

12-12-2021

## The Use of Virtual Reality in Patients Undergoing Regional Anesthesia and its Impact on Patient Satisfaction, Anxiety, and Pain level: An Evidence-based Education Module

Iris Molina  
imoli007@fiu.edu

Valerie Diaz  
vdiaz@fiu.edu

Follow this and additional works at: <https://digitalcommons.fiu.edu/cnhs-studentprojects>

---

### Recommended Citation

Molina, Iris and Diaz, Valerie, "The Use of Virtual Reality in Patients Undergoing Regional Anesthesia and its Impact on Patient Satisfaction, Anxiety, and Pain level: An Evidence-based Education Module" (2021). *Nicole Wertheim College of Nursing Student Projects*. 62.  
<https://digitalcommons.fiu.edu/cnhs-studentprojects/62>

This work is brought to you for free and open access by the Nicole Wertheim College of Nursing and Health Sciences at FIU Digital Commons. It has been accepted for inclusion in Nicole Wertheim College of Nursing Student Projects by an authorized administrator of FIU Digital Commons. For more information, please contact [dcc@fiu.edu](mailto:dcc@fiu.edu).

The Use of Virtual Reality in Patients Undergoing Regional Anesthesia and its Impact on Patient Satisfaction, Anxiety, and Pain level: 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

Iris Molina, MSN, RN

Supervised By  
Valerie J. Diaz, DNP, CRNA, APRN, CAPT, USN, NC

Approval Acknowledged \_\_\_\_\_, DNA Program Director

Date: \_\_\_\_\_

Approval Acknowledged: \_\_\_\_\_, DNP Program Director

Date: \_\_\_\_\_

## TABLE OF CONTENTS

ABSTRACT .....	4
INTRODUCTION .....	5
Description of the Problem .....	5
Background .....	6
Systematic Review Rationale .....	7
Objectives of the Systematic Review .....	7
METHODOLOGY OF LITERATURE REVIEW .....	8
Search Strategy and Sources .....	8
Study Selection and Screening of Evidence .....	8
RESULTS OF LITERATURE REVIEW.....	9
Study Selection .....	9
Study Characteristics .....	10
Definitions and Outcomes .....	13
Risk of Bias .....	14
DISCUSSION OF LITERATURE REVIEW.....	16
Summary of Evidence .....	16
Limitations of the Systematic Review .....	17
Recommendations for Future Research .....	18
CONCLUSION OF LITERATURE REVIEW .....	19
METHODOLOGY OF QUALITY IMPROVEMENT.....	20
Setting.....	20
Recruitment and Participants.....	20
Intervention & Procedures.....	21
Protection of Human Subjects.....	22
Data Collection.....	22

Measurement and Analysis.....	22
RESULTS OF QUALITY IMPROVEMENT.....	23
Pre-test and Post-test Sample.....	23
Pre-test Knowledge.....	24
Post-Test Knowledge.....	25
Perspective of Use in Practice.....	26
DISCUSSION OF QUALITY IMPROVEMENT.....	27
Limitations.....	27
Future Implications for Advanced Nursing Practice.....	27
CONCLUSION.....	27
REFERENCES .....	29
Appendix A: PRISMA Flow Diagram.....	31
Appendix B: Matrix Table .....	32
Appendix C: IRB Exemption Letter .....	38
Appendix D: QI Project Consent .....	39
Appendix E: QI Project Survey .....	40
Appendix F: Educational Module.....	43

## ABSTRACT

**Background:** Anxiety and pain experienced when regional anesthesia (RA) is implemented can hinder patient care due to the nature of the procedure. Throughout the implementation of RA, virtual reality (VR) can distract patients from noisy, scary, and uncomfortable environments and alleviate these feelings at different points in the patient care experience. This problem is often overlooked and addressed incorrectly. An educational module will be presented with the findings of the investigation to the certified registered nurse anesthetists (CRNA) to inform them about the benefits virtual reality may have on patients undergoing regional anesthetic techniques.

**Objectives:** The literature review aimed to investigate the use of VR in different points of care when using RA and explore its usefulness in reducing anxiety and pain levels as well as increasing patient satisfaction scores. The overall feasibility of implementation in the operating room setting is also examined. An educational module was used to inform CRNA's on the subject and assess their knowledge and willingness to implement the novel modality into their practice.

**Data Sources:** Investigators used CINAHL, MedLine, and PROQUEST databases to answer the PICO (i.e., population, intervention, comparison, outcome) question: *Does the use of virtual reality in patients undergoing regional anesthesia lead to improved patient satisfaction, anxiety, and pain levels?*

**Study Selection:** Six studies were included in this systematic review and incorporated in the recommendations. Inclusion criteria involved: Studies in English, adult population over 18 years of age, published in 2010 to present, monitored anesthesia care, local anesthesia, and regional anesthetic technique implementations. Studies that involved amounts of medication usage, pain, anxiety, and satisfaction score evaluation as primary outcomes were chosen to be included in the review.

**Results:** The studies had a combined sample size of 266 patients. Five studies reported increased patient satisfaction scores or decreased anxiety and pain when the virtual reality experience was executed. One study reported no difference in any of the measured outcomes.

**Conclusions:** The empirical evidence shows that in most instances' VR had positive effects on anxiety, pain, and satisfaction scores reported by patients. All of the studies reported excellent acceptability from the patients and medical-surgical team with no increase in turnover time or adverse effects of operating room flow.

**Keywords:** Regional anesthesia, neuraxial anesthesia, virtual reality, anxiety, pain, satisfaction.

## INTRODUCTION

### Description of The Problem

New technology and advancements in Regional Anesthesia (RA) have led to an increase in its popularity and implementation in recent years. Such techniques offer numerous benefits, including enhanced recovery times, improved patient satisfaction, and increased pain relief.<sup>1</sup> However, the RA approach presents a unique nature which allows the patient to have varying levels of awareness throughout the procedure leading to apprehension and pushback often displayed by patients. Vigilance during surgery may also increase concerns, including being aware of the surgical procedure and the perceived pain experienced. Patients are already under a high level of stress, and literature suggests that perioperative anxiety is as high as 60-80% in the western population.<sup>2</sup> When regional anesthesia is used, the patient is still conscious and able to feel stimuli that accompany the surgical process, presenting dynamic factors attributing to increased patient anxiety. The problem can present itself at different points in the patient care visit. It may start before the regional anesthetic technique occurs to when the block is being performed and extend into the intraoperative period when the patient is conscious, and the surgical procedure is taking place.

Uncontrolled anxiety has many adverse effects on the patient throughout the perioperative period. If left untreated or unrecognized, the sympathetic nervous system is activated, and patients experience a myriad of physiological responses, including increased heart rate, elevated blood glucose, bronchodilation, and peripheral vasoconstriction, to name a few.<sup>3</sup> Such physiologic effects counteract the benefits of regional anesthesia and defeat the purpose of its core implementation. Recent studies have observed that patients with high anxiety have increased postoperative complications such as nausea, vomiting, and heightened pain perception.<sup>4</sup> These complications can add to an already challenging patient experience. The undesirable side effects of untreated patient anxiety can delay postoperative recovery time compared to those

whose fear is actively and adequately addressed.<sup>4</sup> Reducing patient stress has a clinical benefit that far exceeds patient comfort and therefore is a matter of boundless significance.

## **Background**

Anxiety and pain are pervasive and inevitable feelings in the perioperative period; however, there are pharmacologic options to counteract its adverse effects. These include opioids, sedatives, hypnotics, and anxiolytics. One study comparing the use of dexmedetomidine and midazolam to reduce patient anxiety undergoing RA reported perioperative side effects that included hypotension, bradycardia, desaturation, headache, nausea, and vomiting.<sup>5</sup> These medications, although effective, are not without adverse effects, accumulating to an unsatisfactory user profile. Non-pharmacologic interventions such as music, therapeutic communication, and proper perioperative patient education have also been incorporated. Studies show that intraoperative music to minimize anxiety has no significant impact on anxiety state, bispectral index score (BIS) index, blood pressure, heart rate, or oxygen saturation when compared to control groups.<sup>3</sup> The current methods used to address this issue are not sufficiently effective or introduce complications that only compound patient difficulties.

Several methods to diminish anxiety have been investigated; however, numerous knowledge gaps still exist. There is a discrepancy of information regarding the anesthesia providers' perceptions of fear as an issue in patients undergoing RA techniques. Only one-third of providers feel that anxiety is common among patients having RA, and even less (23%) acknowledge it is a concern, resulting in pronounced underestimation of the problem.<sup>6</sup> Further investigation of the anesthetist's ability to identify anxiety and choose the best treatment modality is warranted. Distinct apprehensions make it problematic for the patient to control their fear and consent to the proposed technique. Current methods used to attenuate these experiences are insufficient, leading to the investigation of a modern-day modality.

## **Systematic Review Rationale**

When used as an adjunct to regional anesthesia, the evidence suggests that the use of virtual reality (VR) has anxiety-reducing benefits.<sup>7</sup> It has been used as an educational and distraction tool in the perioperative setting. This unique intervention presents the patient with a sense of illusion believed to distract and minimize anxiety more effectively than other pharmacologic and non-pharmacologic interventions. VR is non-invasive, and its implementation is a feasible option because it is inexpensive, readily available in the clinical setting, and non-threatening to patients.<sup>7</sup> Implementing VR may improve patient satisfaction, reduce perioperative anxiety, and provide hemodynamic stabilizing effects, with no associated complications, and has shown to have excellent acceptability from the surgical team.<sup>7</sup> Recent literature reflects that VR reduces anxiety as reported by the visual analog scale (VAS), by measurement of salivary cortisol levels, and by determining physiological stress based on heart coherent scores.<sup>8</sup> VR is new and innovative, drawing attention from stakeholders looking to leverage adjuvant modalities to augment regional anesthesia techniques.

Immersive virtual reality (VR) has also shown potential as an analgesic and sedation sparing agent.<sup>9</sup> It is thought to reduce anxiety in patients undergoing regional techniques, therefore halting the use of certain anxiolytics and opioid administration. In the past, it has revealed potential in the management of wound care, physical therapy, and other anxiety-provoking procedures.<sup>9</sup> RA has been shown to increase pain and anxiety; therefore, decreasing patient satisfaction with said chosen anesthetic technique.

## **Objectives of the Systematic Review**

The purpose of this review will help answer the question: Does the use of virtual reality (VR) in patients undergoing regional anesthesia lead to improved patient satisfaction, anxiety, and pain levels? The population (P) being observed is patients undergoing regional anesthesia with the intervention (I) of virtual reality, in comparison (C) to patients receiving no virtual



reality experience. The outcomes (O) that will be analyzed are anxiety levels, pain levels, and satisfaction scores.

The goal is to explore the implementation of virtual reality to reduce patient anxiety and pain while increasing patient satisfaction and sustaining the benefits regional anesthesia has to offer. The findings of this investigation will later be presented to raise awareness of the patient experience during RA to the certified registered nurse anesthetist (CRNA) and expand their knowledge regarding alternative methods to mitigate anxiety using virtual reality.

## **METHODOLOGY OF LITERATURE REVIEW**

### **Search strategy and Sources**

A search was conducted to synthesize data proving the efficacy of VR to reduce anxiety, decrease pain and improve patient satisfaction, using CINAHL, PROQUEST, and MedLine databases. The key searches along with Boolean operators developed for the practice question were "regional anesthesia," using quotation marks to keep this phrase together, AND "virtual reality" OR "anxiety" OR "pain." The search conducted included a filter date range from 2010 to 2020. CINAHL yielded a total of five articles, PROQUEST produced six pieces, and the majority of results were found in the MEDLINE database with a total of ten studies; five additional studies resulted from other sources. After duplicates were removed, only 24 articles were left to be appraised. After careful selection, only 12 of these articles were included to guide further inclusion and exclusion criteria.

### **Study selection and Screening of Evidence**

Specific Inclusion and exclusion criteria were applied in order to develop a thorough investigation. Articles with a higher level of evidence were curated from the search results. Included in the review are four randomized control trials, one monocentric before and after study, one retrospective cohort study, and a pilot monocentric prospective study. Given that the concept of virtual reality is relatively novel, no systematic reviews were discovered. The inclusion criteria included patients receiving any type of regional anesthetic technique, including peripheral nerve

blocks and neuraxial anesthesia. Being that any kind of general anesthetic (GA) would make the use of VR obsolete, and any patient undergoing GA would not be able to cooperate and follow directions, studies using general anesthetics were omitted. The pediatric population, anyone less than 18 years old, were excluded. Applying these baseline criteria left a total of six articles to explore further.

**Table 1.** Inclusion and Exclusion Criteria

<b>Inclusion</b>	<b>Exclusion</b>
Population:	Population:
<ul style="list-style-type: none"> <li>• Ages 18 and over</li> </ul>	<ul style="list-style-type: none"> <li>• Pediatric population</li> </ul>
Type of anesthetic:	Type of anesthetic:
<ul style="list-style-type: none"> <li>• MAC anesthesia</li> <li>• Local anesthesia</li> <li>• Regional anesthesia</li> <li>• Neuraxial anesthesia</li> </ul>	<ul style="list-style-type: none"> <li>• General anesthesia</li> </ul>
Intervention:	Intervention:
<ul style="list-style-type: none"> <li>• Virtual reality distraction technique</li> </ul>	<ul style="list-style-type: none"> <li>• Anything other than virtual reality</li> </ul>
Primary outcomes:	Primary Outcomes:
<ul style="list-style-type: none"> <li>• Pain levels</li> <li>• Anxiety levels</li> <li>• Satisfaction levels</li> <li>• Amount of medication used</li> </ul>	<ul style="list-style-type: none"> <li>• Anything other than the inclusion criteria</li> </ul>
Type of study:	Type of study:
<ul style="list-style-type: none"> <li>• English language</li> <li>• Randomized controlled trials</li> <li>• Systematic reviews</li> <li>• Meta-analysis</li> </ul>	<ul style="list-style-type: none"> <li>• Non-English</li> <li>• Publication date before 2010</li> <li>• Questionnaire</li> <li>• Dissertations/theses</li> </ul>

## **RESULTS OF LITERATURE REVIEW**

### **Study Selection**

A total of six studies were included in this review. Of the excluded studies, many of them were omitted due to lack of quality (i.e., non-randomized group selection, along with insufficient investigation and results delivered). As well as inappropriate patient population (i.e., pediatric patients, parturient), exclusion of intervention being investigated (no virtual reality implementation), an anesthetic that did not allow for adequate patient assessment (general anesthesia), or inadequate study design (quality improvement study). The exclusion criteria were applied in order to permit a more precise and valuable investigation.

### Study Characteristics

The study conducted by Ganry et al. investigates the use of virtual reality in a single-blind trial taking place at the Hendri-Mondor teaching hospital in France. Virtual reality was implemented in the pre-operative period before any procedure took place. Effects of VR were measured by administering psychological tests, measuring salivary cortisol levels, and determining heart coherence scores. The study presented the most varied and unbiased data collection of them all, superior to further studies. Patients' anxiety scores decreased by 0 to 2 points (out of 10 points) after VR immersion, according to the visual analogue scale (VAS). The average of all scores decreased from 3.3 before the VR test to 2.85 after the VR test, a significant difference ( $P < 0.009$ ).<sup>8</sup> The VAS is a self-assessment scale that measures patient anxiety and evaluates their expectations regarding the surgical procedure.

The average salivary cortisol concentrations in this same study dropped from 14.55 before the VR test to 12.86 after the VR test, a significant difference ( $P < 0.005$ ).<sup>8</sup> Salivary cortisol levels were measured using a Salivette swab (Sarstedt™) to ensure that collected saliva samples were reproducible. The average physiological test (heart coherence) scores decreased from 50.6 before the VR test to 46.9 after the VR test, making the difference between these two averages not significant ( $P = 0.056$ ).<sup>8</sup> These scores were measured using pulse oximetry software for three minutes before and after the VR implementation, these results disproved any advantage for hemodynamic stability.

The study conducted by Brown et al. explores the feasibility, acceptability, and impact of a brief reality relaxation video on periprocedural pain and anxiety in chronic low back pain patients receiving spinal injections. It is important to note that anesthesia providers do not routinely perform spine injections for pain, but the nature of these procedures applies to the routine neuraxial techniques executed by CRNA's. A one-way analysis of variance (ANOVA) using pain and anxiety change scores, was used to check for statistically significant differences between the three groups. Results of a one-way between-group ANOVA were non-significant ( $P$

= .50) using interim and post-anxiety change scores.<sup>11</sup> Results of a one-way ANOVA were significant ( $P = .003$ ) using baseline/interim (pre-injection) anxiety change scores.<sup>11</sup> The significance of these scores results in an overall improvement of pain and anxiety levels compared to the control group, but no paramount importance when comparing a standard audiovisual presentation to the virtual reality environment.

Most importantly the study demonstrated the feasibility of VR implementation in a busy fluoroscopy injection clinic and positive acceptability in this patient population.<sup>11</sup> It is important to mention that the patient population the study was conducted for, is complex with pre-existing pain disorders and comorbidities; this group of people might not have been the best choice to choose VR implementation for.

The study conducted by Pandya et al. investigated virtual reality distraction as a non-pharmacological method to prevent acute pain in patients undergoing total knee arthroplasty receiving pre-operative adductor canal catheters. The control group received routine care; intravenous medication was administered at the discretion of the anesthesia provider. The other group was offered VR during the knee arthroplasty after the adductor canal block was performed, with the option of IV sedation upon request. The primary outcome, fentanyl dose, was lower in the group that used VR (0 [0–20]  $\mu\text{g}$ ) versus the non-VR group (50 [30–100]  $\mu\text{g}$ ;  $P = 0.008$ ). Of the seven patients who used VR, only one (14%) received intravenous sedation (fentanyl alone) versus six of seven (86%) who received usual care ( $P = 0.029$ ); one patient in the non-VR group requested no intravenous sedation.<sup>12</sup> The use of VR distraction in this study nearly eliminated the need for intravenous sedation and reduced procedure-related pain without increasing the procedural duration.

A randomized control trial performed by Huang et al. assessed the effects of immersive virtual reality on the self-administered sedation requirements of patients undergoing joint replacement surgery under regional anesthesia. The primary outcome measured was intra-operative propofol use. Propofol use remained similar (22.1 mg/hour (IQR 0, 94.5) in IVR group

and 40 mg/ hour (IQR 11.1, 93.9) in control group,  $p = 0.37$ ), the total propofol use was smaller, however there were no differences between groups (35 (IQR 0, 165) mg in IVR group and 80 (IQR 25, 180) mg in control group,  $p = 0.36$ ).<sup>9</sup> The study does not support the hypothesis that IVR confers sedation sparing effect on patients receiving joint replacement surgery under regional anesthesia; it does, however, demonstrate that it is feasible to implement IVR without much difficulty in a busy operating room theater.

In the study performed by Moon et al., the use of virtual reality during endoscopic urology surgery with spinal anesthesia was investigated. Sedative use in both groups was measured, as well as satisfaction scores in patients and anesthesia providers. The distribution of the satisfaction scores of the patients and anesthesiologists were significantly different between the groups ( $p = 0.025$  and  $p = 0.001$ , respectively), while the score of the surgeons was not very different.<sup>13</sup> The incidence of extreme satisfaction (satisfaction score 5) for patients and anesthesiologists was substantially higher in the VR group than in the sedation group (patients,  $n = 17$ , 94.4% in the VR group vs.  $n = 12$ , 63.2% in the sedation group,  $p = 0.042$ ).<sup>13</sup>

An interesting finding worth pointing out is the increase in patients who developed apnea in the sedation group versus the VR group; one patient even had to receive assisted mask ventilation, in contrast, two patients in the VR group fell asleep. No difference was shown in the duration of stay in the recovery area in addition to no alterations between the two groups in terms of hemodynamic stability, including bradycardia and hypotension. The incidence of optimal patient anesthesia and surgical conditions was significantly higher in the VR group than in the sedation group ( $n = 17$ , 94.4% in VR group vs.  $n = 13$ , 68.4% in the sedation group,  $p = 0.043$ , risk difference (95% CI) 0.17 (-0.08 to 0.42).<sup>13</sup> It was also distinguished that the content should be targeted to the population and presented over a lengthier period of time. When measuring the satisfaction among patients and anesthesiologists, satisfaction scores were significantly different and higher for the virtual reality group as opposed to the sedation group. It is important to comment that the surgeon noted no difference.<sup>13</sup>

According to Alaterre et al., when used as an add-on to regional anesthesia, virtual reality has been reported to provide anxiety-reducing benefits and sedation sparing effects<sup>7</sup> This is a monocentric before and after observational study that includes 100 patients who underwent ambulatory upper limb surgery under peripheral nerve blocks. Primary outcomes were self-rated satisfaction scores evaluated right after surgery. Secondary outcomes included a 2-month patient satisfaction score, perioperative self-rated anxiety, and intraoperative hemodynamic changes. Compared to former standard care, VR distraction was associated with significantly higher postoperative satisfaction scores (10 [IQR 9; 10] vs. 9 [8; 10],  $p < 0.001$ ) still reported two months after surgery (10 [10;10] vs. 10 [8.5;10],  $p = 0.06$ ).<sup>7</sup> Measuring satisfaction scores at a 2-month interval is a unique measurement in this study, proving that VR's effects extend beyond that of the patient care visit. surgery (10 [10;10] vs. 10 [8.5;10],  $p = 0.06$ ). Patient median intraoperative anxiety score was lower in the VR group, compared to Standard Care group (0 [0; 2] vs. 3 [0.25; 7],  $p < 0.001$ ), and occurrence of intraoperative hemodynamic changes was also lessened in the VR group (2% vs. 16%, OR = 0.11[95% CI 0.002–0.87],  $p = 0.031$ ).<sup>7</sup>

### **Definitions and Outcomes**

From the studies reviewed, outcomes were measured in distinctive ways in order to identify the efficacy of VR implementation. Outcomes measured included numeric pain and anxiety scales, amount of propofol given in milligrams (mg), amount of fentanyl given in micrograms (mcg.), patient satisfaction scores at different time intervals, and stress levels by numerous scale variants. One study, in particular, tracked the satisfaction scores of not only the patient but the surgeon and anesthesiologist as well.<sup>13</sup> This included an essential aspect of the procedure and anesthetic technique that might oftentimes be overlooked and beneficial to note for future studies. In another occurrence, superior objective data that was gathered measured stress levels by a visual analog scale (VAS), cortisol levels, and physiological stress based on heart rate and coherence scores.<sup>8</sup> This was found to be the most conclusive study of them all since it

included physiological and biological evaluation factors and could provide a more in-depth assessment as to the efficacy of virtual reality.

### **Risk of Bias**

The various methods used to measure these outcomes introduce a significant amount of bias into the study. A greater degree of homogeneity could be achieved in order to define the efficacy of VR when implemented, if the outcomes measured would have been more consistent, or the same across all studies. Bias is also introduced when the VR experience is implemented at different points during the patient visit. The various type of procedures included also add to the risk of bias, considering that each procedure presents its own unique nature, which may distort the patient experience in different forms.

**Table 2.** Studies Selection

<b>Author (Year) &amp; Level of Evidence</b>	<b>The research, Participants, Interventions, &amp; Setting</b>	<b>Findings in Groups with Virtual Reality Implementation</b>
Brown et al. (2020) Level I, Quality B <sup>14</sup>	An exploratory randomized control trial took place in an outpatient spine clinic—a sample size of 45. They were randomly divided into three groups of 15. One group was presented with an audiovisual monitor flat screen—a second group with a virtual reality headset. The third group had no control intervention.	Results of a one-way analysis of variance (ANOVA) were significant ( $P = .003$ ) using baseline/interim (pre-injection) anxiety change scores. A Bonferroni analysis revealed the significance was between the control and the audiovisual group ( $P = .002$ ). The variances in the baseline/ interim pain change scores were unequal between groups, violating the assumptions of a one-way ANOVA using these change scores. Results of a one-way between-group ANOVA were non-significant ( $P = .50$ ) using interim and post-anxiety change scores. Variances were equal between groups.
Huang et al. (2020) Level I, Quality A <sup>14</sup>	A single center randomized control trial took place in St. Vincent's Hospital in Melbourne, Australia. The sample size of 50, randomly divided into two groups: 25 receiving virtual reality intervention IVR and 25 receiving patient-controlled sedation.	Propofol use remained similar (22.1 mg/hour (IQR 0, 94.5) in IVR group and 40 mg/ hour (IQR 11.1, 93.9) in control group, $p = 0.37$ ), the total propofol use was smaller, however there were no differences between groups (35 (IQR 0, 165) mg in IVR group and 80 (IQR 25, 180) mg in control group, $p = 0.36$ )

Alaterre et al. (2020) Level II, Quality A <sup>14</sup>	Monocentric observational before and after study took place in a French University Hospital. The sample size of 100, observed 50 subjects before and 50 topics after implementation of intraoperative virtual reality (VR) distraction.	Immediate postoperative satisfaction score was significantly higher in the VR group compared to the Standard Care group (median satisfaction score = 10 [Interquartile 9; 10] vs. 9 [8; 10], $p < 0.001$ , Figure 2) with a significant increase in the proportion of very satisfied patients ( $n = 48$ vs. $n = 32$ , ( $p < 0.001$ ), Odds Ratio = 13.2 [95% CI 2.8–125.1]).
Pandya et al. (2017) Level II Quality B <sup>14</sup>	Retrospective cohort study. A sample size of 14. Patients were allocated randomly by the scheduled date of surgery. Seven patients received standard of care with no implementation, and the other seven received virtual reality implementation at the time of pre-operative adductor canal block (ACC) prior to elective total knee arthroplasty (TKA).	Seven patients received usual care, and seven used VR. In the VR group, 1/7 received intravenous sedation versus 6/7 who received usual care ( $P = 0.029$ ). The fentanyl dose was lower (median [10th–90th percentiles]) in the VR group (0 [0–20] $\mu\text{g}$ ) versus the non-VR group (50 [30–100] $\mu\text{g}$ ; $P = 0.008$ ). Midazolam use was lower in the VR group (0 [0–0] mg) than in the non-VR group (1 [0–1] mg; $P = 0.024$ ). Procedure-related pain was lower in the VR group (1 [1–4] NRS) versus the non-VR group (3 [2–6] NRS; $P = 0.032$ ). There was no difference in other outcomes.
Ganry et al. (2017) Level II, Quality C <sup>14</sup>	Pilot monocentric, prospective, single-blind trial, at the Henri-Mondor teaching Hospital in France outpatient department. Twenty patients were included, 10 received the virtual reality experience, and 10 received the standard of care.	The stress level visual analog scale (VAS) score was significantly reduced after the simulation ( $P < 0.009$ ), as was the level of salivary cortisol ( $P < 0.04$ ). Heart coherence scores remained unchanged ( $P = 0.056$ ).
Moon et al. (2018) Level I, Quality A <sup>14</sup>	Single-blind randomized control clinical trial conducted in Seoul National University Hospital. Thirty-seven patients were randomly selected to a virtual reality group or sedation group.	The distribution of the satisfaction scores of the patients and anesthesiologists were significantly different between the groups ( $p = 0.025$ and $p = 0.001$ , respectively), while the score of the surgeons was not very different. The incidence of extreme satisfaction (satisfaction score 5) for patients and anesthesiologists were significantly higher in the VR group than in the sedation group (patients, $n = 17$ , 94.4% in the VR group vs. $n = 12$ , 63.2% in the sedation group, $p = 0.042$ ).



## DISCUSSION OF LITERATURE REVIEW

### Summary of Evidence

All six studies were individually analyzed and assigned an appropriate level of evidence, according to study design, following the Johns Hopkins appraisal scale. Three readings involved were categorized as level I evidence, experimental studies. Level I evidence was assigned due to the manipulation of an independent variable, presence for a control group, and random assignment of both the intervention and control groups. The other three studies were given level II labels. Two of the studies were done in a retrospective aspect, presenting a unique nature and not allowing randomized allocation of the participants. In the remaining article, participants were assigned according to the anesthesiologist, allowing some degree of investigator control into the experiment, making it a quasi-experimental study.

The results of the review are summarized as follows:

- Five out of the six studies reported an increase in satisfaction scores or a decrease in anxiety and pain level when VR immersion was experienced. <sup>7, 8, 11-13</sup>
- All of the studies reported no adverse effects related to VR including, nausea, vomiting, and patient agitation. <sup>7-9, 11-13</sup>
- Two studies measured the anesthesia providers' satisfaction scores resulting in increased anesthesia provider satisfaction scores in the VR group. <sup>7, 13</sup>
- One study reported no difference in the pattern of propofol used when comparing a control group with the VR immersion group over the course of the procedure.<sup>9</sup>
- All the studies included in the review reported the VR experience to be easily implementable, having excellent acceptability from the medical-surgical team, and not increasing turnover time. <sup>7, 8, 11-13</sup>

- Only one study reported improved intraoperative hemodynamic changes with VR immersion experience.<sup>7</sup>
- None of the studies reported a shortened length of stay in the PACU.<sup>7, 8, 11-13</sup>

### **Limitations of the research**

Several limitations were observed in the review, mainly the fact that virtual reality is still in its infancy, and only a limited amount of superior quality evidence is available. Furthermore, all six of the studies consisted of small sample sizes, making the results inadequately replicable in specific settings. There was very high heterogeneity when comparing outcomes in the studies. The outcomes measured varied from patient satisfaction scores, anxiety levels, pain levels, amount of medication used and provider satisfaction reports. A higher amount of examination must be conducted in order to develop a standard set of criteria by which to measure outcomes. There were several variations in the way the VR immersion experience was implemented; some VR experiences took place before the procedure, and others during the procedure. Although the variance in phases when VR was implemented can allow for supplementary and valued information, it may also have the potential to sway the validity of the results negatively.

A vast discrepancy in the uniformity within each study of sedation and pain medication administered was also observed. Only one study allowed a total contraindication of any form of pre-medication sedation to the control group.<sup>13</sup> It would be important to conduct these analyses when patients receive the same anxiolytic if any at all. The findings included inconsistencies of the patients who disproportionately received fentanyl or midazolam in the perioperative period, which might further skew the differences in pain, anxiety, and satisfaction scores for many of the searches. There was one study in particular that offered invaluable insight into the application of VR; however, it was implemented for patients undergoing chronic back pain injections.<sup>11</sup> The anesthesia provider does not typically engage in these types of procedures; nonetheless, the VR

experience was implemented for periprocedural pain. Its effects can be paralleled to those applicable for neuraxial anesthetic techniques.

Measurements were frequently taken before the procedure, during the procedure, and after, as these would give significant results to produce meaningful data collection. However, there is no information on potential long-term satisfaction scores, only a single study measured patient satisfaction scores at an additional two-month interval.<sup>7</sup> It would be useful to gather this data and see what impact VR may have on the patient beyond their visit, alternatively providing insight regarding their acceptability or apprehension to return for surgical procedures, and select regional anesthesia again.

### **Recommendations for Future Research**

Future trials should have a standard set of exclusion criteria, with special emphasis on psychological factors. This involves excluding patients with chronic pain, history of alcohol or drug abuse, chronic psychosis, claustrophobia, or severe cognitive impairment. These pre-existing conditions can give rise to bias because of their psychological complexity and may impair the uniformity of results. Future RCTs should investigate the uniformity of comparable procedures or regional anesthetic techniques, being that the interventions themselves produce different levels of anxiety and pain. The study performed by Brown et al. highlights the patient population and their chronicity of pain being moderate to high, further stating that these factors can contribute to the complexity of biophysical determinants of pain responses, making the potential impact of the VR intervention more muted.<sup>11</sup> Therefore, it is advised that future studies try and avoid these complex patient populations in order to explore the feasibility of VR implementation to its full effect.

The reporting of satisfaction and anxiety scores provide worthy patient feedback and are great outcomes to be measured; however, more objective forms of measuring outcomes should be present in the studies. Aside from hemodynamic values, one article measured salivary cortisol levels, in addition to heart coherence scores, which proved to be superior and more reliable than

subjective data.<sup>8</sup> In this approach, the results can be more generalizable and easily compared to other trials, in comparison to using several different scales to measure anxiety or pain.

In order to successfully implement VR into the perioperative setting and have valuable results, several specific criteria must be followed. It may be favorable to institute VR in patients with increased risk factors for pre-operative anxiety, such as cancer, smoking, moderate to intensive pre-operative pain, and relatively major surgery.<sup>8</sup> This way, the patients that may garner the most benefit from the modality can be included. According to Ganry et al. VR may be a new way to address the patient's anxiety in the waiting period prior to the surgical procedure.<sup>8</sup> This period of implementation is the most feasible; however, the most beneficial time VR can be implemented is in the awake patient that has already had the regional anesthetic block performed when the surgical procedure is taking place. The majority of the studies concluded that when referring to the "virtual reality" experience, this modality must be immersive in order to provide the reported benefits. The study performed by Brown et al. shows that the outcomes differed when the immersive virtual reality is implemented versus content given in a computer flat screen monitor.<sup>11</sup>

### **CONCLUSION OF LITERATURE REVIEW**

Regional anesthesia has garnered much attention and popularity, but it is widely acknowledged that anxiety is one of the main drawbacks towards patient acceptance. There are many modalities in use to reduce patient anxiety and pain, but they have associated side effects or have proven to be unsuccessful. VR is a pioneering adjuvant that attenuates patient anxiety and pain, allowing for the acceptance of RA for surgery and its well-documented benefits. VR is low-cost, accessible, and non-threatening, warranting its achievable and practical implementation in the perioperative period. Differences in consistent outcome variables do introduce several disadvantages to conclude one concrete benefit. However, they all provide diverse information and distinct angles of implementation to be further explored.

There is sufficient high-level quality evidence on the subject that gives promising guidance to determine benefits. Through these various searches, it is noted that VR has the potential to be an impactful counterpart in the realm of regional anesthesia. Its validity, ease of implementation, and acceptability are essential factors to acknowledge. Overall anxiety and pain levels showed to be decreased, and satisfaction scores were reported to be increased. Virtual reality is still a novel intervention and, as such, needs further scrutinizing with application to undoubtedly validate its efficacy. Overall, the use of virtual reality and its outlook has given promising results, and its future appears optimistic. These preliminary findings give anticipation to successful outcomes and demonstrate the strengths of VR implementation.

## **METHODOLOGY OF QUALITY IMPROVEMENT**

### **Setting**

The setting was a significant public research institution, Florida International University, located in Miami, Florida. The participants were allocated through an alumni database pertaining to the Doctor of Nursing Practice Nurse Anesthesia program. The ages ranged from 26-55, with experience in practice from 1 up to 15 years. All of the participants had previously performed or had been involved in the management of regional anesthetic techniques.

### **Recruitment and Participants**

The target population consists of Certified registered nurse anesthetists (CRNA's) with experience performing regional anesthetic techniques. Participants were identified through the alumni database. The CRNA's were e-mailed an invitation for participation in the project. Only alumni of FIU's Nurse Anesthesia program were eligible to participate in the educational intervention. Other anesthesia providers such as anesthesiologists, residents, and student nurse anesthetists were excluded from participating in the study. All CRNA's that met this inclusion criterion were given the opportunity to take the pre-and post-tests in addition to accessing the informational PowerPoint provided. Five participants in total completed both pre-and post-intervention survey (See Appendix E).

**Intervention**

The project was composed of an educational presentation to educate CRNA's on the benefits of implementing virtual reality into their regional anesthetic practice and the adverse effects untreated anxiety and pain have on the patient care experience. Introduction to this novel intervention is paramount since VR is in its infancy. Early demonstration of its advantages will contribute to a promising outlook in terms of adaptability to the CRNA. The educational session is presented with basic information regarding the topic, amplification of the concern, and current unsuccessful practices regarding present-day practices through a voice over PowerPoint presentation. The module includes simplified recommendations reflecting evidence-based research and guidance regarding who, when, and how VR should be used. Brief recommendations for future research are also explained. The educational module's objective is to present the findings in a simplified format and allow the CRNA a modest and brief introduction of the problem.

**Procedures**

An informational letter was sent to all certified registered nurse anesthetists, former students of the Nurse Anesthesia program at FIU. An anonymous link to the pre-intervention survey was included in the e-mail. The CRNA's completed the pre-test Virtual Reality and Regional Anesthesia Survey on their mobile devices or computers via the Qualtrics survey platform. The pre-test was presented to the CRNA's with no prior knowledge or awareness regarding VR and its use in RA. Then the participants created a unique code identifier for the survey. No personal identifiable data was obtained from this input, besides demographic information. By following the protocol, the privacy of those who volunteered to participate in the project was protected as there was no accessibility of linking the responses to their identity. The post-test was then administered after the presentation was presented.

**Protection of Human Subjects**

By using unique code identifiers, the CRNA's participating in the survey remained anonymous, and the data was secured. The digital data collected from the pre-test and the post-test on Virtual Reality and Regional Anesthesia were protected by laptop passwords and spyware. These protective measures ensured the safety of the data.

**Data Collection**

The data from Qualtrics was used to analyze and compare the responses from the pre and post-test surveys. Data was examined in order to identify if there was a significant change in the knowledge, attitudes, and behaviors of the CRNA's after reviewing the educational module.

**Measurement and Analysis**

The investigator for the project will be the DNP student responsible for obtaining the list of FIU DNP Alumni and distributing the project via an e-mail list provided by the institution. Each question will be measured, and responses recorded to identify the knowledge base before and after the education module. Through statistical analysis, the study results will likely identify patterns that will be used to determine the effectiveness of the educational module and if the module improved the anesthesia providers knowledge.

Before and after surveys of the CRNA's knowledge, attitude, and behavior toward the implementation of virtual reality were analyzed based on a validated survey tool. The assessment consisted of 15 multiple-choice questions. Ten of those fifteen questions were based on knowledge presented in the educational module that the anesthetist was likely not aware of beforehand. The other two were questions regarding the feasibility of virtual reality implementation into their own practice. Data was also collected regarding the demographics of the participants.

## RESULTS OF QUALITY IMPROVEMENT

**Table 3.** Participant demographic data

<b>Demographic</b>	<b>n (%)</b>
<b>Total Participants</b>	5 (100%)
<b>Gender</b>	
Male	3 (60%)
Female	2 (40%)
<b>Age</b>	
20-30	0(0%)
31-40	4(80%)
41-50	1(20%)
50+	2 (40%)
<b>Ethnicity</b>	
Hispanic	3 (60%)
Caucasian	1 (20%)
African American	0 (0%)
Asian	1 (20%)
Other	(0%)
<b>Level of Education</b>	
Master's Degree	2(40%)
Other	3(60%)
<b>Years of Experience</b>	
Less than 1 year	0(0%)
1 to 5 years	3 (60%)
6 to 10 years	1(20%)
More than 10 years	1(20%)

### **Pre-test and Post-test Sample**

There were 5 participants in the pre-test demographics. The majority of the participants were male (n=3, 60%), female (n=2, 40%). There were also a range of ethnicities represented: Caucasian (n=1, 20%), Hispanic (n=3, 60%), and Asian (n=1, 20%). Information was obtained regarding the participant's role at the clinic. It was found that all participants were CRNAs given the criteria of the project. They were questioned about the length of time practicing, identifying that their practice period ranged from: 1 to 5 years (n=3, 60%), 6 to 10 years (n=1, 20%) and more than 10 years (n=1, 20%). The participants consisted of Master level prepared CRNA's (n=2, 40%) and other (n=3, 60%).



### Pre-Test Knowledge

The pre-test contained information regarding prior knowledge of the practitioner regarding virtual reality and its implementation. The majority of participants (n=3, 60%) did not know what the major risk factors for perioperative anxiety were. The survey concluded that all participants (n=5, 100%) were not well informed regarding the primary risk factors for pre-operative anxiety. In the pre-test, the participants (n=4, 80%) reported accurate knowledge regarding the effects of pre-operative anxiety. All of the participants were well informed regarding the different means of measuring anxiety, which include heart rate, salivary cortisol levels and anxiety reporting scales, (n=5, 100%).

The survey further centers on identifying the knowledge practitioners held regarding the virtual reality implementation. Only a few practitioners identified the way virtual reality could be described (n=2, 40%), a form of distraction therapy. Most of the participants identified the contraindications to the implementation of virtual reality, (n=4, 80%). Very few participants were informed regarding the benefits VR could offer in other settings, (n=1, 20%). The majority of the participants identified the best time to measure patient anxiety was after the virtual reality experience had been implemented (n=3, 60%), followed by before the virtual reality experience (n=2, 20%), and in the post anesthesia recovery unit (n=1, 10%). None of the participants (n=0, 0%) selected reduced salivary cortisol levels as an effect of VR implementation.

The willingness to apply VR into personal practice was explored. Out of the five participants only one chose most likely (n=1, 20%), three chose somewhat unlikely (n=3, 60%), and one chose somewhat likely (n=1, 20%). Overall, there was not a strong inclination to implement the VR experience for these practitioners before the educational module was presented.

**Table 4.** Difference in Pre- and Post-Test Knowledge

Knowledge Questions	Pre-test	Post-test	Difference
---------------------	----------	-----------	------------

The primary risk factors for pre-operative anxiety include all of the following, except:	<b>0%</b>	80%	20%
Preoperative anxiety may lead to all of the following, except?	<b>80%</b>	100%	20%
Means of measuring Anxiety include:	<b>100%</b>	100%	0%
Virtual reality can be described as:	<b>40%</b>	100%	60%
Contraindications to virtual reality include:	<b>80%</b>	100%	20%
Virtual reality has shown analgesia and sedation sparring effects in all of the following situations except:	<b>20%</b>	60%	40%
When is the best time to measure the patient's anxiety levels and determine if virtual reality is effective?	<b>0%</b>	100%	100%
Immediately after anxiety provoking procedures, virtual reality has shown to reduce which of the following, except:	<b>0%</b>	100%	100%

### Post-Test Knowledge

The post-test contained content to analyze the practitioner's knowledge acquired after viewing the educational module. All differences were evident of an increase in knowledge, alongside a positive attitude towards adapting virtual reality for Regional Anesthesia into their own practice. The majority of participants (n=3, 60%) did not know what the major risk factors for perioperative anxiety were beforehand, which improved by a large percentage (n=4, 80%). The pre-test showed that a majority of the participants (n=4, 80%) were already knowledgeable regarding the effects of pre-operative anxiety, resulting in a small but effective 20% increase in knowledge in the post-test (n=5, 100%). All of the participants were well informed regarding the different means of measuring anxiety, which include heart rate, salivary cortisol levels and anxiety reporting scales, (n=5, 100%). No change of knowledge was seen in this section.

The survey focuses on identifying the knowledge practitioners held regarding the virtual reality implementation. All of the participants described virtual reality accurately (n=5, 100%). Contraindications to virtual reality included severe cognitive impairment, chronic psychosis, and

claustrophobia. These factors were identified correctly by all of the practitioners (n=5, 100%). The situations where virtual reality could be implemented were identified by the majority, showing a large increase in knowledge (n=4, 80%). Only one participant identified the correct time to measure the patient's anxiety (n=1, 10%), which does not provide any evidence of increased knowledge for this particular area.

### **Perspective of Use in Practice**

There was an overwhelming increase of change in attitude demonstrated after the presentation of the educational module. Most of the participants stated they would most likely implement virtual reality in their facility if available (n=4, 80%), and all of the participants stated they were more likely to prioritize patient anxiety when performing regional anesthetic techniques (n=5, 100%). This positive change in attitude demonstrated immense efficacy in the potential the educational module has to impact the CRNA's everyday practice.

**Table 5.** Implementation of Virtual Reality when using Regional Anesthesia

<b>Knowledge Questions</b>	<b>Pre-test</b>	<b>Post-test</b>	<b>Difference</b>
How likely are you to implement virtual reality if available in your facility?	<b>0%</b>	80%	80%
How likely are you to prioritize anxiety when performing regional anesthesia in the future?	<b>80%</b>	100%	20%

### **Summary**

Overall, the results reflected an improvement in knowledge based on the pre-test and post-test scores. The participants' knowledge resulted in an average increase of 25%. In addition, the post-test demonstrated that participants are most likely (n=4, 80%) to implement virtual reality in their facility, if available. The practitioners also stated that they are all most likely (n=5, 100%) to prioritize patient anxiety when performing regional anesthesia. The most significant advancements were seen in the change of attitude CRNA's held toward the matter and willingness of implementation.

## **DISCUSSION OF QUALITY IMPROVEMENT**

### **Limitations**

Limitations of the study include a limited sample size; the survey was emailed to the FIU alumni directory. There were 62 emails on the list; however, only five people completed the entirety of the pre and post survey. A larger sample size would have been preferred to offer a more comprehensive assessment of change in knowledge alongside differences in attitude. The survey link was e-mailed twice in hopes of reaching a larger audience, however only 1 more complete response of both surveys was obtained. The project was presented through e-mail and entirely online. Perhaps other forms of communication and means of presentation would have obtained a better response from participants.

### **Future Implications for Anesthesia Practice**

As evidenced by the results of the educational module, little is known about virtual reality and its application in practice, especially in regional anesthesia. With proper education and communication efforts, this new modality can become a standard of care and be easily implemented in the clinical setting. Appropriate knowledge of how, when and to who, VR can be used is paramount in order to exhibit its true benefits.

The CRNA has prior knowledge in dealing with anxiety and pain, however new methods can serve as additional instruments in their practice. It is also helpful for re-education efforts to take place regarding the patient experience in new settings and procedures. Moving forward, the CRNA should explore new methods to use throughout the patient experience, even if these modalities are new into their personal practice. VR has demonstrated to be safe, and easy to implement with very little impact on the course of patient care.

## **CONCLUSION**

The literature demonstrated that satisfaction scores increased, and anxiety and pain scores decreased when the VR experience was implemented. None of the studies reported adverse effects related to the VR implementation. As such, virtual reality is a promising technique to

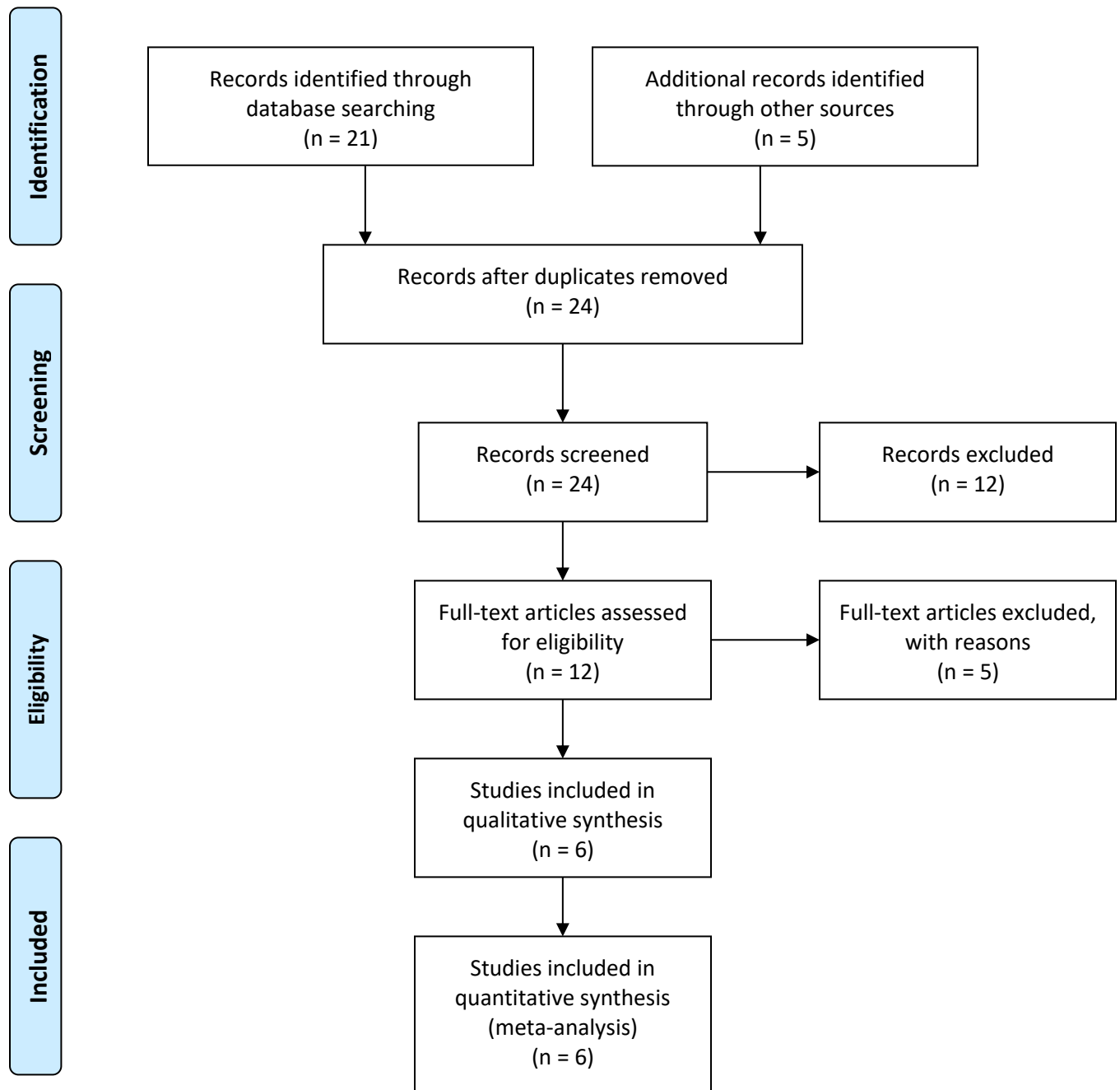
alleviate the prevalence of anxiety, specifically in patients undergoing regional anesthesia. Both techniques provide a new realm of possibilities in the world of regional anesthesia. All of the studies included in the literature review reported the VR experience to be easily implemented and have excellent acceptability from the medical-surgical team. No increase in turn over time or patient care flow was observed.

Anxiety and pain are issues regularly treated with antiquated methods in the perioperative period and not looked into further. Bringing awareness to the problem, which is often times disregarded, can enhance the patient experience, especially when new modalities are implemented, such as regional anesthesia. The educational module provides practitioners with another perspective that aids the patient and can have a constructive impact on their stay. The presentation is a way to highlight the importance of said issues, focusing on the methods in which this intervention is most beneficial, and how to best apply it into practice. Most importantly, the project demonstrates the willingness of the practitioner to employ virtual reality into their training if it were available. The world of anesthesia is ever growing, and one must be open to changes and novelties focused on enhancing the patient experience with the goal of employing said expertise and applying evidence-based care.

## REFERENCES

1. Albrecht E, Chin KJ. Advances in regional anaesthesia and acute pain management: a narrative review. *Anaesthesia*. 01 2020;75 Suppl 1:e101-e110. doi:10.1111/anae.14868
2. Jafar MF, Khan FA. Frequency of preoperative anxiety in Pakistani surgical patients. *Journal of the Pakistan Medical Association*. 2009;59(6):359.
3. Bae I, Lim HM, Hur MH, Lee M. Intra-operative music listening for anxiety, the BIS index, and the vital signs of patients undergoing regional anesthesia. *Complement Ther Med*. Apr 2014;22(2):251-7. doi:10.1016/j.ctim.2014.02.002
4. Bheemanna NK, Channaiah SRD, Gowda PKV, Shanmugham VH, Chanappa NM. Fears and Perceptions Associated with Regional Anesthesia: A Study from a Tertiary Care Hospital in South India. *Anesth Essays Res*. 2017 Apr-Jun 2017;11(2):483-488. doi:10.4103/aer.AER\_51\_17
5. Senses E, Apan A, Kose E, Oz G, Rezaki H. The effects of midazolam and dexmedetomidine infusion on perioperative anxiety in regional anesthesia. *Middle East J Anesthesiol*. 2013;22(1):35-40.
6. Jlala HA, Bedfordth NM, Hardman JG. Anesthesiologists' perception of patients' anxiety under regional anesthesia. *Local and regional anesthesia*. 2010;3:65.
7. Alaterre C, Duceau B, Sung Tsai E, et al. Virtual Reality for PEripheral Regional Anesthesia (VR-PERLA Study). *J Clin Med*. Jan 2020;9(1)doi:10.3390/jcm9010215
8. Ganry L, Hersant B, Sidahmed-Mezi M, Dhonneur G, Meningaud J. Using virtual reality to control preoperative anxiety in ambulatory surgery patients: A pilot study in maxillofacial and plastic surgery. *Journal of stomatology, oral and maxillofacial surgery*. 2018;119(4):257-261.
9. Huang MY, Scharf S, Chan PY. Effects of immersive virtual reality therapy on intravenous patient-controlled sedation during orthopaedic surgery under regional

- anesthesia: A randomized controlled trial. *PLoS One*. 2020;15(2):e0229320.  
doi:10.1371/journal.pone.0229320
10. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med*. Jul 21 2009;6(7):e1000097 doi: 10 1371/journal pmed 1000097 Epub 2009 Jul 21.
  11. Brown L, Chen ET, Binder DS. The use of virtual reality for Peri-procedural pain and anxiety at an outpatient spine clinic injection visit: an exploratory controlled randomized trial. *American Journal of Translational Research*. 2020;12(9):5818.
  12. Pandya PG, Kim TE, Howard SK, et al. Virtual reality distraction decreases routine intravenous sedation and procedure-related pain during preoperative adductor canal catheter insertion: a retrospective study. *Korean J Anesthesiol*. Aug 2017;70(4):439-445.  
doi:10.4097/kjae.2017.70.4.439
  13. Moon JY, Shin J, Chung J, Ji S-H, Ro S, Kim WH. Virtual reality distraction during endoscopic urologic surgery under spinal anesthesia: a randomized controlled trial. *Journal of clinical medicine*. 2019;8(1):2.
  14. Dearholt S, Dang D, Sigma Theta Tau International., Johns Hopkins University. School of Nursing. *Johns Hopkins nursing evidence-based practice : models and guidelines*. 2nd ed. Sigma Theta Tau International; 2012:xxiv, 264 pages.

APPENDIX A: PRISMA FLOW DIAGRAM<sup>10</sup>



APPENDIX B: Matrix Table

Citation and Theme of the article	Design/Method	Sample Setting	Major Variables Studied and Their Definitions	Measurement And Data Analysis	Findings	Results	Conclusions	Appraisal: Worth to Practice/Level
<p>Brown L, Chen ET, Binder DS. The use of virtual reality for Peri-procedural pain and anxiety at an outpatient spine clinic injection visit: an exploratory controlled randomized trial. <i>American Journal of Translational Research</i>. 2020;12(9):5818.</p>	<p>Exploratory randomized control trial. A printed computer-generated randomization table was used ensuring 15 patients in each group. Three groups: 1. group presented with an audiovisual monitor flat screen. 2. group presented with a virtual reality headset. 3. Group with no control intervention.</p>	<p>Sample size was 45, 15 individuals in each group. They were recruited from the medical practice with the inclusion criteria of allowing a spinal injection intervention to be possible and patients meeting the definition of chronic lower back pain. Exclusion criteria included anyone younger than 18, and not being fluent and literate in English.</p>	<p>DV1 = Group presented with an audiovisual monitor flat screen.            DV2 = Group presented with a virtual reality headset.            IV1 = group with no control intervention.</p>	<p>Outcome measures: Numeric pain scale (1-10) and Anxiety thermometer (1-10). Both surveys administered to all groups, pre-injection (two time points) and post-injection (at the conclusion of all standard clinic procedures).</p>	<p>Results of a one-way ANOVA were significant (P = .003) using baseline/interim (pre-injection) anxiety change scores (Figure 3). Variances were equal between the three groups. A Bonferroni analysis revealed the significance was between the control and the audiovisual group (P = .002). The variances in the baseline/interim pain change scores were unequal between groups, violating the assumptions of a one-way ANOVA using these change scores.</p> <p>Results of a one-way between-group ANOVA were non-significant (P = .50) using interim and post-anxiety change scores. Variances were equal between groups.</p>	<p>Viewing a brief relaxation nature video in AV or VR format was not associated with lower pain scores following an injection procedure, but the intervention was associated with lower anxiety scores.</p>	<p>The virtual reality intervention was feasible for integration into the clinical setting, however content should be targeted to the population and given over a longer period of time.</p>	<p>Assignment of group was not blinded to the patient or research staff, can introduce potential for observation bias and/or reporting bias. There might also be subjective difference when reporting of pain and anxiety scales. Missing data is a threat to the study due to a busy clinical environment; data collection points may be missed. No conflict of interest was reported. Level I study – RCT: the study demonstrated reasonably consistent results.</p>

Citation and Theme of the article <sup>⊗</sup>	Design/Methods <sup>⊗</sup>	Sample/Setting <sup>⊗</sup>	Major Variables Studied and Their Definitions <sup>⊗</sup>	Measurement <sup>†</sup> And Data Analysis <sup>⊗</sup>	Finding <sup>⊗</sup>	Results <sup>⊗</sup>	Conclusions <sup>⊗</sup>	Appraisal: <sup>†</sup> Worth to Practice/Level <sup>⊗</sup>
Huang MY, Scharf S, Chan PY. Effects of immersive virtual reality therapy on intravenous patient-controlled sedation during orthopaedic surgery under regional anesthesia: A randomized controlled trial. <i>PLoS One</i> . 2020;15(2):e0229320. doi:10.1371/journal.pone.0229320 <sup>†</sup> <sup>†</sup> <sup>⊗</sup>	Single-center randomized control trial. Enrolled patients were randomized to the virtual reality group or control group by computer-generated randomization in Microsoft Excel. <sup>⊗</sup>	Trial took place at St. Vincent's Hospital in Melbourne, Australia. It included a total of 50 patients undergoing elective total knee and total hip arthroplasty. <sup>⊗</sup>	IV1 = Patient's received <u>patient-controlled analgesia (PCA)</u> only. <sup>†</sup> DV1 = received VR in conjunction with PCA. <sup>⊗</sup>	Primary outcome measured was intra-operative propofol use. <sup>†</sup> Secondary outcomes measured were the pattern of propofol over each hour, amount of adjuvant midazolam <u>used before</u> the case and the overall unmet propofol demand, and post-operative patient satisfaction score. <sup>⊗</sup>	The pilot study trialing the Oculus Rift as an adjunct during joint surgery under regional anesthesia showed that the IVR group used 63 ± 21 mg/hour propofol (mean ± SEM) and the control group used 155 ± 45 mg/hour (mean ± SEM). Standard deviation for the IVR group was 63.09 mg (n=9) and 141.79 mg (n=10) for the control group. <sup>†</sup>  <sup>⊗</sup>	In patients receiving joint replacement surgery with PCS, IVR was well-tolerated but did not decrease the overall sedation requirement. <sup>⊗</sup>	The study does not support the hypothesis that IVR confers a sedation-sparing effect on patients receiving joint replacement surgery under RA, it does however demonstrate that it is feasible to implement IVR without much difficulty in a busy operating room theatre. <sup>⊗</sup>	This is a level I randomized control trial, providing consistent and generalizable results. There are a number of limitations which include the use of midazolam or fentanyl given by the anesthesiologist which concludes difficulty in how it affects the amount of propofol administered. NO definitive conclusion was met <u>in regards to</u> diminish propofol usage, however the study presented good feasibility to realistic implementation of VR technology. <sup>⊗</sup>

Citation and Theme of the article <sup>□</sup>	Design/Method <sup>□</sup>	Sample/Setting <sup>□</sup>	Major Variables Studied and Their Definitions <sup>□</sup>	Measurement and Data Analysis <sup>□</sup>	Findings <sup>□</sup>	Results <sup>□</sup>	Conclusions <sup>□</sup>	Appraisal: Worth to Practice/Level <sup>□</sup>
Alaterre C, Duceau B, Sung Tsai E, et al. Virtual Reality for Peripheral Regional Anesthesia (VR-PERLA Study). <i>J Clin Med</i> . Jan 2020;9(1)doi:10.3390/jcm9010215 <sup>¶</sup> ¶ ¶ ¶ ¶ ¶ ¶ ¶ ¶ ¶ ¶ ¶ □	Monocentric observational before-after study included 100 patients who underwent ambulatory upper limb surgery under peripheral nerve block in January 2019. 50 subjects were observed before, and 50 after implementation of the intraoperative virtual reality (VR) distraction protocol. □	164 patients aged 18 or older received upper limb orthopedic surgery under peripheral regional anesthesia in the center in January 2019, 74 before and 90 after VR implementation. During the second period 58 patients were evaluated, eight were excluded: four patients declined the VR helmet and four patients had contraindications (language barrier or epilepsy). □	IV1=No implementation of intraoperative virtual reality distraction protocol (standard of care). ¶ ¶ DV1=Virtual reality distraction protocol implemented. □	Primary outcome measured was self-rated satisfaction scores evaluated right after surgery. ¶ Secondary outcomes included a 2-month patient reported satisfaction score, perioperative self-rated anxiety and intraoperative hemodynamic changes. □	Compared to former standard care, VR distraction was associated with significantly higher postoperative satisfaction scores, still reported two months after surgery. Patient median intraoperative anxiety score was lower in the VR group, compared to Standard Care group, and occurrence of intraoperative hemodynamic changes was also lessened in the VR group. ¶ □	The present findings suggest that VR distraction program in the operating room could effectively improve patient satisfaction with anxiety reduction and hemodynamic benefits. □	Implementation of a virtual reality distraction protocol in the OR as a peripheral regional anesthesia could effectively improve patient satisfaction and reduce perioperative anxiety, with hemodynamic stabilization effects, without any complication related to the device and with excellent acceptability from the medico-surgical team. □	Level III Evidence level. □

Citation and Theme of the article	Design/Method	Sample/Setting	Major Variables Studied and Their Definitions	Measurement and Data Analysis	Findings	Results	Conclusions	Appraisal: Worth to Practice/Levels
<p>Pandya PG, Kim TE, Howard SK, et al. Virtual reality distraction decreases routine intravenous sedation and procedure-related pain during preoperative adductor canal catheter insertion: a retrospective study. <i>Korean J Anesthesiol.</i> Aug 2017;70(4):439-445. doi:10.4097/kjae.2017.70.4.439</p>	<p>This Retrospective cohort study was performed in patients undergoing preoperative adductor canal catheter's (ACC) placement prior to elective total knee arthroplasty (TKA).</p>	<p>Over the course of one month fourteen sequential patients underwent elective unilateral primary TKA and received a preoperative ACC. Seven patients received usual care without VR, and seven were offered and shoe to try VR.</p>	<p>DV1 = The implementation of a VR headset. <math>\uparrow</math> IV1 = standard of care, no VR implementation. <math>\circ</math></p>	<p>Primary outcome measured was the use of fentanyl. Secondary outcomes are midazolam administration, procedure related pain, procedural time, and blood pressure change scores. <math>\circ</math></p>	<p>The primary outcome fentanyl dose was lower in the group that used VR, versus the non-VR group. Of the seven patients who used VR, only one received intravenous sedation (fentanyl alone), versus six of seven who received usual care. <math>\uparrow</math> <math>\circ</math></p>	<p>The use of VR distraction technique during perioperative ultrasound guided ACC insertion for patients scheduled to undergo TKA nearly eliminated the need for intravenous sedation and reduced procedure related pain without increasing the procedural duration. <math>\circ</math></p>	<p>Virtual reality distraction may provide an effective non-pharmalogical alternative to intravenous sedation for the ultrasound-guided placement of certain perineural catheters. <math>\circ</math></p>	<p>Level II evidence. This study took place in a retrospective manner, but it is an individual case control study. <math>\circ</math></p>

Citation and Theme of the article	Design Method	Sample/Setting	Major Variables Studied and Their Definitions	Measurement And Data Analysis	Findings	Results	Conclusions	Appraisal: Worth to Practice/Levels
Ganry L, Hersant B, Sidahmed-Mezi M, Dhonneur G, Meningaud J. Using virtual reality to control preoperative anxiety in ambulatory surgery patients: A pilot study in maxillofacial and plastic surgery. <i>Journal of stomatology, oral and maxillofacial surgery</i> . 2018;119(4):257-261.	Pilot monocentric, prospective and single-blind study. Performed for surgical cancer procedures at the Henri-Monroe teaching Hospital in France.	The study enrolled 20 patients (10 men and 10 women) with an average age of 56.9 years. Inclusion criteria were anticipated high stress level during the surgical procedure as assessed by the French version of the Amsterdam preoperative anxiety information scale (APAIS) >11. Exclusion criteria were pregnancy, breastfeeding, impaired cognitive function and age <18 years old.	DV1= Virtual reality experience. IV1= Standard of care.	Their stress levels were assessed before and after this experience by making user of a visual analog scale (VAS), by measuring salivary cortisol levels and by determining physiological stress based on heart and coherence scores.	<i>VAS scores decreased by 0 to 2 points (out of 10) after VR immersion. The average of all scores decreased from 3.3 before the VR test to 2.85 after the VR test, a significant difference (P&lt;0.009). Biological test (salivary cortisol): the average salivary cortisol concentrations dropped from 14.55 before the VR test to 12.86 after the VR test, a significant difference (P&lt;0.005). Physiological test (heart coherence): the average of all scores went from 50.6 before the VR test to 46.9 after the VR test. The difference between these 2 averages was not significant (P=0.056).</i>	VR system seems to reduce preoperative anxiety, particularly with respect to the physiological and biological evaluation factors.	Virtual reality allows patients to be immersed in a relaxing, peaceful environment. It represents a non-invasive way to reduce preoperative stress levels with no side effects and no need for additional medical or paramedical staff. Results indicate that VR may provide an effective complementary technique to manage stress in surgery patients.	Level II the main weakness of this study was that no independent variable was present, just an implementation group.

Citation and Theme of the article	Design/Method	Sample/Setting	Major Variables Studied and Their Definitions	Measurement And-Data Analysis	Findings	Results	Conclusions	Appraisal: Worth-to-Practice/Level
<p>Moon JY, Shin J, Chung J, Ji S-H, Ro S, Kim WH. Virtual reality distraction during endoscopic urologic surgery under spinal anesthesia: a randomized controlled trial. <i>Journal of clinical medicine</i>. 2019;8(1):2.</p>	<p>Single-blind, randomized controlled clinical trial. Virtual reality distraction was compared with pharmacologic sedation using repeat doses of midazolam 1-2mg every 30minutes during urologic surgery under spinal anesthesia.</p>	<p>The study was conducted in Seoul National University Hospital. 37 patients were randomized to a VR group, or a sedation group.</p>	<p>IV1 = Sedation group. DV1 = virtual reality group.</p>	<p>Primary outcome measured – patient reported satisfaction score by a 5-point verbal rating scale. Secondary outcomes – The surgeon and the anesthesiologist's satisfaction score.</p>	<p>The distribution of the satisfaction scores of the patients and anesthesiologists were significantly different between the groups (<math>p=0.025</math> and <math>p=0.001</math>, respectively), while the score of the surgeons was not significantly different. The incidence of extreme satisfaction (satisfaction score 5) for patients and anesthesiologists was significantly higher in the VR group than in the sedation group (patients, <math>n=17</math>, 94.4% in the VR group vs. <math>n=12</math>, 63.2% in the sedation group, <math>p=0.042</math>).</p>	<p>The likelihood of both patients and anesthesiologists being extremely satisfied was significantly higher in the VR group than the sedation group. The surgeon's satisfaction scores remained unchanged.</p>	<p>The present findings suggest that VR distraction is better than drug sedation with midazolam in terms of patients and anesthesiologist's satisfaction and avoiding the respiratory side effects of midazolam during endoscopic urologic surgery under spinal anesthesia. The study may have value as the first trial to investigate the effect of a specific VR program as a single modality to replace drug sedation during spinal anesthesia.</p>	<p>This is a level I study. Selection of participants into groups was random, which adds validity and strength to the investigation. Several limitations are present, the primary outcome measured was the patient reported satisfaction score and the sample size was calculated based on the difference in this score. Other secondary variables were not considered when calculating the sample size, therefore the study may have lacked statistical power for the secondary outcomes. Overall, it addresses an important nature of the operating room, not only assessing satisfaction the patient, but in the surgeon and anesthesiologist as well.</p>

## APPENDIX C: IRB Exemption Letter



Nicole Wertheim College of Nursing and Health Sciences  
Department of Nurse Anesthetist Practice

### **The Use of Virtual reality in Patients Undergoing Regional Anesthesia and its Impact on Patient Satisfaction, Anxiety and Pain level: An Evidence-based Education Module**

Dear FIU Nurse Anesthesia Alumni:

My name is Iris Molina, 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. This project aims to improve health care provider knowledge on the implementation of virtual reality to decrease anxiety and pain in patients undergoing regional anesthetic procedures. You are eligible to participate in this project because you are an alumni of Florida International University Nurse Anesthesia program.

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 a 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 entirely voluntary. You can choose to be in the study or politely decline. If you'd like to participate or have any questions about the survey, please email or contact me at [imoli007@fiu.edu](mailto:imoli007@fiu.edu) or (305)587-0118.

Your consideration is much appreciated.

Sincerely,

Iris Molina SRNA, BSN, CCRN

## APPENDIX D: QI Project Consent



### Pretest and Posttest Questionnaire:

#### The Use of Virtual reality in Patients Undergoing Regional Anesthesia and its Impact on Patient Satisfaction, Anxiety and Pain level: An Evidence-based Education Module

#### INTRODUCTION

The primary aim of this education module is to increase the CRNA's awareness regarding the benefits of virtual reality on patient satisfaction, anxiety, and pain. Please answer the questions below to the best of your ability. The questions are multiple choice and are meant to measure knowledge and perceptions regarding the VR immersion experience.

#### PERSONAL INFORMATION

1. **Gender:** Male    Female    Other \_\_\_\_\_
2. **Age:** \_\_\_\_\_
3. **Ethnicity:**  
                   Hispanic    Caucasian    African American    Asian    Other \_\_\_\_\_
4. **Level of Education:** Associates    Bachelors    Masters    Other \_\_\_\_\_
5. How many years have you been an anesthesia provide?  
                   Over 10      5-10 years      2-5 years      1-2 years



**APPENDIX E: QI Project Survey****QUESTIONNAIRE**

**1. The primary risk factors for pre-operative anxiety include all of the following,**

**except:**

- a. Cancer
- b. Smoking
- c. Psychiatric disorders**
- d. Diabetes

**2. Preoperative anxiety may lead to all of the following except?**

- a. Medical and surgical complications
- b. Behavioral problems
- c. Increased sense of awareness**
- d. Emotional distress

**3. Means of measuring anxiety include**

- a. Heart rate
- b. Salivary cortisol levels
- c. Anxiety reporting scales
- d. All the above**

**4. Virtual reality can be described as:**

- a. An out of body experience
- b. An experience to attenuate the patient's senses
- c. A form of distraction therapy**
- d. A technique to sleep better

**5. Contraindications to virtual reality include:**

- a. Severe cognitive impairment
  - b. Chronic psychosis
  - c. Claustrophobia
  - d. All of the above**
- 6. Virtual reality has shown analgesia and sedation sparing effects in all of the following situations except:**
- a. Psychotic episodes**
  - b. Physical therapy
  - c. Wound care
  - d. Anxiety provoking procedures
- 7. When is the best time to measure the patient's anxiety levels, and determine if virtual reality is effective?**
- a. During the virtual reality experience**
  - b. Before the virtual reality experience
  - c. After the virtual reality experience has been finished
  - d. In the post anesthesia recovery unit
- 8. Immediately after anxiety provoking procedures, virtual reality has shown to reduce which of the following, except**
- a. Anxiety levels
  - b. Salivary cortisol levels
  - c. Patient satisfaction**
  - d. Heart coherence scores
- 9. How likely are you to implement virtual reality if available in your facility?**

- a. Most likely
- b. Somewhat likely
- c. Somewhat unlikely
- d. Most unlikely

**10. How likely are you to prioritize patient anxiety when performing regional anesthesia in the future?**

- a. Most likely
- b. Somewhat likely
- c. Somewhat unlikely
- d. Most unlikely

## APPENDIX F: Educational Module

His Molina  
Florida International University

### Virtual reality in Patients Undergoing Regional Anesthesia and its Impact on Patient Satisfaction, Anxiety and Pain level: An Evidence-based Education Module

1

★

### Learning Goals

After this presentation you will be able to

- Identify patients at high risk of experiencing anxiety during regional anesthesia.
- Identify who might and might not benefit from virtual reality.
- Identify when is the best time for implementation of virtual reality.
- Better assess patient anxiety.
- Identify the benefits of virtual reality implementation.

2

★

### The Problem

- Perioperative anxiety is as high as 60-80% in the western population.
- Only one third of anesthesia providers feel that anxiety is common among patients having regional anesthesia, and only a 23% acknowledge it is a concern.
- Regional anesthesia is unique in its effects on patient anxiety.

3

★

### Education of the problem

Uncontrolled anxiety can lead to increased postoperative complications.

- Autonomic nervous system hyperactivity: hypertension, arrhythmia, and palpitations.
- Nausea, vomiting, heightened pain response, elevated blood glucose levels, bronchospasm.
- Medical and surgical complications.
- Behavioral problems.
- Emotional distress.

4

★

### Current methods to reduce anxiety and pain

- Music therapy
- Therapeutic communication
- Proper perioperative patient education
- Medications (opioids, sedatives, hypnotics.)

5

★

### What is virtual reality?

- A form of distraction therapy.
- Consists of a headset with an internal or external display, motion sensors, and audio.
- Previously shown analgesic and anxiolytic effects in physical therapy, dental care and other anxiety provoking procedures.
- Used as an educational tool in the perioperative setting.
- Presents the patient with a sense of illusion believed to distract and reduce anxiety, even effectively compared to other pharmacologic and non-pharmacologic interventions.

6

★

### Who is a good candidate, and who is not?

- Primary risk factors for preoperative anxiety include patients with a history of chronic anxiety and diabetes.
- Some contraindications for VR implementation include severe cognitive impairment, claustrophobia, psychosis, claustrophobia.
- Any patient undergoing a regional anesthesia procedure, including neuraxial anesthesia and local anesthesia.
- Virtual reality is contraindicated or impractical when applied to sedated or unconscious patients undergoing general anesthesia.

7

★

### When to implement virtual reality?

Best time to assess the intervention and determine patient anxiety and pain level is during the virtual reality experience.

8

★

### Best way to measure outcomes

- Self reported anxiety and pain scores at different time intervals
- Self reported patient satisfaction levels
- Self reported stress levels
- Amount of medication given in group comparisons (midazolam, propofol, fentanyl, precidex)
- Heart coherence scores
- Salivary cortisol levels

9

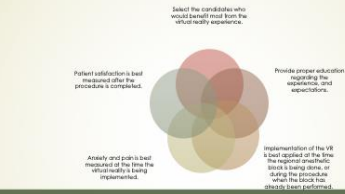
★

## Summary of the evidence

- Evidence suggests a substantial increase in patient satisfaction scores, significant reduction in patient anxiety scores and a decrease in stress and salivary cortisol levels.
- Decreased patient pain was evidenced, although not substantial.
- Insufficient evidence to prove virtual reality lessens hemodynamic changes.
- No adverse effects including nausea, vomiting, or patient agitation.
- No effect on turn over time or on length of PACU stay.



10



## Recommendations for practice

11



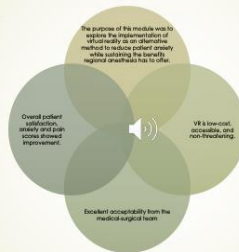
## Recommendations for future research



12



## Summary



13



## Summary

- Virtual reality is a novel intervention and still needs a significant amount of research.
- Differences in consistent outcome variables do introduce several disadvantages to conclude one concrete benefit.
- However, they all provide a different and interesting angle of implementation. There is sufficient high-level quality evidence on the matter giving promising guidance to conclude its benefits.

14



## References

1. Jahn M, Wirth H. Frequency of operative anxiety in children. *Journal of Pediatric Anesthesia*. 2004;19(3):201.
2. Berman M, Glickman M, et al. The use of virtual reality for preoperative anxiety and pain management in children. *Journal of Pediatric Anesthesia*. 2010;25(1):1-6.
3. Berman M, Glickman M, et al. The use of virtual reality for preoperative anxiety and pain management in children. *Journal of Pediatric Anesthesia*. 2010;25(1):1-6.
4. Berman M, Glickman M, et al. The use of virtual reality for preoperative anxiety and pain management in children. *Journal of Pediatric Anesthesia*. 2010;25(1):1-6.
5. Berman M, Glickman M, et al. The use of virtual reality for preoperative anxiety and pain management in children. *Journal of Pediatric Anesthesia*. 2010;25(1):1-6.
6. Berman M, Glickman M, et al. The use of virtual reality for preoperative anxiety and pain management in children. *Journal of Pediatric Anesthesia*. 2010;25(1):1-6.
7. Berman M, Glickman M, et al. The use of virtual reality for preoperative anxiety and pain management in children. *Journal of Pediatric Anesthesia*. 2010;25(1):1-6.
8. Berman M, Glickman M, et al. The use of virtual reality for preoperative anxiety and pain management in children. *Journal of Pediatric Anesthesia*. 2010;25(1):1-6.
9. Berman M, Glickman M, et al. The use of virtual reality for preoperative anxiety and pain management in children. *Journal of Pediatric Anesthesia*. 2010;25(1):1-6.
10. Berman M, Glickman M, et al. The use of virtual reality for preoperative anxiety and pain management in children. *Journal of Pediatric Anesthesia*. 2010;25(1):1-6.

15