DEVELOPMENT AND EVALUATION OF AN EDUCATIONAL MODULE AND VISUAL GUIDE FOR THE FACILITATION OF UNINTERRUPTED POSTOPERATIVE BREASTFEEDING

Morgan Elizabeth Barnes

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Approved by:

Wanda Williams, PhD, MSN, RN, WHNP-BC, CNE	DNP Program Director
Joshua Borders, PhD, DNP, NP-C, ACHPN	Faculty Advisor

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Dedication and Acknowledgments

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Abstract

Background: Previous recommendations given to breastfeeding mothers included to "pump and dump" breastmilk for a period of time following anesthesia. This advice was advertised when little was known about drug transfer into breastmilk. With more evidence now available, evidence-based recommendations support that most mothers should be able to breastfeed when fully awake and alert after surgery. The old advice to "pump and dump" is still widely circulated on the internet, however, resulting in confusion among patients and providers. **Purpose:** This project sought to improve nurse anesthetist knowledge of, confidence in, and adoption of current postoperative breastfeeding recommendations through an educational module and visual guide resource. **Methods:** Nurse anesthetists at a regional hospital without an obstetrics department were invited to participate in a multifaceted intervention including an educational module and dissemination of an informational visual guide. Participants completed a pretest, immediate posttest, and a final posttest eight weeks later. **Results:** There were 19 final participants with paired data. Mean knowledge and confidence scores increased significantly from pretest to initial posttest and from pretest to final posttest. Mean adoption score increased from both pretest to initial posttest and pretest to final posttest, but the increase from pretest to final posttest was not significant. **Conclusion and Recommendations:** This project demonstrates that a multifaceted intervention including an educational module and visual guide is effective at increasing nurse anesthetist knowledge and confidence related to evidence-based perioperative breastfeeding recommendations over a span of eight weeks at a regional hospital. Further study is warranted to develop methods for increasing adoption of postoperative breastfeeding recommendations.

Keywords: Nurse anesthetist, CRNA, anesthesia, breastfeeding, lactating, educational module, visual guide

Background and Significance

When lactating mothers undergo surgical procedures, there can be confusion among patients and providers regarding continuation of breastfeeding postoperatively. This confusion may be due to outdated information on the internet recommending that women discard breast milk immediately after surgery before continuation of breastfeeding (American Society of Anesthesiologists Committee on Obstetric Anesthesia, 2019). Lactating mothers who wish to continue breastfeeding but do not know how to proceed might ask healthcare providers for advice. Therefore, it is important for certified registered nurse anesthetists (CRNAs) to not only promote the current evidence-based recommendations but also use the most current evidence to support decision-making in anesthetic drug administration to support postoperative breastfeeding.

Benefits and Importance of Breastfeeding

Benefits of breastfeeding for both infants and mothers are well documented and established in medical literature. The World Health Organization (2017) considers breastfeeding as the cornerstone of child survival, nutrition, and development. Due to numerous health benefits for children, the World Health Organization (2017) recommends exclusive breastfeeding for the first six months of life. There is evidence to support that breastfeeding has a protective effect against risk of acute otitis media, infections, and asthma (Bowatte et al., 2015; Duijts et al., 2010; Lodge et al., 2015). Additionally, studies demonstrate decreased odds of developing type 2 diabetes or obesity in breastfed subjects (Horta et al., 2015b). Breastfeeding has also been positively associated with intelligence test performance (Horta et al., 2015a). Some benefits for mothers who breastfeed include reduced risk of breast cancer, ovarian cancer, and type 2 diabetes (Chowdhury et al., 2015).

Perioperative Breastfeeding Recommendations

In consideration of the benefits of breastfeeding and data on drug accumulation in breastmilk, the American Society of Anesthesiologists Committee on Obstetric Anesthesia (2019) released a statement recommending uninterrupted breastfeeding after surgery for lactating mothers. This means that most mothers should be able to safely breastfeed when they are fully awake and alert after surgery. The historic advice given to breastfeeding mothers after major surgery was to discard breastmilk before breastfeeding (Bond & Holloway, 1992). This advice, however, was made before evidence about anesthetic drug transfer into breastmilk became widely available. The outdated advice to discard breastmilk after anesthesia is still circulated on the internet, however, which creates confusion for patients and providers who disagree with or have not been made aware of newer recommendations. Taking into account both the American Society of Anesthesiologists Committee on Obstetric Anesthesia statement and preferences of lactating mothers, surgical facilities and staff should create an enabling environment for uninterrupted breastfeeding.

Consequences of Interrupted Breastfeeding

Consequences of interrupted breastfeeding and missed feeds can include lactation difficulties such as mastitis, engorgement, and decreased milk production (Wilson et al., 2020). Systemic symptoms of mastitis can include fever, chills, body aches, and headache (Wilson et al., 2020). Preventing perioperative mastitis is important because symptoms of mastitis can resemble those of a postoperative surgical infection. While there is a lack of incidence data regarding postoperative mastitis in lactating women, the incidence of mastitis for the general population of breastfeeding women is as high as 11.1 episodes of mastitis per 1,000 breastfeeding weeks for the period of 0-25 weeks postpartum (Wilson et al., 2020). In addition to

lactation difficulties, another concern in the perioperative period includes undesired early termination of breastfeeding. A study by Odom et al. (2013) found that early termination of breastfeeding was positively associated with maternal concerns regarding lactation difficulties and illness or need to take medicine. Therefore, maternal surgery and hesitation about drugs administered during surgery may discourage women from accomplishing their breastfeeding goals. These complications from interrupted breastfeeding highlight the importance of enabling lactating mothers to breastfeed as soon as possible after surgical procedures.

DNP Project Development

A hospital in North Carolina was noted to lack a protocol, medication information guide, and educational program for the care of breastfeeding surgical patients. This lack of protocol or readily available guide may result in inconsistent anesthetic practice and counseling for breastfeeding patients, potentially leading to lactation complications and unintended early termination of breastfeeding (Odom et al., 2013; Wilson et al., 2020). For this project, the following question was used as a guide: In practicing CRNAs (P) at a single facility, does an educational intervention and visual guide (I) versus no intervention or guide dissemination (C) increase CRNA knowledge of, confidence in, and adoption of early post-anesthesia breastfeeding recommendations (O) eight weeks after implementation (T)?

Purpose

This project seeks to improve CRNA knowledge of, confidence in, and adoption of current postoperative breastfeeding recommendations through an educational intervention and readily available visual guide resource. Specific aims include increased knowledge about current recommendations and best practices regarding drug administration in lactating women, increased

confidence in both the evidence-based recommendations and in personal anesthetic practice for this patient population, and increased adherence to the evidence-based recommendations.

Review of Current Evidence

A literature search using CINAHL, PubMed, and Scopus databases utilizing search terms "breastfeeding," "breast milk," and "anesthesia" yielded a total of 557 results for review. Literature included for analysis were peer-reviewed journal articles, available in the English language, and selected based on relevance. Guidelines and protocols published within the last five years were included for analysis to assess for differences in current recommendations. Duplicates and articles not relating to anesthetic drug safety for lactating mothers were excluded. Literature was not excluded based on date of publication due to the paucity of literature on the topic of postoperative breastfeeding. Ultimately, 10 articles were selected from the searches using the listed search terms, and 13 additional articles were included from a review of references for a total of 23 articles. The paucity of available literature may be attributed to the vulnerability of the studied populations including postpartum mothers and their infants.

Current Published Guidelines and Recommendations

Multiple guidelines and protocols exist to clarify the safety of breastfeeding after anesthesia. Current professional guidelines and protocols support uninterrupted breastfeeding, meaning that lactating women should be able to breastfeed as soon as they are alert and able after waking up from anesthesia (American Society of Anesthesiologists Committee on Obstetric Anesthesia, 2019; Martin et al., 2018; Mitchell et al., 2020; Reece-Stremtan et al., 2017). Organizations acknowledge that outdated recommendations to pump and discard breast milk following anesthesia were made before evidence regarding safety became widely available (American Society of Anesthesiologists Committee on Obstetric Anesthesia, 2019; Mitchell et

al., 2020; Reece-Stremtan et al., 2017). A search of the literature did not reveal any published guidelines that did not support uninterrupted breastfeeding after surgery. However, current guidelines emphasize that infant health status and maturity should be considered due to metabolism differences (Mitchell et al., 2020; Reece-Stremtan et al., 2017). For example, pre-term infants are more sensitive to effects of medications than neonates and young infants because of immature hepatic and renal function (Mitchell et al., 2020).

While standard doses of narcotics are considered safe in women with healthy, term infants, multimodal analgesia is recommended to limit narcotic consumption (American Society of Anesthesiologists Committee on Obstetric Anesthesia, 2019; Martin et al., 2018; Mitchell et al., 2020; Reece-Stremtan et al., 2017). Multimodal approaches to analgesia include drugs with differing mechanisms of pain relief and thus decrease administration of large amounts of one type of drug (Prabhakar et al., 2014). Citing available evidence and the importance of breastfeeding, professional organizations encourage support for and facilitation of perioperative breastfeeding (American Society of Anesthesiologists Committee on Obstetric Anesthesia, 2019; Martin et al., 2018; Mitchell et al., 2020; Reece-Stremtan et al., 2017).

Drug Transfer into Breastmilk

Research has shown that amounts of most anesthetic drugs present in breast milk or colostrum after anesthesia are either undetectable or too low to affect breastfeeding infants (Borgatta et al., 1997; Dailland et al., 1989; Esener et al., 1992; Goma et al., 2008; Nitsun et al., 2006; Oliveira et al., 2019; Steer et al., 1992; Stuttmann et al., 2010). In most studies included for analysis, researchers took direct measurements from breast milk and/or blood to construct or verify pharmacokinetic models and determine the concentration of drugs in breast milk (Borgatta et al., 1997; Dailland et al., 1989; Esener et al., 1992; Goma et al., 2008; Nitsun et al., 2006;

Oliveira et al., 2019; Steer et al., 1992; Stuttmann et al., 2010). Of the studies that found drugs safe for use in lactating women, most studies made recommendations based on single, normally prescribed doses (Borgatta et al., 1997; Esener et al., 1992; Goma et al., 2008; Nitsun et al., 2006; Steer et al., 1992; Stuttmann et al., 2010). In uncomplicated surgeries and short procedures for healthy women, single doses of these drugs may provide adequate anesthesia.

In consideration of the available evidence, the literature overwhelmingly supports uninterrupted breastfeeding (Borgatta et al., 1997; Gilder et al., 2021; Goma et al., 2008; Nitsun et al., 2006; Oliveira et al., 2019; Steer et al., 1992; Stuttmann et al., 2010), though caution should be used with diazepam and meperidine (Gilder et al., 2021; Oliveira et al., 2019). The uninterrupted breastfeeding recommendation mainly comes from studies that analyzed drugs with no active metabolites or clinically insignificant levels of metabolites (Nitsun et al., 2006; Oliveira et al., 2019; Steer et al., 1992; Stuttmann et al., 2010). Even though there is a gap in evidence regarding direct observations and measurements involving infants, recommendations incorporate known drug metabolism and breast milk elimination in conjunction with known infant pharmacokinetics and pharmacodynamics (Borgatta et al., 1997; Gilder et al., 2021; Goma et al., 2008; Nitsun et al., 2006; Oliveira et al., 2019; Steer et al., 1992; Stuttmann et al., 2010).

Relative Infant Dose

The relative infant dose (RID) is an indicator of drug transfer into breast milk that is used to determine drug safety for lactating mothers and their infants. The relative infant dose is calculated by dividing the infant's dose received via breast milk (mg/kg/day) by the mother's dose (mg/kg/day) (Hale, 2021). RID <10% is generally accepted as safe when determining risk to infants (Hale, 2021). When considering anesthetic drug safety in the literature, RID is not always reported but is considered a useful indicator.

Opioids and Opiates

Studies support that intravenous fentanyl, given in standard doses, transfers to breast milk in such small amounts that no adverse effects are expected in breastfed infants (Goma et al., 2008; Nitsun et al., 2006; Oliveira et al., 2019; Steer et al., 1992). A systematic review of the literature did not find information regarding multiple doses or continuous infusions of fentanyl (Oliveira et al., 2019). In studies that examined concentrations of fentanyl in breast milk and colostrum, sample sizes were small, and samples only included healthy participants (Nitsun et al., 2006; Steer et al., 1992). There is a lack of literature studying effects of post-anesthesia breast milk on preterm infants and neonates with health challenges. Health and age of the breastfeeding infant should be considered when determining breastfeeding safety because newborn preterm infants have substantially reduced fentanyl clearance capabilities (Wu et al., 2021). Thus, caution and pediatric specialist consultation should be utilized with breastfed preterm infants and neonates with health challenges.

Morphine has limited transfer to breast milk and poor oral availability, and although it is considered safe to use in lactating women in single doses, safety with the use of multiple doses or patient-controlled analgesia (PCA) is uncertain (Oliveira et al., 2019). Studies that examined neonatal behavior with breastfeeding mothers receiving PCA morphine or meperidine found that meperidine groups were associated with significantly more neurobehavioral depression than morphine groups (Wittels et al., 1990, 1997). Due to the association of meperidine and its active metabolite normeperidine with neonatal neurobehavioral depression, meperidine is not recommended for use in breastfeeding mothers (Oliveira et al., 2019; Wittels et al., 1990, 1997).

Similarly to meperidine, codeine and tramadol are not recommended for use in lactating women. Avoidance of codeine is encouraged due to the chance of mothers being genetically

ultrarapid codeine metabolizers and excreting large amounts of morphine into breast milk, potentially increasing risk of infant central nervous system depression and neonatal toxicity (Madadi et al., 2008). Tramadol avoidance is recommended by the United States Food and Drug Administration (FDA) due to the same risks of ultra-rapid metabolism as codeine (United States Food and Drug Administration, 2017). While limited use of tramadol in lactating women is permitted in other areas of the world, the FDA recommends against use of tramadol in lactating women due to risk of serious adverse consequences (Martin et al., 2018). More data is needed to determine safety for infants and newborns, as available literature does not reveal cases of adverse events definitively attributed to tramadol. CRNAs should counsel lactating mothers to encourage avoidance of codeine or tramadol for postoperative pain.

Remifentanil is used safely for labor analgesia due to its extremely short half-life (Zhang et al., 2021). Adverse events in the breastfed newborn receiving even smaller doses via breast milk have not been reported. No signs of sedation were observed in four breastfed infants whose mothers received remifentanil, propofol, rocuronium, and xenon during general anesthesia (Stuttmann et al., 2010). There are no published experiences with intravenous alfentanil or sufentanil in mother-baby couplets with established lactation. There are also no available studies that report infant responses or breast milk levels of mothers receiving intravenous hydromorphone.

Benzodiazepines

Midazolam is considered safe for uninterrupted breastfeeding after general anesthesia (Nitsun et al., 2006; Oliveira et al., 2019). Extended infusions of midazolam have not been studied in breastfeeding mothers, but single doses preoperatively or intraoperatively appear safe due to low amounts excreted in breast milk (Nitsun et al., 2006; Oliveira et al., 2019). On the

contrary, due to the long half-lives of both diazepam and its active metabolite nordiazepam, diazepam is considered a drug to avoid in breastfeeding women (Gilder et al., 2021; Oliveira et al., 2019). In a quasi-experimental study involving just nine women, Borgatta et al. (1997) found that diazepam and its metabolites were not detected in any samples (Borgatta et al., 1997). In a systemic review, however, Oliveira et al. (2019) determined that diazepam is best to avoid in lactating mothers after weighing evidence from a case report and two retrospective observational studies that found neonatal lethargy, weight loss, electroencephalogram changes, infant sedation, and high amounts of the active substance in an infant days after a single maternal dose. Further, a retrospective chart review of 298 breastfed neonates whose mothers received ketamine and diazepam for postpartum tubal ligation found that high doses of intravenous diazepam (>0.1 mg/kg) increased the risk of clinically significant infant weight loss ninefold and hyperbilirubinemia threefold (Gilder et al., 2021).

Propofol

Evidence in the literature supports that propofol administration is safe for breastfeeding women. Multiple studies found low levels of propofol in breast milk (Dailland et al., 1989; Nitsun et al., 2006; Stuttmann et al., 2010). Dailland et al. (1989) determined that propofol levels in breast milk were low after both single induction doses and continuous infusions; concentrations in breast milk were negligible when compared to placental transfer in a quasi-experimental study with repeated measures. Since low levels of propofol were present in breast milk at four and eight hours after surgery, study authors determined that breast milk was a minor route of propofol elimination (Dailland et al., 1989). The Dailland et al. (1989) study also used a validated neurological tool to assess healthy infants after anesthesia and found that the neurological scores improved for all infants, including ones who did not receive propofol; there

was no correlation between propofol levels and the neurological tool scores. In a quasi-experimental study involving intravenous propofol and inhaled xenon, traces of propofol were low (Stuttmann et al., 2010). This study, however, was severely limited because breast milk and blood samples were collected from only two lactating women.

A rare side effect attributed to propofol was found in case reports (Bulut & Ovali, 2021; Rainone et al., 2018). These case reports found green discoloration of breast milk following propofol administration for a preterm emergency Cesarean section (Bulut & Ovali, 2021) and an appendectomy (Rainone et al., 2018). In both case reports, infants were not fed the discolored breast milk. Both reports suggested inconclusive results as to the cause of the discoloration, but both studies analyzed the medications and health history of the women to ultimately suggest an association of discolored breast milk with propofol administration. Rainone et al. (2018) tested discolored milk samples and found no measurable levels of propofol or metabolites at 22 hours after surgery. Breastfeeding resumed without complication when the breast milk color returned to normal on postoperative day four (Rainone et al., 2018). Rainone et al. (2018) hypothesized that propofol metabolites were present in breast milk and that further validity and sensitivity testing was needed for the gas chromatography-mass spectrometry instrument. In contrast to the testing present in the Rainone et al. (2018) case study, Bulut and Ovali (2021) did not seek to measure propofol concentration in the discolored breast milk. Instead, Bulut and Ovali (2021) tested the breast milk for pathogens, and finding none, qualitatively assessed color, smell, and viscosity only. Bulut and Ovali (2021) made conclusions based on weak available case reports to suggest a possible inactive causal metabolite. With the cause of the discoloration and effects in infants unknown, authors suggested vigilance and caution in mothers with discolored breast milk until the return of normal breast milk color (Bulut & Ovali, 2021; Rainone et al., 2018).

Inhaled Anesthetics

There are no published studies regarding the transfer of isoflurane, sevoflurane, or desflurane to human breast milk. However, the known pharmacokinetic characteristics of these drugs (low solubility, rapid excretion, and poor bioavailability) and brief exposure period for the mother make the theoretical risk for infants low (Oliveira et al., 2019). In a quasi-experimental study severely limited by a sample size of two mothers, xenon was undetectable in maternal breast milk and blood samples immediately following extubation (Stuttmann et al., 2010).

Other Common Drugs

Limited data exists examining the use of ketamine in lactating mothers. In a retrospective chart review of 298 breastfed neonates whose mothers received ketamine for postpartum tubal ligation, there were no measured infant adverse effects with high versus low doses of ketamine (Gilder et al., 2021). Even though Gilder et al. (2021) suggest that ketamine appears safe for uninterrupted breastfeeding, more studies are needed to determine ketamine breast milk transfer further. In light of limited available evidence, guidelines suggest low doses of ketamine with careful monitoring for infant sedation or avoidance of ketamine altogether (American Society of Anesthesiologists Committee on Obstetric Anesthesia, 2019; Mitchell et al., 2020; Reece-Stremtan et al., 2017).

Data regarding the safety of dexmedetomidine in lactating mothers is also limited. In small studies measuring dexmedetomidine concentrations in breast milk of women recovering from Cesarean section, dexmedetomidine was detected in small amounts in human breast milk at six hours and was undetectable in all samples at 24 hours (Nakanishi et al., 2017; Yoshimura et al., 2017). Concentrations of dexmedetomidine determined a measured RID of <1% (Nakanishi et al., 2017; Yoshimura et al., 2017). Further, in a study that measured levels of

dexmedetomidine in breast milk during and after a single awake craniotomy, researchers determined that all measured concentrations were low and likely safe for uninterrupted breastfeeding (Dodd et al., 2021). More robust studies are warranted to determine safety of dexmedetomidine in lactating mothers.

Etomidate is known to redistribute from the central nervous system rapidly, therefore amounts of etomidate in milk are small and decrease rapidly (Flood et al., 2014). Etomidate seems safe for lactating mothers in single doses at induction of anesthesia based on known pharmacology and a quasi-experimental study that found rapidly decreased concentrations of etomidate in blood and breast milk of 20 women (Esener et al., 1992). Thus, a systematic review and current guidelines support the use of etomidate for induction in lactating women (American Society of Anesthesiologists Committee on Obstetric Anesthesia, 2019; Mitchell et al., 2020; Oliveira et al., 2019; Reece-Stremtan et al., 2017).

Recommendations regarding neuromuscular blocking agents are currently made in reference to known pharmacology, as no data measuring breast milk pharmacokinetics exists. Neuromuscular blocking agents have low lipid solubility, are largely distributed in the extracellular volume, are fully ionized in normal pH, and do not cross membranes easily (Flood et al., 2014). Similarly, while breast milk data is largely absent, pharmacologic properties of reversal agents and anticholinergics support their safety. Neostigmine and glycopyrrolate are both quaternary ammonium compounds and thus are not expected to be found in breast milk, while atropine, a tertiary amine, is expected in trace amounts (Flood et al., 2014). Sugammadex is a large and highly polar molecule, so the concentration in breast milk is likely to be very low (Flood et al., 2014). A systematic review and current guidelines suggest that neuromuscular

blocking agents, reversal agents, anticholinergics, and sugammadex are theoretically safe for use in lactating mothers (Mitchell et al., 2020; Oliveira et al., 2019; Reece-Stremtan et al., 2017).

No data regarding the transfer of ondansetron, metoclopramide, and dexamethasone into breast milk are available. However, these antiemetic agents lack sedating effects (Flood et al., 2014), so they are generally considered safe in current guidelines (American Society of Anesthesiologists Committee on Obstetric Anesthesia, 2019; Mitchell et al., 2020; Reece-Stremtan et al., 2017). The predicted relative infant dose (RID) of ondansetron is 3%, which is well below the accepted safety threshold (Job et al., 2022).

Gaps in the Literature

Most recommendations for postoperative uninterrupted breastfeeding are from expert opinion due to the lack of extensive studies and trials. Recommendations are made based on known pharmacologic properties, limited studies with milk levels, and rare reported side effects. There is a paucity of controlled studies regarding outcomes of postoperative breastfeeding, however multiple review articles support breastfeeding when mothers are awake and alert (Chu et al., 2013; Cobb et al., 2015; Dalal et al., 2014; Lee & Rubin, 1993). One current systematic review exists, and authors acknowledge that small sample sizes of healthy participants limit most existing studies, and most of the data are based on single doses of medications (Oliveira et al., 2019). Due to data limitations, authors suggest individual risk/benefit analyses for mothers of infants with health concerns (Oliveira et al., 2019). More specific and high-quality studies regarding breastfeeding outcomes after general anesthesia are needed to determine safety in infants with health concerns and safety of repeated doses. Information regarding medication safety during lactation is updated regularly by the United States National Library of Medicine on the LactMed database.

Interventions to Facilitate Postoperative Breastfeeding

There is a paucity of literature describing implementation of programs providing perioperative breastfeeding support for lactating women. Lack of consistent messaging may put breastfeeding patients at risk for lactation complications including, but not limited to, milk stasis, engorgement, mastitis, decreased milk supply, and undesired or premature weaning (Odom et al., 2013; Wilson et al., 2020). Recent articles addressing the need for perioperative lactation programs include a descriptive study to inform further research (Rieth et al., 2018) and an evidence-based quality improvement project (Moore et al., 2021). Rieth et al. (2018) implemented a perioperative breastfeeding program to facilitate breastfeeding at a hospital that lacked in-house lactation consultants and obstetric services. These services are also absent at the site for this DNP project. While the Rieth et al. (2018) study only focuses on descriptive information to guide the next phase of research focusing on outcomes, the need for perioperative lactation support at similar institutions is highlighted. Rieth et al. (2018) found that the institution regularly cared for lactating patients during the study period (about two to three patients per month), and 89% of lactating women received at least one non-narcotic analgesic intraoperatively during perioperative lactation program implementation.

Perioperative lactation program implementation at separate institutions in the Moore et al. (2021) and Rieth et al. (2018) studies suggests that varying guidance and inconsistent lactation support are problems not isolated to a single institution. After finding that breastfeeding guidance after surgery was inconsistent at their institution and not grounded in current research, Moore et al. (2021) educated staff and developed a protocol to standardize perioperative staff delivery of postoperative breastfeeding recommendations. Authors found that immediately after the educational intervention, there was increased knowledge and confidence among perioperative

healthcare personnel, but the single educational intervention wasn't enough to sustain results two years later amid substantial staff turnover (Moore et al., 2021).

Other studies that have measured the impact of educational interventions on health care provider knowledge have also found that while educational interventions alone initially improved knowledge and practices, results were not sustained (Hickin et al., 2017; Kakkar et al., 2021; Lohr, 2021). Educational interventions in these studies included online modules or in-person education. Given the uncertainty of in-person gathering during a pandemic and the convenience of online learning, literature was searched regarding effectiveness of online module-based educational interventions. A systematic review with rigorous search and appraisal strategies found that module-based online educational interventions were associated with improvement in knowledge of clinical practice guidelines among health care providers, however comparisons to in-person workshops or paper-based self-learning were not made (Verville et al., 2021). Further studies with multifaceted interventions including online modules and visual guides found more sustained improvements in health care provider knowledge, practices, and/or patient outcomes months or years later (Bonkowski et al., 2018; Kihlstrom et al., 2018; Phillips et al., 2018). In consideration of these studies, this project includes a multifaceted intervention to increase nurse anesthetist knowledge and confidence regarding care of lactating surgical patients with both module-based learning and visual guide dissemination.

Conceptual Framework

The Awareness-to-Adherence Model (Pathman et al., 1996) is a model that was developed to increase provider adoption of clinical guidelines. The Pathman et al. (1996) model suggests that there are sequential, cognitive, and behavioral steps that clinicians make when they comply with guidelines. The four main parts, in order, of the Awareness-to-Adherence Model

include awareness, agreement, adoption, and adherence (Pathman et al., 1996). First, providers must be aware of specific guidelines. Then, they must agree with them intellectually before deciding to adopt the guideline into practice. Finally, the last step of the model is successful guideline adherence in appropriate situations.

The Awareness-to-Adherence Model was applicable for this project because the project aimed to promote adherence to the American Society of Anesthesiologists Committee on Obstetric Anesthesia (2019) statement supporting the continuation of breastfeeding after anesthesia. Since one of this DNP project's aims was to increase CRNA adherence to recommendations and current literature surrounding medications and breastfeeding in lactating women undergoing anesthesia, the Awareness-to-Adherence Model was used to guide an educational module. The structure of the content in the educational module followed the four sequential parts of the Awareness-to-Adherence Model. Nurse anesthetists were made aware of current recommendations, first and foremost. If participant CRNAs lack awareness of the clinical practice recommendation, dissemination of information is an appropriate next step according to Pathman et al. (1996). Information was then presented following presentation of practice recommendations. Providers who are aware of the clinical practice recommendations and disagree with them need convincing that the familiar guideline is sound (Pathman et al., 1996). The literature shows that all current anesthesia authorities and recommendations agree with uninterrupted postoperative breastfeeding, and this consensus is present in the educational module. Additionally, evidence supporting the current recommendations was presented. CRNA agreement was assessed in pre- and posttest surveys. Next steps of the DNP project, following the Awareness-to-Adherence Model, included assessing adoption into practice post-intervention

and then later assessing adherence. The methods for assessing adoption and adherence for this project included surveys for CRNAs.

Methods

Project Purpose and Design

This evidence-based practice project sought to improve CRNA knowledge of, confidence in, and adoption of current postoperative breastfeeding recommendations through an educational module and visual guide resource. The educational module was delivered via Qualtrics, with a pre- and posttest embedded. Responses were quantitative. Visual guides summarizing educational module content and evidence-based recommendations were disseminated to the CRNA group via email and became available for resource use in the CRNA group's shared electronic resource folder. CRNAs completed a final posttest approximately eight weeks after completion of the initial posttest.

This project promoted published evidence-based recommendations supporting uninterrupted breastfeeding after anesthesia. Recommendations include mothers being able to breastfeed their children when awake and alert enough to do so. Additionally, recommendations support multimodal analgesia and limiting narcotics. Some drugs such as meperidine and diazepam are not considered safe for breastfeeding women. An analysis of evidence regarding lactating mothers and opioids, benzodiazepines, propofol, and other commonly used drugs were presented.

Translational Framework

This project followed the Iowa Model for evidence-based practice implementation. The Iowa Model was appropriate because it is frequently used to assist healthcare providers in translating evidence into clinical practice. Main steps of the Iowa Model include identifying

triggering issues or opportunities, stating a question or purpose, determining topic priority, team formation, evidence appraisal and synthesis, determining whether evidence is sufficient, designing and piloting practice change, determining appropriateness for adoption into practice, integration of practice change, and results dissemination (Iowa Model Collaborative, 2017). In terms of this project, the process outlined in the Iowa Model was appropriate because it included steps to determine topic importance, appraise evidence, design a project, and integrate and sustain a practice change. The first step of identifying an opportunity was presented as a lack of standardized protocol for breastfeeding after general anesthesia at the site. A PICOT question was then developed. The stakeholders at the clinical site including the clinical coordinator and Chief CRNA agreed that the topic was a priority at the site. A team consisting of the clinical coordinator, Chief CRNA, and principal investigator (PI) was formed to ensure stakeholder support and involvement. Synthesis of appraised evidence revealed evidence-based recommendations supporting uninterrupted postoperative breastfeeding and multimodal educational interventions to successfully facilitate increased knowledge, confidence, and adoption of evidence-based recommendations. Designing the practice change included incorporation of the Awareness-to-Adherence Model as a framework. Ultimately, the goal of this project was to integrate and sustain adherence to the most recent recommendations regarding breastfeeding after general anesthesia while increasing provider knowledge and confidence in making anesthetic decisions for breastfeeding patients.

Setting

The setting for this project was a 186-bed regional academic hospital in central North Carolina. Surgical services at this site cover a wide array of general, neurosurgical, and orthopedic surgical services. Notably, there is no obstetrics department at this hospital. The

setting for this project was consistent with a study that implemented a perioperative breastfeeding program in a hospital without an obstetrics department (Rieth et al., 2018).

Sample

The participant sample was selected from a group of approximately 30 CRNAs who work at the regional hospital. All CRNAs employed in the anesthesia group at the time of recruitment were invited to participate in an electronic educational module with pre- and posttests through convenience sampling. Eligibility for participation was not restricted based on gender, age, ethnicity, or educational preparation. All CRNAs at the facility were above the age of 18. Recruitment was via email, with an introductory email sent to all CRNAs a week prior to implementation, an invitation email with a link sent on implementation day, and a reminder email two days after the link was sent. Respondents had a week to complete the initial surveys, and another reminder email was sent to those who had not responded on the last day the initial surveys were open. Recruitment for the final survey began eight weeks after the initial survey link was sent. This second round of recruitment included emails to only CRNAs who completed the initial surveys. An email with an invitation and final survey link was sent eight weeks after the initial survey. A reminder email was sent two days after the final survey link was sent. A final reminder was emailed on the last active day of the survey to CRNA participants who still had not completed the final survey.

A maximum sample size was needed due to frequent turnover and the small number of people in the anesthesia group, so a short script explaining the project was read at a weekly Wednesday staff meeting the week before implementation, the day of implementation, and on the last day the surveys were open (one week after implementation). The principal investigator

read the script on these days at the staff meetings. To encourage participation, participants received a $5 Amazon gift card via email one week after completion of all surveys.

IRB Approval and Human Subject Protections

This project was submitted for Institutional Review Board (IRB) approval at the PI's university. Recruitment and data collection began after approval of study procedures to ensure participant protection. All information submitted to the Qualtrics survey was de-identified so that the PI and faculty advisor were not able to discern the answers associated with each respondent. Further, the survey platform itself was password-protected, thus survey operations and results were only accessible to the PI and faculty advisor. All tracking information was hidden to the PI and faculty advisor. The PI and faculty advisor were only able to see the email addresses of people who had completed the survey through Qualtrics, and that information was used for gift card distribution. De-identified survey data was aggregated and stored in the password-protected digital Box platform, and all data was destroyed upon study completion. The survey and participant emails were deleted permanently from the Qualtrics platform upon study completion, as well.

This project was anticipated to pose minimal risk to participants. Participants were advised that absolute confidentiality of data provided through the internet could not be guaranteed due to the limited protections of internet access. Therefore, the PI suggested minimizing risk through use of a secured network. Additionally, the PI recommended closing the browser upon survey completion so that others would not have access if their device was shared. Participants were also advised that they could withdraw from the study at any time, without penalty, by closing the browser. A prompt in the Qualtrics survey asked for a personalized response to pair data from pre- and posttest, and the prompt was broad so that identification risk

was low but specific enough that multiple participants were unlikely to have identical responses. Participants may have felt uncomfortable disclosing information to respond to this prompt, even if the response was broad. Thus, participants always had the option to close the browser to withdraw at any time if discomfort arose. Additionally, Qualtrics was programmed to not store any data from surveys that were incomplete. If surveys were closed and not completed, partial responses were not recorded.

Intervention

Existing literature demonstrates that multifaceted interventions including online modules and visual guides have resulted in sustained improvements in health care provider knowledge, practices, and/or patient outcomes months or years later (Bonkowski et al., 2018; Kihlstrom et al., 2018; Phillips et al., 2018). In consideration of these studies, this project included a multifaceted intervention to increase nurse anesthetist knowledge and confidence regarding care of lactating surgical patients. This project's intervention included both online module-based learning and electronic visual guide dissemination. Qualtrics was the online platform utilized for surveys and educational module delivery. The module was a video presentation created by the PI that included a voiced-over slideshow with a presentation of current recommendations, evidence behind the recommendations, and consensus of support among experts. The visual guide summarized the evidence presented in the online module. Aspects of the visual guide included a summary of evidence-based consensus statements, a color-coded chart of commonly used medications with their safety statuses, and scannable quick response "QR" codes for up-to-date database resources and references. The visual guide was disseminated after module completion to the regional hospital's CRNAs via email and an employer-sponsored shared electronic resource folder.

Data Collection

All data collection took place through the Qualtrics platform via personalized survey links. The survey was formatted to function on both mobile and desktop browsers. Data collection included demographic data as well as survey questions relating to knowledge of, confidence in, and intent to adopt evidence-based practice recommendations regarding postoperative breastfeeding. Demographic data included age, years in practice as a CRNA, and years working at the facility of employment.

Procedures

The PI sent out an introductory email to all CRNAs one week prior to the implementation date (the date the initial survey links are sent). This email included a message that explained the project purpose, methods, participant selection, time commitment, confidentiality, voluntary participation, and information explaining the $5 Amazon gift card incentive. It also included PI contact information for any questions that arose. The initial email went out on the same day as a weekly staff meeting. The PI read a script that included the same subjects as the email at this meeting.

Implementation day was one week after the initial email and meeting announcement, and the PI attended the weekly staff meeting to read another script. This script explained that the Qualtrics link was sent via email that day and reiterated the study purpose, voluntary participation, an incentive reminder, and the PI's contact information. The second email was sent to all CRNAs at the facility that morning and included a personalized survey link, a request for voluntary participation, study purpose, participant selection, time commitment, confidentiality measures, incentive reminder, and the PI's contact information for questions. The link could be accessed at the time and place of the participant's choosing, since the survey was accessible via

mobile or desktop browser, but the link was only active for one week. Accessing the link directed the participant to a prompt for the purposes of data pairing. CRNA participants were advised to answer this prompt with the same response on the final posttest. The prompt had multiple parts and said, “Type the year you became a registered nurse (not CRNA), the color of your first car, and the number of cousins you have.” This prompt included simple answers that did not have identical pieces across all participants. The prompt was not personal enough to identify participants, though. Completion of the pairing question led to a demographic survey. Completion of the demographic survey then led to the 10-question pretest assessing knowledge, confidence, and adoption of postoperative breastfeeding recommendations (see Appendix A). The educational module video followed the pretest. A posttest identical to the pretest followed the educational module. When the posttest was submitted, the participants saw a message thanking them for participation.

Two days after the link was sent, a reminder email was sent to all CRNAs. This email included a thank-you for participation, a reminder that the survey link was only going to be active for one week only, a reminder that participation was voluntary, and PI contact information for any questions. The last email reminder was be sent only to CRNAs who had not responded to the survey and was sent in the morning on the last day the survey was active. This email thanked the CRNAs for considering participation, reminded them that the survey link would expire after that day, reminded them of the incentive, and included the PI contact information for questions. This day was also a staff meeting day (one week from sending out the link), the PI read a short script at the weekly staff meeting reminding CRNAs that it was the final day to complete the initial survey and to contact the PI with any questions.

The morning after the initial survey closed, the PI emailed participants thanking them for their participation, and the email included the visual guide summarizing the evidence-based recommendations, medication use evidence, and up-to-date resources from the educational module (see Appendix B). Participants were encouraged to utilize the visual guide as needed. The Chief CRNA uploaded the visual guide to the CRNA group's shared resource drive, as well. The PI did not initiate contact with the participants until eight weeks after the initial survey link was sent. At the eight-week mark, the PI sent an email to the CRNAs who participated in the initial survey, and the email included the final survey link, a thank-you for participation, a reminder that participation was voluntary, a reminder of the incentive, and the PI's contact information for questions. A reminder email was sent two days later to all CRNAs who received the final survey link, and this email included a thank-you for participation, a reminder that the survey link would be active for one week only, a reminder that participation was voluntary, and PI contact information for any questions. The last email reminder was sent only to CRNAs who had not responded to the final survey and was sent in the morning on the last day the survey was active. This email thanked the CRNAs for considering participation, reminded them that the final survey link would expire after that day, reminded them of the incentive, and included the PI contact information for questions. The PI sent the participants who completed all of the surveys a $5 Amazon gift card via email seven days after the final survey closed.

Instrument

There was no established tool identified from the literature that assessed the variables of interest for this project. Face validity through anesthesia department faculty was established to ensure that the tool measured the intended variables. Demographic data was obtained prior to the pretest. Three demographic questions seeking age, years in CRNA practice, and years at the

facility included free text areas seeking whole number answers. The surveys, including a pretest and two posttests, were identical (see Appendix A). Three questions assessed CRNA confidence in caring for lactating patients and CRNA confidence in choosing medications that would facilitate postoperative breastfeeding. The three confidence questions used a Likert-scale type scoring system (scored 1-5 from strongly disagree to strongly agree about feeling confident). Questions assessing adoption of recommendations into practice also used a Likert-scale type scoring system (scored 1-5 from never to always). These questions asked whether the CRNA used current recommendations when advising breastfeeding patients and when choosing medications. The surveys concluded with five multiple choice questions to assess knowledge, and these questions were scored as correct or incorrect. Knowledge questions asked about general recommendations, pharmacologic concepts related to medication transfer into breast milk, and safety of specific medications used in anesthesia practice.

Data Analysis

Descriptive data was analyzed based on distribution, spread, and measures of central tendency. The PI then analyzed data from the pretest and posttests to determine whether knowledge, confidence, and adoption intent increased. Descriptive data analysis took place using Microsoft Excel statistics functions. IBM SPSS (Version 28) software was used for statistical tests involving data from pre- and posttests. Data from pre- and posttests was analyzed to determine whether differences in mean scores were significant from pretest to posttest one and pretest to posttest two. Wilcoxon signed-rank tests were used for knowledge assessment questions with total mean scores of the five knowledge questions compared between the pretest and initial posttest, then the pretest and final posttest. Wilcoxon signed-rank tests were also used

for Likert-scale confidence and adoption intent questions. As with the knowledge questions, the confidence and adoption questions were averaged together for mean scores for each participant.

Results

There were 21 CRNA participants who completed the initial survey that included a pretest, module, and posttest. Two participants were lost to follow-up when the final surveys were submitted eight weeks later, so the final number of participants was n=19 with successful data pairing. Post hoc data analysis using G*Power was utilized to determine effect size needed to achieve 80% power. Analysis included a two-tailed distribution, α of 0.05, and sample size of 19. An effect size of 0.7 was calculated to achieve a power of 80%. The mean age of participants was 44.5 years, with a median of 45 years, and a standard deviation of 7.9 years. The maximum age was 57 years, and the minimum age was 28 years (range of 29 years). In terms of experience, the mean number of years practicing as a CRNA was 13.4. The median years practiced as a CRNA was 14 years, and the standard deviation was 9.7 years. The maximum years as a CRNA was 40, and the minimum was 1 year (range of 39 years). In terms of years practiced at the setting of this project, the mean number of years was 5.8, with a median of 4 years, standard deviation of 6 years, maximum of 25 years, minimum of 1 year, and range of 24 years. Participants included 16 females (84%) and 3 males (16%). Demographic information is organized in Table 1.

Table 1

Demographic Information (n=19)

Measure	Age (Years)	Years CRNA	Years at Site
Mean	44.5	13.4	5.8
Median	45.0	14.0	4.0

Mode	34.0	4.0	4.0
Std. Deviation	7.9	9.7	6.0
Range	29.0	39.0	24.0
Minimum	28.0	1.0	1.0
Maximum	57.0	40.0	25.0

Knowledge Data

Knowledge scores were averaged based on the number of correct answers out of five knowledge questions (n=19). The average number correct from the pretest was 3.1579 for n=19. The average number correct for the initial and final posttests were 4.5789 and 3.7895 for n=19, respectively. Knowledge scores from each participant are reported below in Table 2. Descriptive statistics for knowledge data is presented in Table 3. Significance values (two-tailed) from Wilcoxon signed-rank tests for knowledge scores were $p < 0.001$ (Posttest 1 – Pretest) and $p = 0.044$ (Posttest 2 – Pretest). Table 4 provides a summary of test statistics for knowledge data.

Table 2

Knowledge Scores (n=19)

Participant	Pretest	Posttest 1	Posttest 2
1	2	5	5
2	4	5	4
3	4	5	3
4	4	5	5
5	3	3	3
6	3	5	5
7	4	5	4
8	3	5	3
9	4	3	2
10	2	5	3
11	2	5	4

12	4	5	5
13	3	4	4
14	4	5	5
15	3	5	4
16	2	4	2
17	3	3	4
18	4	5	3
19	2	5	4

Table 3

Descriptive Statistics – Knowledge Data

Test	*n*	*M*	*SD*	Minimum	Maximum	25th Percentile	50th Percentile	75th Percentile
Pretest	19	3.1579	0.83421	2	4	2	3	4
Posttest 1	19	4.5789	0.76853	3	5	4	5	5
Posttest 2	19	3.7895	0.97633	2	5	3	4	5

Table 4

Test Statistics from Wilcoxon Signed-Rank Tests – Knowledge Data

	Posttest 1 - Pretest	Posttest 2 – Pretest
Z	-3.453[a]	-2.012[a]
Significance (2-tailed)	< 0.001***	0.044*

[a] Based on negative ranks

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Confidence Data

Confidence scores were averaged based on Likert-scale scores from three confidence questions in the surveys (n=19). The average confidence score from the pretest was 3.6316 for n=19. The average confidence scores for the initial and final posttests were 4.8596 and 4.8421 for n=19, respectively. Mean confidence scores from each participant are reported below in Table 5. Descriptive statistics for confidence data is presented in Table 6. Significance values

(two-tailed) from Wilcoxon signed-rank tests for confidence scores were $p < 0.001$ (Posttest 1 – Pretest) and $p < 0.001$ (Posttest 2 – Pretest). Table 7 provides a summary of test statistics for confidence data.

Table 5

Confidence Score Means (n=19)

Participant	Pretest	Posttest 1	Posttest 2
1	5	5	5
2	4.6667	5	5
3	4	5	5
4	4	5	5
5	4.6667	5	5
6	5	5	5
7	4	5	5
8	3	5	5
9	4.6667	5	5
10	3	5	5
11	4.3333	4.3333	4.6667
12	4	5	4.6667
13	1.3333	5	4.6667
14	2	4	4.6667
15	3.3333	5	4.3333
16	2	5	5
17	3.6667	4	5
18	1.3333	5	4
19	5	5	5

Table 6

Descriptive Statistics – Confidence Data

Test	*n*	*M*	*SD*	Minimum	Maximum	25th Percentile	50th Percentile	75th Percentile
Pretest	19	3.6316	1.2166	1.3333	5	3	4	4.6667
Posttest 1	19	4.8596	0.3391	4	5	5	5	5
Posttest 2	19	4.8421	0.2804	4	5	4.6667	5	5

Table 7

Test Statistics from Wilcoxon Signed-Rank Tests – Confidence Data

	Posttest 1 - Pretest	Posttest 2 – Pretest
Z	-3.425[a]	-3.526[a]
Significance (2-tailed)	< 0.001***	< 0.001***

[a] Based on negative ranks

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Adoption Data

Adoption scores were averaged based on Likert-scale scores from two adoption questions in the surveys (n=19). The average adoption score from the pretest was 4.1053 for n=19. The average adoption scores for the initial and final posttests were 4.8158 and 4.6053 for n=19, respectively. Mean adoption scores from each participant are reported below in Table 8. Descriptive statistics for confidence data is presented in Table 9. Significance values (two-tailed) from the Wilcoxon signed-rank tests for adoption scores were $p = 0.011$ (Posttest 1 – Pretest) and $p = 0.060$ (Posttest 2 – Pretest). Table 10 provides a summary of test statistics for adoption data.

Table 8

Adoption Score Means (n=19)

Participant	Pretest	Posttest 1	Posttest 2
1	5	5	5
2	5	5	5
3	4	5	5
4	5	5	5
5	5	5	2
6	5	5	5
7	4	5	5
8	5	5	5

9	5	5	5
10	3	4.5	4
11	5	5	5
12	4	5	5
13	2	5	5
14	3	4	4
15	3	5	4
16	2	5	3.5
17	3	3	5
18	5	5	5
19	5	5	5

Table 9

Descriptive Statistics – Adoption Data

Test	*n*	*M*	*SD*	Minimum	Maximum	25th Percentile	50th Percentile	75th Percentile
Pretest	19	4.1053	1.1002	2	5	3	5	5
Posttest 1	19	4.8158	0.5058	3	5	5	5	5
Posttest 2	19	4.6053	0.7920	2	5	4	5	5

Table 10

Test Statistics from Wilcoxon Signed-Rank Tests – Adoption Data

	Posttest 1 - Pretest	Posttest 2 – Pretest
Z	-2.555[a]	-1.879[a]
Significance (2-tailed)	0.011*	0.060

[a] Based on negative ranks

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Discussion

Mean knowledge, confidence, and adoption scores for n=19 all increased from pretest to initial posttest and from pretest to final posttest. The differences in mean scores from pretest to initial posttest were significant at the $\alpha = 0.05$ level for knowledge ($p < 0.001$), confidence ($p <$

0.001), and adoption ($p = 0.011$). The differences in scores from pretest to final posttest were significant at the $\alpha = 0.05$ level for knowledge ($p = 0.044$) and confidence ($p < 0.001$) only. The increase in mean adoption scores from pretest to final posttest was not significant ($p = 0.06$). The effect size of 0.7 for a power of 80% was achieved for all mean comparisons except for the pretest and final posttest adoption score means.

The purpose of this project was to improve CRNA knowledge of, confidence in, and adoption of current postoperative breastfeeding recommendations through an educational intervention and readily available visual guide resource. While all measures increased from pretest to initial posttest and pretest to final posttest, the increase in adoption scores was not significant from pretest to the final posttest, suggesting that the increase in intent to adopt was not sustained after eight weeks. The Moore et al. (2021) study was unable to sustain increased provider knowledge, recommendations, and confidence in evidence-based breastfeeding recommendations after two years with a single educational intervention. Unlike the Moore et al. (2021) study, this project was able to achieve sustained increases in knowledge and confidence eight weeks after implementation with an educational module and the addition of a visual guide for use in clinical practice. The sustained knowledge and confidence increases from this multifaceted project echo successes from other studies using multifaceted methodology to sustain outcomes (Bonkowski et al., 2018; Kihlstrom et al., 2018; Phillips et al., 2018). Multifaceted interventions including online modules and visual guides resulted in sustained improvements in health care provider knowledge, practices, and/or patient outcomes in the Bonkowski et al., Kihlstrom et al., and Phillips et al. studies, and similar successes were achieved for knowledge and confidence measures in this project after adaptation of these techniques for CRNAs.

Interestingly, the initial mean adoption score (4.1053) from this project was higher than the initial mean confidence score (3.6316). While initial participant scores indicated that they were not as confident in the current recommendations regarding breastfeeding and anesthesia, participants still initially scored highly on intent to use current evidence-based recommendations. The Awareness-to-Adherence Model of awareness, agreement, adoption, and adherence suggests that providers need to know about guidelines before agreeing with them and subsequently adopting the guidelines (Pathman et al., 1996). In this project, the educational module presented information about current evidence. Knowledge scores immediately increased from an average of 3.1579 out of five knowledge questions correct to 4.5789 correct (posttest one). Awareness of the evidence and increased mastery of it was present in immediate assessment. According to the Awareness-to-Adherence Model, if providers agree with the information presented, they will be more likely to adopt the guidelines (Pathman et al., 1996). There was an immediate increase in mean adoption score after the module, as well (from 4.1053 to 4.8158). Adherence was assessed by comparing adoption mean scores from pretest to final posttest eight weeks later, and the final increase in scores (from 4.1053 to 4.6053) was not enough to be significant for sustained adherence to guidelines. Some factors that may have contributed to an insignificant increase in mean adoption score could include unclear wording of questions or misinterpretation of questions. Given that the project site rarely cares for lactating surgical patients, participants may have interpreted the question as frequency of caring for these patients instead of how often they adhere to the evidence-based recommendations.

The Iowa Model was used as a translational framework for this project, and the steps as described previously were followed through designing and piloting the practice change (Iowa Model Collaborative, 2017). An attempt was made to sustain the practice change with the

development and dissemination of a visual guide. While the project was successful at significantly increasing knowledge and confidence in applying evidence-based practice recommendations for lactating surgical patients, the increase in adoption scores after eight weeks was not enough to be significant ($p = 0.060$). According to the Iowa Model, next steps would include consideration of alternatives and perhaps redesign to promote sustained practice change (Iowa Model Collaborative, 2017). Perhaps modification of the adoption questions to focus on intent instead of frequency of guideline use in practice would make the instrument clearer.

Recommendations

While there remains a paucity of rigorous literature studying implementation of postoperative breastfeeding guidelines in anesthesia departments, this project can contribute to filling gaps and informing future studies. Recent studies have begun the work to discover best practices for evidence-based postoperative breastfeeding policy implementation (Moore et al., 2021; Rieth et al., 2018). Successful sustained increases in confidence and knowledge were attained in this project through digital and accessible methods. In a society and healthcare environment reliant upon technology and convenience, interventions using accessible digital methods are relevant and current. This project's successful educational methods may inform educational aspects of future postoperative breastfeeding guideline implementation projects in similar anesthesia departments. Additionally, this project's results relating to adoption measures may inform future studies that this specific project's methodology and instrument may not be adequate to sustain adoption or measure true adoption appropriately.

Limitations

Barriers and limitations for this project included timing, CRNA turnover, sampling method, and small sample size. With a timeline based on a rigorous academic schedule,

conducting a project over a longer period of time was not feasible, although true long-term sustained change would be more appropriately measured over years instead of weeks or months. CRNA turnover was also a barrier to success. The department was experiencing heavy turnover at the time of project implementation, so some emails were invalid, while other incoming CRNAs joined the department after the implementation date and were thus unable to participate. Implementing the project on a continuous basis would possibly allow for rolling recruitment. At the time of recruitment, there were approximately 30 CRNAs available for participation. Convenience sampling was used for this project in order to obtain the largest possible sample from the CRNA group, but this sampling method presents a limitation for this project. A simple random sample would have provided more randomization and thus more rigor. Another limitation of this project is the small sample size of n=19. A larger sample size would have also increased rigor and strength of results.

Conclusion

This project demonstrated that a multifaceted intervention including an educational module and visual guide is effective at increasing CRNA knowledge and confidence related to evidence-based perioperative breastfeeding recommendations over a span of eight weeks at a regional hospital. The current body of evidence overwhelmingly supports that most lactating patients should be able to breastfeed after anesthesia when they are fully alert and awake. The literature and recommendations support a shift in practice from “pumping and dumping” to uninterrupted breastfeeding. For this project, there was an immediate increase in mean adoption score after the module and visual guide interventions, but the increase from baseline was insignificant eight weeks later. This project supports the recommendation that multifaceted, digital methods including an online module and visual guide are appropriate to increase CRNA

knowledge and confidence measures regarding the care of lactating patients undergoing anesthesia.

While the multifaceted methods were successful for significantly increased knowledge and confidence scores in this small CRNA group at a regional hospital without an obstetrics department, more research is needed to determine interventions that would be effective in larger CRNA groups and anesthesia departments at other sites. This project also supports that more research is needed to determine the best multifaceted project methods to increase CRNA adoption of perioperative breastfeeding recommendations. For optimum patient-centered care that considers current evidence and patient wishes, more studies are also needed to determine best methods for sustained translation of postoperative breastfeeding recommendations into policy and practice. Dissemination of this project's results includes a graduate program poster presentation, a digital manuscript upload into the NC DOCKS repository, and a PDF poster summary emailed to stakeholders, including staff and organizational leadership.

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Appendix A

Instrument

1. Please respond to the following statement with a rating of confidence from 1 = strongly disagree to 5 = strongly agree.

"I am confident about medication choices when caring for lactating patients undergoing general anesthesia."

- ○ Strongly Disagree (1)
- ○ Somewhat Disagree (2)
- ○ Neutral (3)
- ○ Somewhat Agree (4)
- ○ Strongly Agree (5)

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2. Please respond to the following statement with a rating of confidence from 1 = strongly disagree to 5 = strongly agree.

"I am confident in my understanding of current recommendations for breastfeeding after general anesthesia."

- ○ Strongly Disagree (1)
- ○ Somewhat Disagree (2)
- ○ Neutral (3)
- ○ Somewhat Agree (4)
- ○ Strongly Agree (5)

3. Please respond to the following statement with a rating of confidence from 1 = strongly disagree to 5 = strongly agree.

"I am confident in my ability to provide evidence-based advice to lactating mothers regarding breastfeeding after anesthesia."

- ○ Strongly Disagree (1)
- ○ Somewhat Disagree (2)
- ○ Neutral (3)
- ○ Somewhat Agree (4)
- ○ Strongly Agree (5)

4. Please respond to the following statement with a rating from 1 = never to 5 = always.

"I use the current recommendations regarding breastfeeding after anesthesia in my practice when choosing medications for lactating patients undergoing general anesthesia."

- ○ Never (1)
- ○ Rarely (2)
- ○ Sometimes (3)
- ○ Often (4)
- ○ Always (5)

5. Please respond to the following statement with a rating from 1 = never to 5 = always.
"I use the current recommendations regarding breastfeeding after anesthesia in my practice when providing advice for lactating patients undergoing general anesthesia."

- ○ Never (1)
- ○ Rarely (2)
- ○ Sometimes (3)
- ○ Often (4)
- ○ Always (5)

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6. What is the general rule for resumption of breastfeeding after anesthesia?

- ○ Breastfeeding can resume when the lactating mother is awake and alert enough to breastfeed without pumping and dumping any breast milk.
- ○ Breastfeeding can resume when the lactating mother is awake and alert to do so, after pumping and dumping breast milk one time post-anesthesia.
- ○ Breastfeeding can resume 24 hours after anesthesia. The breastfed child should receive alternate nutrition sources during this period of time, and mothers should be encouraged to pump and dump breast milk during this time to prevent engorgement.
- ○ Breastfeeding can resume 6 hours after anesthesia. The breastfed child should receive alternate nutrition sources during this period of time, and mothers should be encouraged to pump and dump breast milk during this time to prevent engorgement.

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7. What is the relative infant dose (RID) that, below this generally accepted threshold, medications are considered safe for breastfed children?

- ○ 5%
- ○ 10%
- ○ 12%
- ○ 15%

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8. True or False? All anesthetic and analgesic drugs transfer to breast milk.

- ○ True
- ○ False

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9. Which drugs should be avoided in lactating women?

- ○ Codeine, Morphine, and Tramadol
- ○ Morphine, Midazolam, and Codeine
- ○ Propofol, Codeine, and Midazolam
- ○ Codeine, Tramadol, and Meperidine

---

10. When tailoring anesthesia for lactating women, it is important to consider that:

- ○ Propofol is considered safe for bolus dosing only.
- ○ Propofol is considered safe when administered as a continuous infusion only.
- ○ Propofol is considered safe when administered via boluses or continuous infusions.
- ○ Propofol is not considered safe to use in lactating women due to a common side effect of green breast milk discoloration.

Appendix B

Visual Guide

Evidence-Based Recommendations for Postoperative Breastfeeding

RECOMMENDATIONS:

- Mothers should be able to safely breastfeed when they are fully awake and alert after surgery.
- Multimodal approaches are recommended (limit narcotic consumption)
- Consider infant health status and maturity.

PROCEED ☑	PROCEED WITH CAUTION/MONITORING	AVOID ⊘
• Fentanyl • Morphine • Remifentanil • Midazolam • Propofol • Inhaled anesthetics • Etomidate • NMBDs • Reversal agents • Anticholinergics • Sugammadex • Ondansetron • Metaclopramide • Dexamethasone • Ketorolac • Acetaminophen	• Ketamine* • Dexmedetomidine* **Limited data*	• Meperidine • Codeine • Tramadol • Diazepam

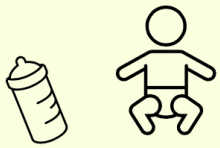
FAST FACTS:

- ALL anesthetic and analgesic drugs transfer to breastmilk
  - Only small amounts/very low concentrations present → clinically insignificant
- Relative Infant Dose (RID) less than 10% generally considered SAFE
- Standard doses of most drugs are SAFE for bolus dosing
  - Bolus doses and continuous infusions of Propofol are safe
  - Continuous infusions of Remifentanil are safe

FOR UPDATED INFORMATION AND EVIDENCE:

- LactMed Database (National Library of Medicine)

(Scan with phone camera)



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