperative period. Acupuncture is a non-pharmacological analgesic technique that has been shown to increase endogenous opioid-like substances in cerebral spinal fluid. TEAS is noninvasive, affords no risk of infection, and is inexpensive. Disposable electrodes are placed on acupoints on the body and stimulated with an electrical current. TEAS has been shown to decrease perioperative opioid use and pain in surgical patients. The purpose of this evidence-based project was to answer the following clinical question: For surgical patients during the perioperative period, does TEAS decrease perioperative analgesia, nausea, vomiting, post-operative recovery time, pain, and increase patient satisfaction?

Methods/Evidence Search

The PICO question was used to direct the search. The investigator utilized Cumulative Index of Nursing and Allied Health Literature, PubMed, Medline, and Google Scholar. Boolean operators were used to specify the limits of the search and truncation was used to catch all variations of search terms. The articles are reproducible with the following search terms: “acupuncture”, “anesthesia”, “pain”, “analgesia, and “surgery.” A total of 2,033 articles were retrieved in the four databases, duplicates were eliminated, and titles were appraised for applicability. The inclusion criteria concentrated on date of publication within 20 years, exposure of interest, geographic location, participants, peer reviewed, setting, reported outcomes, study design and type of publication. All database searches were limited to research involving humans, the English language and decreased opiate usage and/or pain in the perioperative period or while on mechanical ventilation. A total of 15 randomized control studies were included for this systematic review.

Synthesis of Literature/Results/Discussion

All studies found TEAS useful as a non-pharmaceutical method to decrease perioperative pain and analgesia usage. Researchers concluded that acupoint stimulation produced superior analgesia and a decrease in postoperative opiate administration compared to stimulation of non-acupoints. Chen et al found that patients who received TEAS required an average of one dose of
morphine postoperatively, compared to 3.5 doses for those in the control group, \( P=0.004 \). Huang et al found that TEAS decreased intraoperative sufentanil by 33.5\%, \( P<0.001 \). Six studies found that TEAS reduced incidences of postoperative nausea and vomiting (PONV). Two studies found that TEAS decreased time in the post-anesthesia care unit (PACU). Zhang et al found that TEAS patients left the PACU an average of 12.7 minutes faster than those in the control group, \( P=0.01 \). TEAS increased patient satisfaction and quality of recovery scores.

Future studies should be conducted at multiple healthcare sites with a larger and more diverse patient population to validate the existing research on TEAS. Future studies should determine its effectiveness on children and pinpoint the time during the perioperative period that yields the greatest analgesic effect. Most studies had woman as the sample population; including more men would be more representative of the general population along with studies conducted outside of Asia to test the effectiveness of TEAS.

Conclusion/Recommendations for Practice

TEAS is an economical, noninvasive, non-pharmacological adjunct to existing perioperative analgesic regimens that can be administered by healthcare providers with minimal training. The stimulation of the acupoints, Hegu (LI4) and Neiguan (PC6), decreases perioperative opioid use and PONV. Located on the hand and on the wrist, these two acupoints are easy for healthcare providers to access and identify. Hegu (LI4) and Neiguan (PC6) are the acupoints that should be stimulated bilaterally and can be stimulated with any surgical procedure. It is recommended that TEAS be initiated 30 minutes prior to surgery and administered at a dense and disperse frequency of 2/100 Hz for a duration of 30-40 minutes. The intensity should be set above 5 mA. A TEAS protocol for specific surgeries would be beneficial for understanding which interventions produce the best patient outcomes. The empirical evidence indicates that TEAS is effective in decreasing postoperative pain, perioperative opioids, PONV, recovery time, and improve patient satisfaction.

Funding Sources

None.

Conflict of Interest

There are no conflicts of interest in this study.

References


Appendix H: DNP Project Poster

Transcutaneous Electrical Acupoint Stimulation to Decrease Opiate Utilization in Surgical Patients: An Evidence Based Education Module

David W. Luth, BSN, RN, Ann B. Miller, DNP, CRNA, APRN; Carmen L. Chan, DNP, CRNA, APRN
Nicole Wertheim College of Nursing & Health Sciences
FLORIDA INTERNATIONAL UNIVERSITY

Introduction
It is estimated that 7 million Americans are addicted to opioids.1 In 2013, 47,000 people died due to an opioid overdose in the United States.1 It is estimated that the opioid death rate set a new all-time high in 2016, or 2 or 3 times greater than the previous day.1 It is estimated that 25-20% of patients prescribed opioids will misuse them, and 6-12% will develop an addiction.1 One way to combat the opioid crisis is through the use of non-pharmacological methods of management.

Purpose
The purpose of this evidence based education module is to provide an overview of the empirical evidence on utilizing transcutaneous electrical acupoint stimulation to decrease perioperative opiate utilization, postoperative nausea, vomiting, and recovery time, and improve patient satisfaction in surgical patients during the postoperative period. This project meets IFH exempt.

Clinical Significance
- Acupuncture is a non-pharmacological analgesic technique that has been used for over 2,500 years in Asia and has been used in conjunction with anesthesia since the 1950s.2
- The location of acupuncture and other selection is based on traditional Chinese Medicine (TCM) and cannot be necessarily be explained by modern medical science.3
- Studies have shown that acupuncture increases endogenous opioid-like substances in the central nervous system.4
- Transcutaneous electrical acupoint stimulation (TEAS) has shown great promise in providing non-pharmacological, non-invasive pain relief analgesia.5
- TEAS is non-invasive, affordable, and risk of infection, and is inexpensive. Disposable electrodes are placed on acupuncture on the body and stimulated with an electrical current.
- Unlike traditional acupuncture, which should be performed by a trained acupuncturist with years of training, TEAS can be performed with minimal training in an anesthesia provider and nurses.6,7

Methodology
- Randomized, placebo-controlled, double-blind study
- 92 patients (52 in the 4-Hz group and 40 in the 2-Hz group) were equally divided into 2 groups. 4-Hz group received 4-Hz TEAS, and 2-Hz group received 2-Hz TEAS.
- Each patient was randomized to subcutaneous 100 µg bolus of fentanyl for postoperative pain.

Results
- TEAS significantly decreases both intravenous and postoperative opiate usage in surgical patients undergoing a variety of surgeries.
- TEAS significantly reduces postoperative nausea and vomiting.
- TEAS significantly reduces time spent in the post-anesthesia care unit.
- TEAS significantly increases patient satisfaction and Quality of Recovery scores.

Conclusions
- TEAS can be performed in the OR, PACU, and inpatient setting to reduce the amount of opioids required, reduce patients' risk of addiction, reduce postoperative nausea and vomiting, and improve patient satisfaction.
- TEAS is a non-pharmacological, non-invasive analgesic technique that has shown to decrease postoperative pain, perioperative fentanyl, recovery time, and improved patient satisfaction.

References
- Johnson I, et al. JAMA 2017
- Luth D, et al. ANS 2018
- Miller A, et al. ANA 2018

Appendix H: DNP Project Poster

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