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Implementation of Provider Education for a Subanesthetic Ketamine Infusion for Acute Analgesia in Opioid Tolerant Postpartum Patients

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Literature Review

Introduction

Opioid over-prescribing, diversion, misuse, addiction, overdose, and death are escalating global health problems. Opioid use and opioid tolerance, terms previously used to describe impaired control, social impairment and risky use, as well as pharmacologic criteria, including the presence of withdrawal symptoms, have been replaced with the umbrella term, Opioid Use Disorder [OUD] (Drugs and Lactation Database, 2019). The American Psychiatric Association (2013) defined OUD as the recurrent use of opioids that causes significant clinical and functional impairment. The United Nations Office of Drug and Crime (UNODC) reported 15 million people suffering from OUD globally in 2014.

The United States of America represents only four percent of the world's population yet consumes over 80 percent of the world's prescription opioids (Brady, McCauley & Back, 2016). Ninety percent of American female opioid users are of childbearing age (Ludlow, Christmas, Paech & Orr, 2007). A recent dramatic increase in opioid misuse during pregnancy has paralleled the epidemic observed in the general population (ACOG, 2017). Patrick and colleagues (2015) designed a retrospective, longitudinal cohort study of greater than 100,000 deliveries in Tennessee, utilizing hospital discharge codes from 2000-2009 to reveal a four-fold increase in antepartum maternal opioid use which directly correlated with a three-fold increase in the incidence of Neonatal Abstinence Syndrome (NAS), more commonly known as newborn withdrawal. The incidence of NAS and overdose deaths among women have also dramatically increased and are highest in states with the highest rates of opioid prescribing (CDC, 2017 & Patrick et al., 2015).

Cesarean section is the most frequently performed inpatient surgical procedure in the U.S., at over one million per year (Jaafarpour, Vasigh, Khajavikhan & Khani, 2017). Opioids are the traditional therapies for pain management after cesarean section (Hamilton, Martin, Osterman, Curtin & Matthews, 2015). Bateman and colleagues (2017) conducted telephone surveys of post-cesarean patients at six United States academic medical centers from September 2014 to March 2016. Bateman et al. enrolled seven hundred twenty patients were enrolled, just over 85 percent (n=615) of the enrolled patients filled opioid prescriptions. Bateman et al. reported the range of opioid tablets dispensed was 30-40, the range of opioid tablet consumption was 8-30, leaving 3-26 unused opioid tablets. Osmundson and colleagues (2017) conducted a prospective observational cohort study to examine post discharge opioid use after cesarean delivery. Bateman et al. and Osmundson et al. both revealed a significant margin between quantity of opioid tablets prescribed versus actual number needed for pain control. It is also important to note Bateman et al. ancillary survey findings demonstrated no correlation between patient satisfaction or pain control and the number of tablets prescribed.

The National Institute on Drug Abuse [NIDA] (2011) reported many individuals misusing prescription opioids for non-medicinal use and purposes other than intended, have obtained these medications from family or friends. Bateman and colleagues (2017) telephone survey revealed 95.3 percent of the patients enrolled with excess opioids did not discard any leftover tablets. Osmundson et al. (2017) prospective study revealed 75 percent of patients enrolled had leftover opioid tablets and 63 percent of the unused opioids were stored in an unlocked location.

Inappropriate opioid use leads to a myriad of issues for both patient and providers. Exogenous opioid consumption decreases endogenous opioid production, requiring long-term

use of exogenous opioids (Sen et al., 2016). Previous exposure to opioids can lead to a state of sensitization termed opioid-induced hyperalgesia (OIH) causing a paradoxical response whereby the patient becomes more sensitive to painful stimuli (Chu, Martin and Clark, 2008). Carvalho and Butwick (2017), Landau (2013), and Sen et al. (2016), all report hyperalgesia and central sensitization can occur with opioid dependence, or exposure to a single opioid. The allowance of suffering in pain from the undermedication of analgesics is a breach of basic human rights in the United States (Mitra and Sinatra, 2004). Acute pain left untreated results in chronic pain; Sen and colleagues (2016) reported around 100 million Americans were affected by chronic pain in 2010. These patients may develop adverse emotional, cognitive and behavioral responses negatively affecting their quality of life (Mitra and Sinatra, 2004). Ketamine can block this exaggerated response by antagonizing the NMDA-dependent pro-nociceptive systems (Landau et al., 2013).

Aim

The aim of this literature review was twofold. First, to review the medical literature regarding ketamine and the ability to provide analgesia at a low rate of infusion to opioid tolerant postpartum patients. Secondly, to identify ketamine's safety margin for lactation. The key research questions were as follows:

1. What is known about sub-anesthetic ketamine infusion dosing and analgesia?

2. What is known about the maternal transfer of ketamine via breastmilk to the neonate?

Search Strategy

A literature search was conducted in August of 2018 using Ovid (MEDLINE), Pubmed, and Cumulative Index of Nursing and Allied Health Literature (CINAHL) to 1) identify current

research on the use of sub-anesthetic ketamine infusion for perioperative analgesia with opioid tolerant patients; 2) identify ketamine's safety profile during lactation and breastfeeding. Inclusion criteria included: systematic reviews, randomized controlled trials (RCTs), and studies published in English between 2005 and 2018. Exclusion criteria included: animal or laboratory studies in addition to any studies published in a language other than English. The following search terms were utilized in various combinations and orders: ketamine, analgesia, opioid, tolerant, postpartum, pain, peri-operative, sub-anesthetic and low-dose.

Results

Ketamine and Analgesia

The evidence supports subanesthetic intravenous ketamine dosing and or infusions for the reduction in total perioperative opioid consumption, delayed time to request of analgesic request, decrease in pain scores with a wide safety margin and little to no negative side effects. Heesen and colleagues (2015) examined the administration of intravenous ketamine during cesarean section with spinal anesthesia or general anesthesia. Heesen et al. systematically reviewed twelve randomized controlled trials between 1997 and 2013 identified a prolonged time to first request of postoperative opioid in addition to the total perioperative dose of opioids for the spinal anesthesia trials only. Heesen et al. reported another outcome measurement in seven of the 12 trials were neonatal outcomes, more specifically Apgar scores and umbilical pH, which was not affected by maternal administration of intravenous ketamine as adjuncts to both spinal and general anesthetics.

A Cochrane review of forty randomized controlled trials revealed a statistically significant reduction in the development of chronic pain after surgery with ketamine (Chaparro,

Smith, Moore, Wiffen, and Gilron, 2017). Chaparro, et al. identified 40 randomized controlled trials of various systemic medications administered to decrease the incidence of chronic pain after surgical incision. Fourteen of the 40 pharmacological interventions included intravenous ketamine; the others included intravenous steroids, oral gabapentin, oral pregabalin, non-steroidal anti-inflammatories, intravenous fentanyl along with others. A meta-analysis by Chaparro et al. demonstrated a modest, yet statistically significant reduction in the development of chronic pain after surgery with ketamine, not gabapentin or pregabalin.

Laskowski, Stirling, McKay and Lim (2011) systematically reviewed randomized controlled trials involving ketamine administered during the perioperative period as part of a multi-modal management system included 70 studies with over 4,700 patients included in the trials. Laskowski, Stirling, McKay and Lim limited their search by the exclusion of ketamine administration without the use of regional anesthesia. Laskowski, Stirling, McKay and Lim found ketamine to have an overall opioid sparing effect as well as a delay in time to first request of rescue analgesic postoperatively; this was profound for thoracic, abdominal and orthopedic procedures.

Jouguelet-Lacoste, La Colla Schilling and Chelly, (2015) evaluated the use of low-dose ketamine single bolus or infusion for postoperative analgesia in their systematic review and meta-analysis. Five meta-analysis and 39 clinical trials included focused on subanesthetic ketamine administration (Jouguelet-Lacoste, La Colla Schilling and Chelly). Jouguelet-Lacoste, La Colla Schilling and Chelly reported the majority of the studies revealed a reduction in total opioid consumption, pain scores, and time to first request of rescue analgesic postoperatively; Eleven trials demonstrated no difference in side effects between the ketamine and placebo groups. An exceptional finding by Jouguelet-Lacoste, La Colla Schilling and Chelly regarded

ketamine's safety margin: four out of the five meta-analyses reported ketamine as safe without any increase in untoward effects. The fifth meta-analysis reported psychomimetic effects which were short-lived with the adjuvant of a benzodiazepine; none of these side effects were reported as negative (Jouguelet-Lacoste, La Colla Schilling and Chelly).

Ketamine and Lactation

Careful consideration should be given to newborn exposure of maternal medications through breastmilk. Almost all maternal medication transfer into breastmilk in varying amounts (Hale, 2019). Hale reports the total concentration transferred is usually very low. Thomas Hale, author of Hale's Medications & Mothers' Milk (2019) wrote, "Only on rare occasion will the amount of medication transferred into breastmilk be significant enough to produce relevant doses in the infant."

Medication transfer into breastmilk involves passive diffusion from maternal plasma through capillaries into lactocytes lining the alveolus (Hale, 2019). In the first seventy-two hours postpartum, large gaps between the alveolar cells allow maternal medications and other proteins and particles to bypass both bilayer lipid alveolar cellular membranes, permitting greater access of medications into breastmilk (Hale). Hale details maternal medications have greater access to breastmilk during the immediate postpartum time period, also referred to as the colostrum phase. The absolute dose transferred into the breastmilk is still low for the total volume of milk is generally less that 30-100mL/day during the colostral phase (Hale). The production of maternal hormone prolactin increases by the end of the first postpartum week causing alveolar cells to swell, closing intracellular gaps, thereby reducing excessive transcellular entry into breastmilk (Hale). Hale describes after the intracellular gaps are closed, passage of medication into

breastmilk is determined by a multitude of factors including bioavailability, molecular weight, maternal serum levels, protein binding, lipophilicity.

The American Society of Anesthesiologists (ASA) and the American Society of Regional Anesthesia and Pain Medicine (ASRA) dosing guidelines for sub-anesthetic intravenous ketamine infusions are significantly lower at no greater than 1mg/kg/hr (Schwenk, et al., 2018). Concerns regarding the amount of ketamine transfer into breastmilk need attention. The adult half-life of ketamine is considered short at 2.5 hours with a rapid redistribution half-life out of the plasma at 10-15 minutes lending theory to low levels of ketamine in mother's milk (Hale, 2019). Adult dosing of ketamine for induction of general anesthesia ranges from 1-2mg/kg (NLM, 2015; Ketamine, 2018; NIH, 2018). Maternal peak plasma concentrations of ketamine have been well established by original researchers Little et al., 1972, Idvall et al., 1979, and Grant et al, 1983. Their foundational ketamine research revealed peak concentrations of approximately 1200-2400ng/ml would be required to achieve dissociative anesthesia. Maternal plasma levels are a strong determinant of breastmilk drug penetration (Hale, 2019). Clements and Nimmo (1981), Grant et al. (1981), Clements et al. (1981) and more recently Flood and Krasowski (2000) found sub-anesthetic intravenous infusions of ketamine able to produce analgesic effects at plasma concentrations significantly lower between 70 and 160ng/ml.

Oral bioavailability is the amount of medication absorbed into the blood after oral intake and considered a good predictor of the infant's ability to absorb sufficient drug to produce clinically significant plasma levels (Hale, 2019). Due to extensive first pass metabolism ketamine's oral bioavailability is very low, from 16-30 percent, translating to a maximum of 30 percent of the total dose found in the infant's plasma (Chong et al., 2019; Clements et al., 1982;

Grant et al., 1981; Hale, 2019; Karch and Drummer, 2015; Rolan et al., 2014; Sekerci et al., 1996).

The World Health Organization has classified ketamine as compatible with breastfeeding; however, because of the lack of information, caution is advised for the use of ketamine in lactating women (Drugs and Lactation Database, 2019). Breastmilk levels of ketamine have not been measured after administration to humans. Minimal data indicated that ketamine use in nursing mothers may not affect the breastfed infant or lactation. Until more data are available, the Drugs and Lactation Database recommends ketamine be used with careful monitoring during breastfeeding.

The American Academy of Pediatrics [AAP] (2013), The Academy of Breastfeeding Medicine [ABM] (2015), American College of Obstetricians and Gynecologists [ACOG] (2012), the Association of Women's Health, Obstetric and Neonatal Nurses [AWHONN] (2016), and the Centers for Disease Control and Prevention [CDC] (2015) all discourage breastfeeding for women continuing to use illicit substances. The AAP, ABM, ACOG, AWHONN and CDC also discourage providing infants pumped breastmilk from women continuing to use illicit substances. The AAP, ABM, ACOG, AWHONN and CDC recommend only women abstaining from illicit drug use, who are stably enrolled in a substance abuse treatment program with Methadone or Buprenorphine are encouraged to breastfeed their infants. If relapse occurs breastmilk should be pumped and discarded, until the substance is believed to have been eliminated from the breastmilk (AAP; ABM; ACOG; AWHONN; CDC).

In the local setting, there are postpartum mothers who wish to leave the Family Birth Center to use tobacco products. The OUD patient receiving a ketamine infusion is not allowed to

leave the unit with intravenous access per host facility policy. A transdermal nicotine patch will be offered to avoid withdrawal until the ketamine infusion has been discontinued. The American Academy of Pediatrics Committee on Drugs (2013) states transdermal nicotine patch concentrations of 21mg, 14mg or 7mg may be selected based upon the average amount of cigarettes smoked by the mother during the pregnancy. Breastfeeding is not recommended for the majority of OUD mothers, unless compliant medication assisted therapies are in place (AAP, 2013; ABM, 2015; ACOG, 2012; AWHONN, 2016; CDC, 2015). Use of nicotine replacement therapies during lactation produces a milk-to-plasma ratio less than that of secondhand smoke (The American Academy of Pediatrics Committee on Drugs, 2013).

Conclusion

Interventions are needed to truncate the opioid epidemic and better align the number of opioids dispensed with those consumed; until this epidemic is curtailed, protocols need developed to better manage acute pain in the post-partum, post-operative opioid use disorder patient. The evidence supports ketamine as an ideal, non-opioid medication with the ability to inhibit nociceptive pathways while maintaining cardiovascular and respiratory stability. The evidence supports subanesthetic ketamine infusions as an ideal, non-opioid, potent analgesic medication with little to no negative side effects. Low-dose ketamine in conjunction with a multi-modal approach, reduced overall perioperative opioids and pain scores for up to six weeks while maintaining cardiovascular and respiratory stability. Ketamine has been reported to possess anti-inflammatory, neuroprotective, tumor reducing and antidepressant qualities. Evidence of these effects are outside of the scope of this paper.

Acute pain left untreated may lead to chronic pain. Chronic pain is difficult to treat with existing therapies such as opioids. Opioids may increase sensitivities to pain and cause other

negative side effects requiring an increased length of stay and further driving up health care costs. Ketamine infusions have traditionally been reserved for use in the operating room by anesthesia providers and intensive care units under increased monitoring. Subanesthetic dosing is gaining attention for analgesia and reversal/prevention of hyperalgesia and allodynia in the opioid tolerant patient on standard hospital units. Appropriate dosing guidelines, staff training, and patient education must be instituted for the successful implementation any new protocol.

Conceptual Framework

The Revised Standards for Quality Improvement Reporting Excellence SQUIRE (2.0) guidelines was used to guide this project (Ogrinc, Davies, Goodman, Batalden, Davidoff, & Stevens, 2017). The SQUIRE guidelines provide a common format for multi-disciplinary healthcare providers to report quality improvement projects and research. Prior to the development of the SQUIRE guidelines, reporting of quality improvement projects varied widely in both content and quality (Ogrinc et al., 2017). A standardized 19-item checklist is used to ensure all appropriate content has been reported. Use of the SQUIRE guidelines has resulted in expediting quality improvement projects to publication which allows for broad-based practice changes.

Project Methods

Project Design

This project is a non-experimental design for anesthesia providers, Obstetrician Gynecologists, and Registered Nurses working on labor and delivery, post-partum, and nursery units in a single hospital. The project design included assessment of participants knowledge via questionnaire answers before and after implementation of an educational computer-based

learning module. The answers were analyzed comparatively for evaluation of the modules effect on staff knowledge of ketamine and its application of pain management for the opiate-tolerant postpartum patient. The evaluation tool utilized to assess staff knowledge before and after the educational module was a 12-question pre-education survey and a 16-question post-education test. The additional questions added regarded likelihood or barriers for future ketamine use in addition to quality improvement questions. The test format utilized both multiple choice and Likert scale answer options. Questions 1-12 on both pre-survey and posttest were the same, which allowed for accurate comparison.

The educational module was designed using appraised evidence on the use of perioperative ketamine and its analgesic applications for the opioid tolerant post-partum patient. The module began with a pre-survey of participant knowledge, followed by an educational power point presentation accompanied by a voiceover lecture. Upon completion of viewing the power point slideshow, the participant was prompted to complete a posttest prior to closing the module. The project pre-survey and posttest were disseminated to participants work email utilizing Microsoft PowerPoint and Microsoft Forms. Microsoft Forms is a software application which allows the author to create surveys, quizzes, and polls in order to collect feedback in real-time. The primary investigator allowed participant access to pretest and posttest for a period of 45 days.

Staff nurses received educational credit for their participation. Participants were required to use their personal login and password to access and complete the mandatory module, however, individual anonymity was maintained with Microsoft Forms presurvey and posttest. The principle investigator was knowledgeable of participants staff role, main work area within the

hospital, and the number of professional years served in that role from demographical survey answers.

Sample

A convenience sample was obtained from a tertiary care center in a suburban area in the midwestern United States. Participants included in the study included Nurse Anesthetists, Anesthesiologists, Obstetrician Gynecologists, and Registered Nurses employed in the perioperative, labor and delivery, postpartum and nursery areas of the pilot hospital. The sample size was approximately 175 participants. All participants had survey access via email on a list server created specifically for this project's educational module. The educational module became part of annual continuing education for all employees who provide patient care.

Stakeholders

The primary stakeholders for this project were the Obstetrical Staff Nurses, Certified Registered Nurse Anesthetists, Anesthesiologists, and Obstetrician Gynecologists who participated in the educational program at the midwestern tertiary care center. These health care professionals are at the front lines of patient care. The opiate tolerant postpartum patients whom received ketamine infusions for pain management were also included as primary stakeholders. These patients have great potential for improved patient satisfaction, decreased pain scores, and a lower risk for developing chronic pain as a result of poorly managed acute pain.

Stakeholders for the project included the project committee composed of two faculty from Southern Illinois University at Edwardsville, the Director of Obstetrical Hospitalist, the Clinical Director of Obstetrical Anesthesia, and the Clinical Manager of the Family Birth Center for the tertiary care center in midwestern United States. Additional stakeholders included

inpatient medical providers, CRNAs, and registered nurses working with pre-, peri-, and postpartum patients and neonates.

External stakeholders and mentors involved in the development of this mandatory educational program included an Anesthesiologist, an Associate Professor at Southern Illinois University at Edwardsville as well as a member of the Nurse Anesthesia Faculty from Southern Illinois University at Edwardsville. Potential exists for this health care system to implement this educational module and pain management protocol at all facilities, making the health system stakeholders as well. The facility chosen for this study is a part of a health system covering four states, comprised of 45 acute care and specialty hospitals.

Income and Expenses

Facility expenses included the cost of a vial of Ketamine and bag of 250 milliliters of Normal Saline. Ketamine has been off patent for decades and is considered an inexpensive drug. Ketamine is a formulary drug, currently administered at the providers' discretion. Current ketamine and normal saline costs have been negotiated by the pharmacy at the host facility and nondisclosure has been requested. The infusion pumps are currently in hospital inventory. Special port-free tubing was required for safe administration and prevention of ketamine abuse. The cost of the port free tubing was also negotiated with appropriate suppliers by the pilot hospital; again, nondisclosure was requested. The investigator incurred minimal printing and presentation costs.

Human Subjects' Protection

The Institutional Review Board approval was obtained from the project site as well as from Southern Illinois University at Edwardsville. The project did not directly involve human

subjects thus was determined to have no threat to human subjects and participant consent was not required.

Outcomes Measured and Evaluation Plan

Outcomes measured for this project were obtained from nurses in labor and delivery, special care nursery and postpartum areas of host facility. Further outcome measures included perioperative staff knowledge of the ketamine infusion protocol for postoperative pain management of the opioid tolerant patient. The pre-surveys and posttests were evaluated for comparison of knowledge base prior to and comprehension after the educational intervention. The pre-survey and posttest consisted of 12 and 16 questions respectively. The first two questions inquired participants title and main clinical work area via multiple choice answers. Question three required the participant to enter the number of professional years served in the title reported in question two, utilizing a Likert scale for answer options in numerical ranges. Questions four-12 were clinical questions with answers in multiple choice formatting regarding ketamine pharmacodynamics, opioid tolerance, hyperalgesia, specifics of the ketamine infusion protocol and lactation. The last two questions covered staff likelihood to implement the protocol and comfortability caring for a patient receiving a subanesthetic ketamine infusion. The last two questions used the Likert scale for answer ranges. The posttest had four supplemental questions regarding future use of ketamine, barriers to future and suggestions for project quality improvement which allowed the participant to free text answers.

The primary investigator compared participant pretest and posttest results to determine effectiveness of the educational module for the enhancement of staff knowledge on the use of ketamine for pain management in the opioid tolerant postpartum patient population. Findings have been disseminated to the specific participating groups. Upon publication, the findings will

be further disseminated and discussed with all interested persons at the pilot hospital and health system.

Evaluation Process/Instruments

Data Collection Procedure

A voiced-over PowerPoint presentation on the prevalence of opioid use disorder in obstetrics was sent to the study sample. The presentation introduced the analgesic benefits of a subanesthetic intraoperative dose and postoperative infusion of ketamine for opioid dependent parturients requiring cesarean deliveries. A sixteen-question posttest was then administered to all staff members after observing the presentation. The posttest was comprised of the same 12 presurvey questions which included: three demographical questions, eight knowledge-based questions, and one question regarding the administration of ketamine in one's practice prior to the ketamine education. In addition to the presurvey questions, one question was added regarding the likelihood of providers' ketamine administration post education, one question discussing barriers to integrating ketamine into their practice, and two questions regarding quality improvement.

Knowledge Instrument

The eight knowledge-based assessment questions were presented in multiple choice format. The knowledge-based assessment questions addressed multiple topics such as the ketamine pharmacology and pharmacokinetics, the prevalence of opioid use disorder in parturients, opioid induced hyperalgesia, subanesthetic infusions in the postpartum period and level of nursing care required for this patient population. A five-point Likert scale was used to evaluate staff and anesthesia providers administration of ketamine prior to and after the

implementation of the education. The last grouping of posttest questions were in regards to quality improvement and formatted for free text answers.

Data Analysis

Descriptive statistics and frequency tables were used to define demographics within the sample. The eight knowledge-based questions were analyzed for comparison of the percentage of response inaccuracies on the pretest versus the percentage of response accuracies on the posttest. Subsequently, an evaluation of the percentage of correct responses were utilized to determine overall effectiveness of the education presented.

Results

Demographics. Forty-seven participants filled out the pretest survey over an average time of three minutes and then viewed the presentation. After the educational presentation, 38 participants filled out the posttest survey over an average of almost 11 minutes. The attrition rate was 19 percent between pretest and posttest participation. The attrition rate is likely due to a variety of reasons including poor work culture, lack of incentive offered, and stress related to posttest performance. See Table 1 for a complete listing of sample demographics.

Table 1

Demographic Characteristics of Sample (n=38)

Characteristics	**Participants N (%)**
Job Title	
Physician Anesthesiologist	1 (2.63)
Nurse Anesthetist/ Anesthesia Assistant	10 (26.32)
Neonatal Nurse Practioner	0 (0)
Obstetrical Gynecologists	0 (0)
Registered Nurses	27 (71.05)
Main Workplace	
General Operating Room	10 (26.3)
Labor and Delivery	18 (47.37)
Mother/Baby: Postpartum	5 (13.18)
Mother/Baby: Nursery	5 (13.18)

Number of Years in Job Title	
1-5 years	10 (26.3)
6-10 years	8 (21.05)
11-15 years	5 (13.18)
16-20 years	3 (7.89)
Greater than 20 years	12 (31.58)

Knowledge Assessment. A comparative analysis of participants response comparing pretest and posttest knowledge-based assessment questions demonstrate the education positively impacted the participants knowledge related to opioid use disorder in parturients and ketamine pharmacology. The first of the knowledge-based questions requested participants choose which class of medication ketamine belongs. Ninety-seven percent (n=37) of posttest participants were able to correctly identify the classification of medication to which ketamine belongs, compared to only 74 percent (n=35) of pretest participants. Seventy-eight percent (n=37) of pretest responses correctly identified the true statements regarding overdose fatalities and the opioid pandemic. Ninety-seven percent of posttest participants were able to correctly identify true statements regarding the opioid pandemic and overdose fatalities. All posttest participants answered questions regarding Ketamine's mechanism of action and causes of opioid induced hyperalgesia (OIH) correctly; whereas the pretest participants were 27.6 percent (n=13) and 21.3 percent (n=10) correct respectively. One question addressed participants' knowledge regarding the level of nursing care required by a patient with a ketamine infusion. Ninety percent (n=34) of posttest participants were able to correctly identify the appropriate level of nursing care required, compared with only 52 percent (n=24) on the pretest. Posttest participants were able to increase their knowledge forty-two percent related to the infusion rate for postpartum, sub-anesthetic ketamine at the pilot facility. Ninety-seven percent of posttest participants were able to correctly identify contraindications for ketamine administration. Posttest participants increased their

accuracy by 22 percent on the identification of methods by which opioid induced hyperalgesia may be negated.

Likert Scale. A five-point Likert scale was used to assess participants history of ketamine administration as well as their likelihood for future ketamine administration for post-operative opioid use disorder patients. Potential scores along the Likert scale for the question related to the number of ketamine administrations over the past month, ranged from zero through greater than ten times; not applicable was also an option. Responses ranged from never, not at all likely, somewhat likely, definitely likely, and always; not applicable was again a potential response. One post-test question asked the participants how likely they were to administer ketamine having received the education. Ninety-one of the pretest respondents denied ever having administered ketamine versus 50 percent of posttest responses indicated they were "definitely likely" to administer ketamine postoperatively to the opioid dependent postpartum.

Questions/Comments. Thirty-seven total responses were listed in the free-text answer boxes for question 14-16 on the posttest. See table 2 for a list of participants comments and suggestions. Multiple participants listed infrequent use of this policy and lack of recall as a barrier to implementation. To overcome this concern, copies of the policy will be placed in the "Quick Tips" binder at the nurses' station in addition to the medication room.

Another local barrier listed was for the postpartum mothers wishing to leave the Family Birth Center to use tobacco products. A transdermal nicotine patch was offered to avoid withdrawal until the ketamine infusion has been discontinued. Use of nicotine replacement therapies during lactation produces a milk-to-plasma ratio less than that of secondhand smoke.

Table 2

Staff Comments on Posttest

Barriers to implementing sub-anesthetic ketamine into your practice
-I do not have any barriers but wonder if patients would be receptive knowing the will not be given much additional opioid medication. -Lack of staff for adequate monitoring -It is not being used that much, so I won't remember the common practice -Possibly heavy smokers wanting to leave the floor - Not using ketamine very frequently, unsure if I will remember standard practice for it - Not using ketamine frequently, I am unsure if I will remember standard practice for it - Ordering and management consistently by anesthesia and IV access of patients - Patients who refuse to remain on the nursing unit; Concerned about the higher level of acuity of care required by these patients - Drug shortage - Patients with contraindications - Attending physician
Areas of concern not discussed within the education
- Would patients on ketamine infusion require 2 separate IV sites?
Participants suggestions for improvement
- Maybe a tip sheet in med room when we have a patient on Ketamine drip - Very good information and clear presentation - Very good information and clear presentation - Tip sheet in med room for patients that are on ketamine drips - Tip sheet in med room for patients that are on ketamine drips - Great presentation! Information clearly stated and relevant to practice

Limitations

There are multiple limitations to this project requiring consideration. A convenience sample was chosen for this project due to congruent staff member availability and time constraints. A total of 38 participants completed the posttest following the educational presentation resulting in a less than robust sample size. Extrapolation is diminished and the results of the posttest may not be generalizable to a larger population. The posttest attrition rate was most likely due to unplanned dropout, resulting in an uneven pretest-posttest sample size, further complicating comparisons.

The inclusion of anesthesia providers may have diluted the results. An arsenal of available anesthetics exists, including a variety of methods for achieving analgesia. Ketamine is a controlled substance and requires a second signature to witness the wastage of any unused drug after administration. This is a drawback for anesthesia providers whom are rushed from one case to the next with heavily monitored turn over times. Medication bias may have impacted the results as well. Ketamine has a reputation for producing hallucinations and nystagmus. Participants with preconceived notions of the medication may have skipped the education yet completed both pretest and posttest.

Further limitations are related to the climate of the host facility and staff morale. The nursing staff researched the pretest questions and answers on the internet resulting in a false number of correct pretest answers demonstrating little to no change in the pretest and posttest scores. The host facility had recently affiliated with a larger health system causing turnover of contracted employee groups. Some of the private Obstetrical and Gynecological physicians were disgruntled after being coerced to join the health system as employees. Three months prior to the release of the pretest, the contracted group of Neonatal Nurse Practitioners (NNP) were informed they would no longer be employed with the new health system. As a result of the recent changes, there was no participation from the NNPs or OBGYNs. Only a handful of the anesthesia providers within the group provide anesthesia services to Labor and Delivery, resulting in a low participation rate of Nurse Anesthetists and Anesthesia Assistants. One Physician Anesthesiologist participated; this is theoretically due to differences in influence and power between physician anesthesia providers and nurse anesthesia providers.

Recommendations

The evidence presented in the literature review supports the use of sub-anesthetic ketamine for analgesia in postoperative, postpartum patients with opioid abuse. The literature demonstrates better analgesia with a decrease in the overall opioids consumed while decreasing the negative effects of ketamine by running sub-anesthetic dosing. There was no policy directed to the care of this patient population at the host facility prior to the implementation of this project. The quality of care has significantly improved for these patients post project implementation and subsequent policy development. A more aggressive dissemination of the education and collection of pretest and posttest surveys could improve the number of surveys collected and data for analysis. Collaboration with an increased number of physicians may have better results due to abating the nurse-physician power struggle.

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