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Utilizing Ultrasound-Guided Technology for Epidural Placement in Obese Laboring Patients

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UTILIZING ULTRASOUND-GUIDED TECHNOLOGY FOR
EPIDURAL PLACEMENT IN OBESE LABORING PATIENTS

by

Diamond Forkner and Aimee Hoang

A Doctoral Project
Submitted to the Graduate School,
the College of Nursing and Health Professions
and the School of Leadership and Advanced Nursing Practice
at The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Nursing Practice

Approved by:

Dr. Michong Rayborn, Committee Chair
Dr. Nina McLain, Committee Member

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ABSTRACT

Epidural anesthesia is the mainstay choice to provide parturient patient pain relief during the laboring process. However, the incorrect placement of an epidural catheter can result in inadequate control of labor pain and other adverse complications to both mother and fetus. Aside from normal physiologic changes that occur during pregnancy that may contribute to difficulty in placing an epidural catheter, obesity further complicates the procedure by further obscuring anatomical landmarks that are traditionally used for epidural placement in non-obese parturient (Brodsky & Mariano, 2011). As the prevalence of obesity is rising in the United States, anesthesia providers may face more difficulty in placing epidural catheters and providing adequate analgesia to the obese laboring patient. Current literature has shown that by including the utilization of additional tools such as ultrasound-guidance and the traditional landmark-based technique during epidural placement in an obese laboring patient, both anesthesia providers and patients will benefit.

This doctoral project focused on creating an educational module that includes information and video demonstrations in the form of a PowerPoint™ presentation for utilizing ultrasound guidance for epidural placement in obese laboring patients. The educational module was sent to 20 student registered nurse anesthetists (SRNA) in their third year of the nurse anesthesia program and an expert panel consisting of four certified registered nurse anesthetists (CRNA) who are also faculty of the nurse anesthesia program. They were all considered to be relevant stakeholders due to their knowledge concerning regional anesthesia. A post-educational module survey was also sent to each participant to complete afterward to evaluate the educational module's effectiveness and

allowed additional comments and feedback from the participants. All of the stakeholders found the educational module informative on the utilization of ultrasound for epidural placement in obese laboring patients. The expert panel unanimously agreed that this educational module was informative and would consider a practice change in their current practice.

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We would like to express our sincere gratitude to our committee chair, Dr. Michong Rayborn. She has helped us reach our goal of completing this doctoral project ahead of our deadline. Dr. Rayborn's ability to keep up with our persistence in meeting deadlines and ensuring there is continuous communication during these trying times of this pandemic has been a pure example of an extraordinary teacher willing to go above and beyond for their students.

DEDICATION

Diamond Forkner

I would like to dedicate this paper to my husband for his continued support, my godmother for being there every step of the way, and my late grandfather for always pushing me forward. Lastly, I would like to dedicate this paper to my partner, Aimee Hoang, because she has been the best partner to have throughout this journey of the Nurse Anesthesia Program

Aimee Hoang

I would like to dedicate this paper to my immediate family for being understanding of my busy schedule and for all of the times they have had to listen to me talk about school and this doctoral project. I would also like to dedicate this paper to my close friends for keeping in touch and checking in on me to make sure that I am healthy and doing well. Lastly, I would like to dedicate this paper to my partner, Diamond Forkner, because she has been the best partner to have throughout this journey of the Nurse Anesthesia Program.

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LIST OF ABBREVIATIONS

<i>AACN</i>	American Association of Colleges of Nursing
<i>cm</i>	Centimeter
<i>CRNA</i>	Certified Registered Nurse Anesthetists
<i>CSF</i>	Cerebrospinal fluid
<i>DNP</i>	Doctor of Nursing Practice
<i>IRB</i>	Institutional Review Board
<i>kg/m²</i>	Kilograms per meters squared
<i>NAP</i>	Nurse Anesthesia Program
<i>OSA</i>	Obstructive sleep apnea
<i>SRNA</i>	Student registered nurse anesthetist
<i>USM</i>	The University of Southern Mississippi

CHAPTER I – INTRODUCTION

Epidural placement is a common anesthetic intervention to help the laboring mother adapt to the stress and pain that occurs during the labor process. Epidural anesthesia, to some degree, attenuates the stress response that commonly results in increased sympathoadrenal activity (Summers & Flett, 2019). Epidural analgesia effectively relieves pain during labor in comparison to other pharmacological and nonpharmacological interventions (Jones et al., 2012). The anatomical changes that occur during pregnancy affect the technique anesthesia providers utilize for epidural placement (Chestnut et al., 2019). Maternal obese laboring patients have a compound of physiological and anatomical changes that make epidural placement more difficult. These challenges that the anesthesia provider faces increase the risk of displacement of the epidural catheter in the obese laboring patient. The utilization of ultrasound technology has the advantage of being able to identify anatomical landmarks that are otherwise nonpalpable due to the anatomical changes on top of obesity.

Problem Statement

The identification of the epidural space with a small-gauge spinal needle can be challenging for the anesthesia provider due to the excessive adipose tissue at the needle placement site (Chestnut et al., 2019). Laboring obese patients are at higher risk of not achieving optimal pain relief due to the potential displacement of the epidural catheter. Epidural analgesia also allows the anesthesia provider to avoid the possibility of an unanticipated difficult airway in a morbidly obese patient. The correct placement of epidural in advance of the case is preferred in the instance of emergency anesthetic management. The goal of this project was to create a standard of care utilizing ultrasound

technology to address and prevent the risk of inadequate epidural placement in an obese laboring patient.

Available Knowledge

Neuraxial Analgesia

The ideal analgesia choice for labor should be useful in both the early and late stages of labor, along with being safe for both mother and fetus (Summers & Flett, 2019). Neuraxial analgesia is the only type of anesthetic intervention that can provide adequate analgesia for both stages of labor (Chestnut et al., 2019). Neuraxial analgesia comprises of a variety of techniques such as epidural, spinal, combined spinal-epidural, and caudal analgesia. Neuraxial analgesia can be maintained with intermittent or continuous administration of analgesics (Chestnut et al., 2019). Continuous epidural analgesia has been the mainstay in the choice of neuraxial analgesia during labor because the epidural catheter allows the conversion to epidural anesthesia should the chance of a cesarean delivery arise (Chestnut et al., 2019).

Physiological Changes in the Maternal Patient

Physiologic changes that occur during pregnancy, such as edema, obesity, and exaggerated lordosis, may increase the difficulty in palpating anatomical landmarks used for performing epidural placement or providing a neuraxial blockade (Lee, 2014). Alterations in hormones during pregnancy cause the interspinous ligaments to become softer and changes the anatomical landmarks and locations that are traditionally used to palpate for epidural procedures (Lee, 2014). The physiological changes that the maternal patient experiences affect the anatomical changes that the maternal patient endures, which in turn influences epidural placement. The anatomical changes that occur during

pregnancy affect the technique the anesthesia providers utilize for epidural placement (Chestnut et al., 2019). The risk of an inadvertent dural puncture occurrence increases due to the narrowing of epidural and intrathecal space (Lee, 2014). After the correct placement of the epidural catheter is completed, careful attention must be geared towards how maternal patients respond to local anesthetics in comparison to non-pregnant patients.

Maternal patients experience a more rapid onset, along with a longer duration of local anesthetic effects due to the physiological and anatomical changes during pregnancy (Chestnut et al., 2019). Pregnant patients are more prone to hypotension and hemodynamic instability that occurs from the sympathetic block that is induced by neuraxial anesthesia (Chestnut et al., 2019). Anesthesia providers must be aware of the physiological and anatomical changes that occur with maternal patients when providing neuraxial anesthesia. Knowing these changes and the expected outcome will help the anesthesia provider to recognize what is normal and what is abnormal when caring for maternal patients. Maternal patients who are obese bring forth more challenges for epidural placement during labor.

Obese Laboring Patients

Physiological and Anatomical Changes. Obesity is becoming more prevalent in the world, even amongst the maternal patient population. A maternal patient is considered obese when her body mass index is 30 kg/m² or higher (Chestnut et al., 2019). Obese women are at an increased risk for maternal and fetal adverse complications during labor (Melchor et al., 2019). In addition to the physiological complications caused by obesity, pregnancy further potentiates the difficulty of identifying the anatomical landmarks used

to appropriately place an epidural catheter (Brodsky & Mariano, 2011). The anatomical changes that occur with the maternal obese patient, such as redundant tissue, make epidural placement more difficult due to a variety of reasons. The distance between the skin and epidural space is greatly affected by the patient's weight and physiologically body composition changes during the placement of epidural catheters (Brodsky & Mariano, 2011). The maternal obese patient has the extra weight that causes a decrease in cerebrospinal fluid (CSF). Obese patients have a further reduction of cerebrospinal fluid volume during pregnancy due to the increase in abdominal pressure as well as from displacement of the CSF caused by soft tissue compression to the intervertebral foramen (Brodsky & Mariano, 2011). Although epidural catheter placement may be more difficult in the obese laboring patient, neuraxial anesthesia is the best choice for pain during labor (Chestnut et al., 2019). Morbidly obese patients are at an increased risk of airway difficulty, but neuraxial analgesia is the best choice because it avoids the potential of an unanticipated difficult airway.

Difficult Airway. An obese parturient patient is not an ideal candidate to undergo general anesthesia due to the increased risk of morbidity and mortality that result from complications that may occur during general anesthesia. Vernon et al. (2019) identified some dangers and disadvantages of general anesthesia to include “failed intubation, aspirations, and poor postoperative analgesia and recovery” (p. 53). One factor that places an obese parturient at high risk for complications includes a higher Mallampati score from the “excess adipose tissue and edema of the upper airway” that contributes to the anesthetist having difficulty intubating the patient during general anesthesia induction and “is one of the most recognized causes of anesthesia-related maternal mortality”

(Singh et al., 2013, pp. 1–2). An anesthetist must recognize this risk and anticipate that obese parturient patients will have a higher risk for the occurrence of “pulmonary aspiration and inadequate ventilation” (Singh et al., 2013, p. 2). Obese laboring patients, especially those with obstructive sleep apnea who are more sensitive to the depressing respiratory effects of certain anesthetic drugs, may benefit from epidural analgesia along with local anesthetics due to the reduction of required parenteral opioids (Brodsky & Mariano, 2011). A patient receiving epidural analgesia may experience more pain control with less opioid requirements throughout the procedure, less occurrence of postoperative nausea and vomiting, better postoperative pain control, and overall a more satisfying labor experience (Brodsky & Mariano, 2011). Therefore, the placement of an epidural catheter that is reliable and functioning appropriately will decrease the risk of morbidity and mortality for the obese laboring patient and improve fetal outcome (Singh et al., 2013).

Epidural Catheter Placement

Adjuncts to Local Anesthetics. To understand the implications that local anesthetics have on the maternal patient, a basic understanding of local anesthetics mechanisms of action is needed. Local anesthetics provide analgesia by blocking the transmission of the sensation of pain along nerve fibers (Barash et al., 2017). The site of action for local anesthetics is the cell membrane but, more specifically, voltage-gated sodium channels (Barash et al., 2017). Local anesthetics prevent the transmission of pain by stopping the depolarization of the nerve fiber (Barash et al., 2017). The effect of the local anesthetics depends on the concentration and volume given (Barash et al., 2017). The addition of other medications can potentiate the effects of local anesthetics.

Epinephrine in 2% lidocaine is a frequently chosen combination for epidural anesthesia because the addition of epinephrine causes a longer duration of the epidural block (Chestnut et al., 2019). A significant advantage of the epinephrine and lidocaine mixture is the resulting improvement of the epidural anesthesia quality (Chestnut et al., 2019). Epidural opioids, such as fentanyl or sufentanil, can be used as an adjunct to amide local anesthetics for the synergistic effects of lowering the local anesthetic dose requirement and decreasing the amount of motor blockade during labor, which will ultimately result in increased patient satisfaction (Biel et al., 2017; Chestnut et al., 2019). Sodium bicarbonate is another adjunct that may be added to lidocaine to reduce the latency of effects for epidural analgesia (Chestnut et al., 2019).

Patient Safety. Patient safety must be maintained throughout the entire procedure of placing an epidural catheter. The anesthetist must understand the necessary, yet pertinent details of placing an epidural catheter. Factors that the anesthetist must consider identifying which position is best for the patient to be placed in, having all appropriate equipment and emergency supplies available before beginning the procedure, and implementing proper techniques to ensure the method is as safe for the patient as possible.

Patient Positioning

Patients can be placed in either the lateral or the sitting position (New York School of Regional Anesthesia [NYSORA], n.d.). In the lateral position, the facilitation of continuous monitoring of fetal heart rate is possible, and the patient is less likely to experience orthostatic hypotension (Chestnut et al., 2019). However, the lateral position

must be selected cautiously in morbidly obese parturient patients due to the possible occurrence of hypoxemia (Chestnut et al., 2019).

The second is the sitting position, which is often the preferred position (Chestnut et al., 2019). Mace et al. (2011) found that having the patient in the sitting position allows for the ease of locating landmarks as well as decreasing the distance between the patient's skin and epidural space, especially in obese parturient patients. The sitting position allows for a more “direct route to the epidural space,” but maybe a difficult position to maintain in parturient patients (NYSORA, n.d., Sitting Position section, para. 1). The optimal position for the patient to be in during an epidural placement is the sitting position with the patient slouching, flexing their spine as much as possible to “open the vertebral spaces” (NYSORA, n.d., Sitting Position section, para. 2). A disadvantage of this position is the risk of the patient experiencing orthostatic hypotension and syncope (Chestnut et al., 2019). However, the sitting position may be required for obese parturient patients due to the identification of the midline being significantly easier while in this position (Chestnut et al., 2019).

Equipment

Patients receiving neuraxial anesthesia, such as epidural anesthesia are generally awake and conscious throughout the procedure. The placement of an epidural catheter may alter a patient's homeostasis due to the medications required for the procedure, which necessitates the application of monitoring such as continuous electrocardiogram, pulse oximetry, heart rate, and intermittent blood pressures and temperature (NYSORA, n.d.). According to the New York School of Regional Anesthesia (NYSORA, n.d.), appropriate monitors are to be applied to a patient before placement of the epidural and

throughout the administration of the epidural analgesia, especially fetal heart rate monitoring in a laboring patient. Emergency equipment must be readily available in case of an adverse event, such as an inadvertent intrathecal injection causing a life-threatening high-spinal block that may result in cardiac and respiratory compromise. Another emergency that may occur is a compromised airway. Equipment that should be easily accessible for airway emergencies includes an “Ambu bag with a mask, oxygen source, oral and nasal airways, laryngoscope handles and blades, endotracheal tubes, Eschmann stylet/bougie, syringes and needles,” as well as emergency medications to control blood pressure, heart rate, anxiety, local anesthetic systemic toxicity, and paralytics for intubation (NYSORA, n.d., Preparation section).

Special equipment required for the implementation of the procedure includes an epidural needle, the epidural catheter, and a loss-of-resistance syringe (Chestnut et al., 2019). Standard epidural kits or trays usually contain almost all of the equipment needed for the procedure. The epidural needle included in packages is typically a 17 gauge Tuohy needle that has a length of 9 cm. However, an obese patient may require a longer needle length. Longer needles, some measuring up to 15 cm long, available are more appropriate to use in an obese parturient and should be readily accessible in case it is needed during the procedure (NYSORA, n.d.). An efficient way to ensure preparedness for placing an epidural catheter is by having all the necessary equipment on hand, such as needles with adequate lengths available (Brodsky & Mariano, 2011).

Techniques

The sitting position with a stool available for patients to support their feet on with the backs of their knees resting against the edge of the bed allows patients to position

their back closer to the anesthetist (Chestnut et al., 2019). Maintaining a strict aseptic technique is crucial to preventing the occurrence of an epidural space infection (NYSORA, n.d.). To avoid spinal cord damage, the adequate placement for the epidural catheter begins by locating the L4 spinous process by “an imaginary line between the iliac crests,” also known as Tuffier’s line (Wang et al., 2012, p. 3840). Spinal cord damage can also be avoided by using the midline approach to insert a 17 gauge Tuohy needle at the L3–4 or L4–5 intervertebral space until a loss of resistance is met (Vallejo et al., 2010). Once the epidural dura membrane is punctured, the epidural catheter is threaded through without intrathecal dosing (Biel et al., 2017). A test dose is essential to administer before induction to identify a potential intravascularly placed catheter (Biel et al., 2017).

Current Techniques in Obese Population

The difficulty of epidural anesthesia is further increased in obese parturient women due to problems, such as the limitation of back flexion and palpation of landmarks traditionally used to identify the epidural space, leading to an increased incidence of failure rates and multiple needle insertion attempts (Mace et al., 2011). Studies have identified several techniques that may assist in epidural placement in this population of patients. By assessing light touch discrimination, a patient can confirm with the anesthetist to determine the midline (Mace et al., 2011). Another helpful technique is to tilt the table towards the anesthetist to allow the ease of lumbar space opening for epidural placement and locating the interspinous process by using the seeker needle (Mace et al., 2011). The possibility of a change in the epidural catheter’s position may occur when a patient is repositioning from a “sitting-flexed to the sitting-upright or lateral

decubitus position,” especially an obese parturient (Chestnut et al., 2019, p. 251).

Appropriate interventions that may minimize movement of the epidural catheter secured at the patient's skin are to have the patient in the sitting upright or the lateral decubitus position before securing the catheter (Chestnut et al., 2019).

Confirmation of Placement. A successful epidural catheter placement depends on the correct placement of the needle tip, which is in the epidural space (Chestnut et al., 2019). Proper placement of the epidural catheter into the intrathecal area will cause a rapid sensory and motor block along with a sympathetic blockade that results in hypotension (Biel et al., 2017). The identification of the epidural space can be accomplished by either the loss-of-resistance technique, the hanging drop technique, or by utilizing the ultrasound imaging technique (Chestnut et al., 2019; NYSORA, n.d.).

Landmarks

Anatomical landmarks are used to determine the appropriate location to place an epidural catheter. The palpable bony landmarks used to identify the correct intervertebral space are the iliac crest and spinous processes (Wang et al., 2012). The iliac crest is located by palpation to determine the L3–4 or L4–5 intervertebral space (Singh et al., 2013). The optimal space for epidural placement is at or below L2–3, which is determined by estimation based on the anatomical landmarks and Tuffier's line (Arnolds et al., 2019). Once the appropriate intervertebral space is identified, the next landmarks to determine correct epidural placement are nonpalpable. Beginning from the most superficial to the deepest layer, an epidural needle is first inserted through the skin, followed by the subcutaneous tissue, the supraspinous ligament, the interspinous

ligament, and finally through the ligamentum flavum into the epidural space (Chestnut et al., 2019).

The anatomical landmarks can be obscured by the regular changes in weight gain and tissue edema that occur during pregnancy. Assessment in an obese parturient may be less accurate than in a non-obese parturient due to the increased amount of adipose tissue and other anatomical changes that further obscure the ability for the anesthetist to correctly palpate and identify the correct intervertebral space (Wang et al., 2012). In some obese patients, the spinous processes can be as deep as 5 cm, “the ligamentum flavum as deep as 8 cm, and at extremes of 11–12 cm deep” (Singh et al., 2013, p. 2). The incorrect identification of landmarks can result in inappropriately placing the epidural catheter.

Risk of Inadequate Placement. Epidural catheters are not effective in delivering analgesia or controlling labor pain if inadequately placed. The patient may also experience other physiological complications that may result in negative outcomes due to inadequately placed epidural catheters. The additional anatomical changes and challenges caused by obesity in laboring patients increase the chances for epidural displacement. Anesthesia providers being aware of the complications and how to prevent as well as treat them is of high importance for the safety of the patient.

Complications of Displacement

The displacement of an epidural catheter during anesthesia can result in complications to the patient. Vallejo et al. (2010) describe a failed epidural technique as one that requires the replacement of the epidural catheter for a patient during labor. The main result of a failed epidural is the failure to provide analgesia to the patient (Vallejo et

al., 2010). Inaccurately identifying the location of the epidural puncture site may result in puncture failure and an increase in unnecessary needle probing repeats (Wang et al., 2012). Wang et al. (2012) stress the importance of correctly identifying the puncture site to reduce the occurrence of risks that may follow each puncture attempt, including the formation of a “hematoma, neurological damage, infection, and inadvertent dural puncture” (p. 3840).

Neurological damage caused by epidural anesthesia is rare, but is not impossible and can cause detrimental damage to the patient (Barash et al., 2017). Laterally deviated epidural needles can result in damage due to direct needle contact with the spinal cord and the vasculature of the spinal cord (Barash et al., 2017). Also, accidental intravascular injection combined with epidural absorption of local anesthetics can lead to systemic local anesthetic toxicity (LAST) (Barash et al., 2017). LAST can be fatal to both mother and fetus if not treated quickly, which may ultimately result in cardiac arrest (Barash et al., 2017). Incorrect identification of interspinous processes can result in improper epidural placement, leading to a higher neuraxial block than intended (Barash et al., 2017). This higher block can compromise the cardiopulmonary system and ultimately lead to cardiac arrest (Barash et al., 2017). Therefore, the correct direction of epidural needle insertion and catheter placement is crucial to prevent and reduce the risk of harm to the patient and fetus.

Challenges Faced with Obese Population

Obese patients are at a higher risk for epidural displacement. When an obese parturient patient is changing positions to a supine or lateral position from a sitting position, the secured portion of the epidural catheter on the patient’s skin will pull back

and out of the epidural space (Brodsky & Mariano, 2011). Changes in a secured epidural catheter, as much as 1 cm in movement, are more likely to occur in patients with a body mass index (BMI) > 30 kg/m² following position changes (Brodsky & Mariano, 2011). A preventative measure is to insert the epidural catheter 4 cm further into the epidural space with the anticipation for potential catheter displacement during patient repositioning (Brodsky & Mariano, 2011).

Obese parturient patients are at an increased risk of accidental dural punctures during epidural placement due to the difficult identification of their epidural space (Mace et al., 2011). Accidental dural punctures in part is contributed by the greater depth required to reach the epidural space and the “false loss of resistance” by inserting the catheter between the interspinous ligament and the ligamentum flavum instead of through the ligamentum flavum into the epidural space (Mace et al., 2011, p. 563). “The incidence of a false-positive loss-of-resistance” increases in obese patients during identification of the epidural space due to the existence of fat pockets that are otherwise not as apparent in a non-obese pregnant patient (Lee, 2014, p. 352).

A local anesthetic administered in a volume equivalent to one that is delivered to a non-obese patient will have a more significant effect in pregnant obese patients due to the concentration of local anesthetic being higher in a lower cerebrospinal fluid volume (Brodsky & Mariano, 2011). The increased distance between the skin, the decrease in epidural space, and the increased sensitivity to average local anesthetic doses predispose the patient to more complications, which makes it more challenging to find anatomical landmarks for epidural placement. Complications from epidural placement mainly arise from placing the analgesic agent into the spinal anatomy instead of the epidural space

(Biel et al., 2017). The limited ability of obese women to perform back flexion and the difficulty of palpating landmarks traditionally used to place epidural catheters contributes to the difficult epidural placement and an increased rate in epidural failure (Mace et al., 2011).

Ultrasound-Guided Technology. Ultrasound technology can be a useful tool during epidural placement, especially in obese laboring patients. Regarding the risks of inadequate epidural catheter placement, ultrasound can provide a more accurate visualization of the patient's anatomy and the current positioning of the epidural needle and catheter. Ultrasound guidance can offer advantages for anesthesia providers in ensuring proper catheter placement. Although standard guidelines for ultrasound use are available, the possibility of challenges with its use exists.

Accuracy

The use of ultrasound enables *real-time needle guidance* and the identification of landmarks that are not able to be seen underneath the skin (Brodsky & Mariano, 2011). Ultrasound provides additional information such as midline position along with an estimation of epidural depth when faced with obese parturients (Biel et al., 2017). Vallejo et al. (2010) found that the use of ultrasound to confirm a patient's midline, to determine the direction of the needle, and to determine how deep the epidural space is before placement resulted in fewer failure rates, less number of attempts required to place a successful epidural catheter, and less need for catheter replacement. Ultrasound guidance to clarify landmarks for inserting an epidural needle in an obese laboring patient may slightly increase the preparation time but ultimately decreases the time of the procedure for a successful placement, which overall leads to improved patient satisfaction (Vernon

et al., 2019). Other benefits of using ultrasound to guide the placement of an epidural catheter include “superior epidural catheter function and lower complication rates” (Lee, 2014, p. 352).

Current Standard Guidelines

The current standards for epidural placement using ultrasound guidance provides the anesthesia provider with a set of guidelines that will ameliorate the challenges faced in an obese laboring patient. The patient seated in a sitting position allows for optimal ultrasound visualization during the epidural placement with back flexion (Vallejo et al., 2010). Vallejo et al. (2010) found that by identifying and marking the intervertebral space by palpating the “posterior superior iliac crest and on Tuffier’s line” to view “the longitudinal median and transverse ultrasound planes, confirm midline, and determine the final insertion point,” an adequate view of the ligamentum flavum was provided (p. 374).

Challenges of Using Ultrasound Guidance

Ultrasound has been beneficial in locating anatomical landmarks, such as the midline, the vertebral level, and the distance from skin to epidural space, in the obese parturient population (Brodsky & Mariano, 2011). However, an anesthetist using ultrasound guidance in obese parturient patients may experience some difficulties due to the need for a greater depth of penetration compared to a non-obese patient (Brodsky & Mariano, 2011). A challenge that may arise is a decrease in sound waves penetrating to deeper tissues and an increase in the distance the ultrasound beam must travel to reach the deeper tissue (Brodsky & Mariano, 2011). A lower resolution in the ultrasound imaging in obese patients is due to the increased “thickness of adipose tissue between the skin and the tip of the spinous process” (Lee, 2014, p. 352). One option to improve the

ultrasound imaging is by compressing the adipose tissue, but the compression may lead to underestimating the distance between the skin and the epidural space (Lee, 2014).

Advantages for Anesthetists

The use of ultrasound-guided technology is beneficial in all patients in labor, requiring epidural catheter insertion, but is especially helpful in obese parturient patients (NYSORA, n.d.). The use of ultrasound-guidance to perform regional anesthesia promotes a higher success rate and lower complication rate in addition to the “traditional landmark-based techniques” (Lee, 2014, p. 349). Ultrasound guidance may assure the anesthetist with confirmation of the epidural catheter placement. An advantage of ultrasound guidance in comparison to the palpation technique is that the ultrasound allows a more accurate determination of the distance to the ligamentum flavum of subarachnoid space (Kline, 2011). Utilizing ultrasound guidance during invasive procedures tends to be safer, faster, cheaper, and provides greater comfort to patients in comparison to traditional methods (Kline, 2011).

Rationale

Epidural anesthesia is the best choice to provide obese maternal pain with analgesia during labor. The induction of general anesthesia during the intraoperative period is undesirable and has the potential to be hazardous in the morbidly obese patient and on the fetal outcome (Chestnut et al., 2019). The available knowledge has shown that epidural will be more challenging to place in an obese maternal patient in comparison to non-obese maternal patients during labor. Anesthesia providers need to be aware of the complications that are associated with epidural placement in the obese maternal patient, along with an understanding of the utilization of ultrasound-guided technology. Utilizing

ultrasound technology can result in a decrease in the displacement of epidural catheter placement, a reduction of complications due to the displacement of epidural catheter placement, and an increase in obese maternal and fetal safety, outcome, and satisfaction. The purpose of this project is to develop a standard of care for student registered nurse anesthetists (SRNA) when providing neuraxial anesthesia to obese maternal patients during labor utilizing ultrasound technology.

Specific Aims

The specific aim of this doctoral project is to create a best-practice recommendation by bridging the gap in knowledge for anesthesia providers concerning ultrasound technology and epidural placement in obese laboring patients. The goal of this doctoral project is to decrease the risks and adverse outcomes associated with epidural placement in obese laboring patients while achieving adequate pain relief. Obese laboring patients are at an increased risk for epidural failure which could lead to adverse outcomes for both mother and fetus (Barash et al., 2017). This best-practice recommendation addresses the gap in safety and quality of care for epidural placement in obese laboring patients.

DNP Essentials

Eight Essentials are deemed necessary for all graduates of a DNP program (American Association of Colleges of Nursing [AACN], 2006). This doctoral project meets all eight Essentials of doctoral education for advanced practice nursing required by the American Association of Colleges of Nursing (AACN,2006). This doctoral project mainly focused on Essentials III, IV, and VII. Essential III (clinical scholarship and analytical methods for evidence-based practice) was met by extensive research and

analysis of current literature on the efficacy of using ultrasound-guidance for epidural placement in obese parturient patients has been performed to formulate a best practice recommendation. Essential IV (information systems/technology and patient care technology for the improvement and transformation of health care) was met by creating a best-practice recommendation online educational module. Essential VII (clinical prevention and population health for improving the nation's health) was met by creating a best practice recommendation for epidural placement in obese maternal patients to improve outcomes for mother and fetus. The complete list of eight Essentials concerning this project are described in Appendix A.

Summary

The anatomical and physiological changes that occur in maternal patients require special consideration concerning neuraxial anesthesia. In comparison to non-obese laboring patients, obese parturient patients arrive with more challenges and complications for the anesthetist when neuraxial anesthesia is required. Ultrasound-guidance for epidural placement has been shown through the available knowledge from numerous research and studies has shown to have better patient and procedural outcomes compared to the traditional palpation technique. Ultrasound-guided technology provides the anesthetist with the advantages to overcome the complications that are presented in maternal obese patients. The development of this process and methodology for this standard of care are described in the Methods section in Chapter II.

CHAPTER II – METHODOLOGY

Context

This project focused on creating a best-practice recommendation to encourage the utilization of ultrasound technology during epidural placement in obese parturient patients. The authors conducted a synthesis of peer-related literature related to ultrasound technology for epidural placement in obese laboring patients. The evidence gathered from the available peer-reviewed literature clearly shows the gap in knowledge concerning ultrasound technology and epidural placement in obese laboring patients. Evidence has shown that the utilization of ultrasound-guidance to assist anesthesia providers during epidural placement in obese laboring patients is more accurate than palpation alone for correct catheter placement and improves patient outcome. However, this technique may not be utilized by all anesthesia providers (Lee, 2014).

Intervention and Study of the Intervention

The first step in creating this best-practice recommendation was a thorough review of the available literature and evidence-based practice to gather information concerning ultrasound guidance while placing an epidural in obese laboring patients. The next step taken in this doctoral project was proposing it to the DNP Project committee and nurse anesthesia program (NAP) at The University of Southern Mississippi (USM). The proposal was approved by the committee, and an application for project approval from the Institutional Review Board (IRB) was submitted. Upon the project approval by the IRB (Protocol # IRB-20-273) (Appendix C), an invitational letter was sent to twenty student registered nurse anesthetists (SRNAs) in their third year of the NAP at USM, and four certified registered nurse anesthetists (CRNAs) from the NAP at USM requesting

consent to participate in this research project. The CRNAs that were selected for the expert panel are the stakeholders for this best-practice recommendation because of their years of practice as anesthesia providers. The SRNAs were stakeholders because they have completed NUR 840 Principles of Anesthesia Practice II and NUR 842 Advanced Principles of Anesthesia Practice I, which focuses on neuraxial anesthesia and obstetrics respectively, and have vast exposure to epidural placement in the clinical setting. The participants were presented with an education module (Appendix D) and the best-practice recommendation for the utilization of ultrasound-guidance during epidural placement in obese laboring patients in the form of a PowerPoint™ presentation, including videos through email. A link to the online post-education questionnaire through the Qualtrics® online survey tool was provided in the email for the participants to answer once the module was complete, consisting of questions to assess the SRNA's and CRNA's feedback on the best-practice recommendation. A sample of the questionnaire is available in Appendix E. All responses from the surveys were anonymously presented in the manuscript. Once the feedback from the participants were reviewed, and no further changes were suggested or recommended, the educational module and best-practice recommendation remained unchanged. The project was disseminated at USM's School of Leadership and Advanced Nursing Practice DNP Scholarship Day on September 25, 2020.

Measures

The expected impact of this best-practice recommendation was to decrease the number of attempts required to place the epidural catheter, lower the risks associated with epidural displacement, and increase safety for the maternal patient and fetus. The

synthesis of available knowledge indicated that utilizing ultrasound guidance for epidural placement in obese laboring patients has an advantage over placing an epidural catheter with anatomical landmarks alone. While decreasing the number of attempts to place the epidural catheter, ultrasound technology also reduces the risk of epidural displacement, which could lead to adverse outcomes for the maternal patient and fetus. The last, but most important, measure in this doctoral project is the safety of the mother and her baby. Bridging the gap of epidural placement in obese maternal patients and ultrasound technology for the anesthesia provider will allow an improvement of outcomes for the maternal patient and fetus. The feedback from the SRNAs and expert panel will also be utilized as a measure to strengthen the impact of this best-practice recommendation derived from this doctoral project.

Data Collection and Analysis

The data collected for this doctoral project were synthesized from the SRNAs and expert panel. The SRNAs and expert panel were sent an invitation email to participate in an educational module and post-survey questionnaire. Quantitative and qualitative data were gathered from the post-survey questionnaire. The data was reported anonymously and synthesized in a table and graphs in Chapter III. The responses from the surveys were analyzed and used to make appropriate changes to the best-practice recommendation and educational module as needed. There were no suggestions or concerns about the recommendation by the expert panel, so the best-practice recommendation remained unchanged.

Ethical Considerations

Ethical considerations of concern for this doctoral project is the standard of care that should be delivered to all obese maternal patients during labor by an adequately placed epidural. Maternal patients who are overweight experience an increased risk of epidural failure and difficult epidural placement (Uyl et al., 2019). Evidence shows that utilizing ultrasound technology is more accurate when placing an epidural catheter in comparison to using anatomical landmarks alone by the anesthesia provider. Introducing this best-practice recommendation addresses the standard of care, along with providing safety to the mother and fetus. The best-practice recommendation gives the anesthesia provider an advantage that leads to a decrease in the occurrence of adverse outcomes related to displaced epidural catheter.

Summary

This doctoral project aimed to create a best-practice recommendation for the utilization of ultrasound technology for epidural placement in the obese laboring patient. A synthesis of the available knowledge shows a gap in the use of ultrasound technology for epidural placement in the laboring obese maternal patient. An educational module was presented to SRNAs in their third year of the NAP and the expert panel. The feedback from the SRNAs and expert panel were reviewed and synthesized to ensure the strength and safety of the recommendation. The methods for this doctoral project helped to meet the USM School of Leadership and Advanced Nursing Practice and NAP standards as well as the AACN Essentials, which is a requirement for accreditation.

CHAPTER III – RESULTS

An educational module along with a post-educational module survey (Appendix E) was sent to four CRNAs from the NAP at USM to serve as the expert panel and twenty SRNAs in their third year of the NAP at USM. The educational module was presented in a PowerPoint™ format that included video clips of guidance for the proper technique utilizing ultrasound technology for epidural placement in obese laboring patients. The data from the post-educational module survey was collected anonymously via an online survey (Appendix E). The survey assessed the feedback from the CRNAs and SRNAs on the effectiveness of the information presented in the education model, the helpfulness of using ultrasound for epidural placement in an obese laboring patient versus the traditional blind technique, the effectiveness that the best-practice recommendation has on safety and outcome, and whether they would change their current practice based on the information presented. The CRNAs and SRNAs were also given the opportunity to provide comments or suggestions regarding the best-practice recommendation. The responses to the post-educational module (Appendix E) is presented in Figure 1, Figure 2, Figure 3, Figure 4, and Table 1.

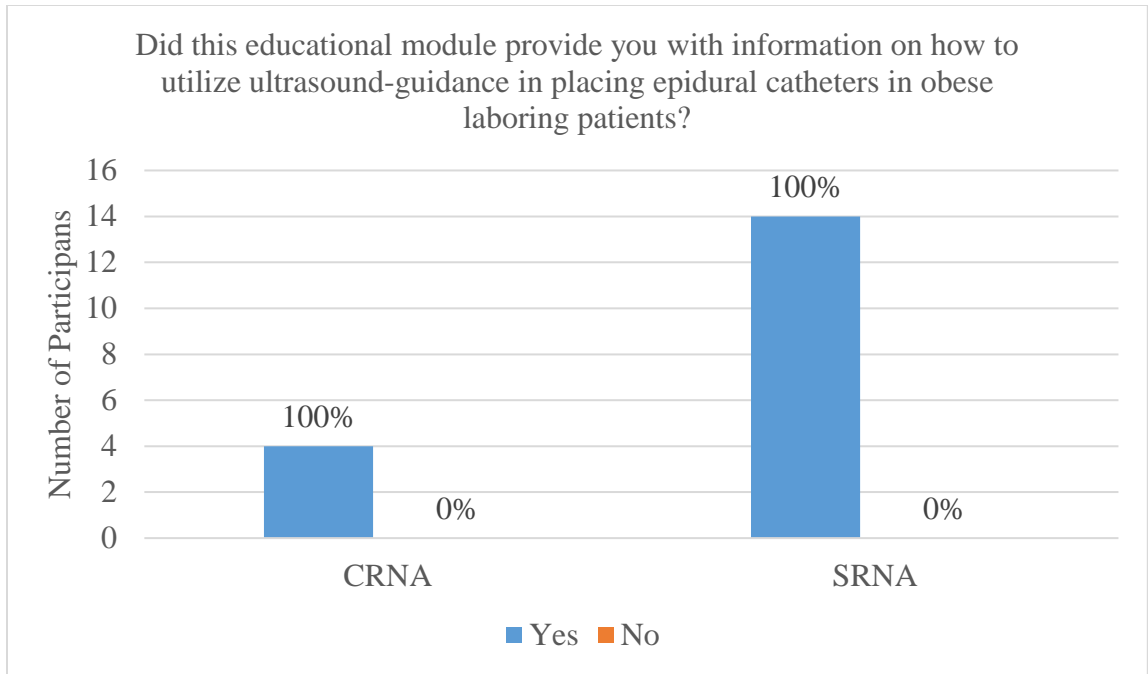


Figure 1. Post-Educational Module Survey Question 1 Responses from CRNAs and SRNAs.

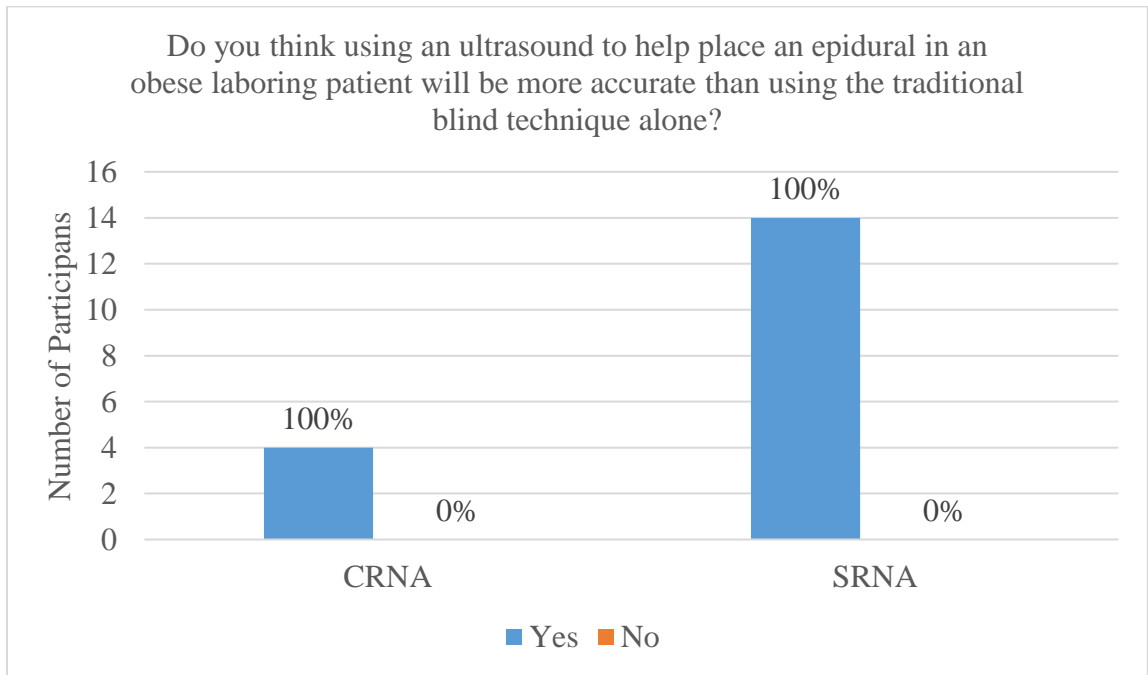


Figure 2. Post-Educational Module Survey Question 2 Responses from CRNAs and SRNAs.

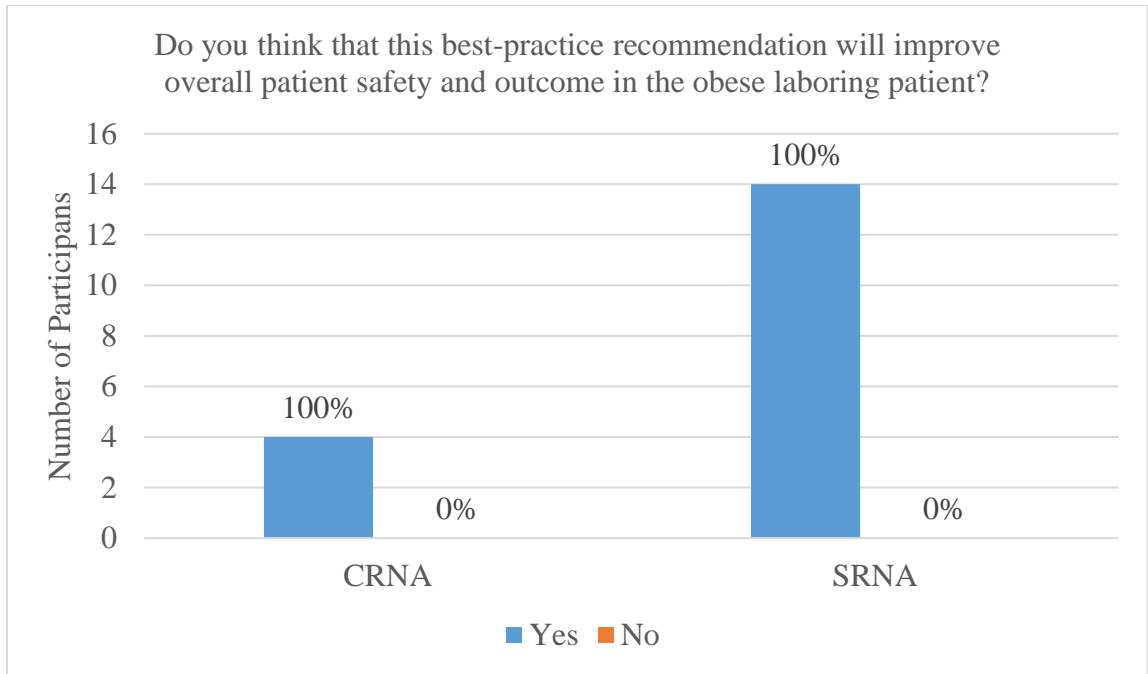


Figure 3. Post-Educational Module Survey Question 3 Responses from CRNAs and SRNAs.

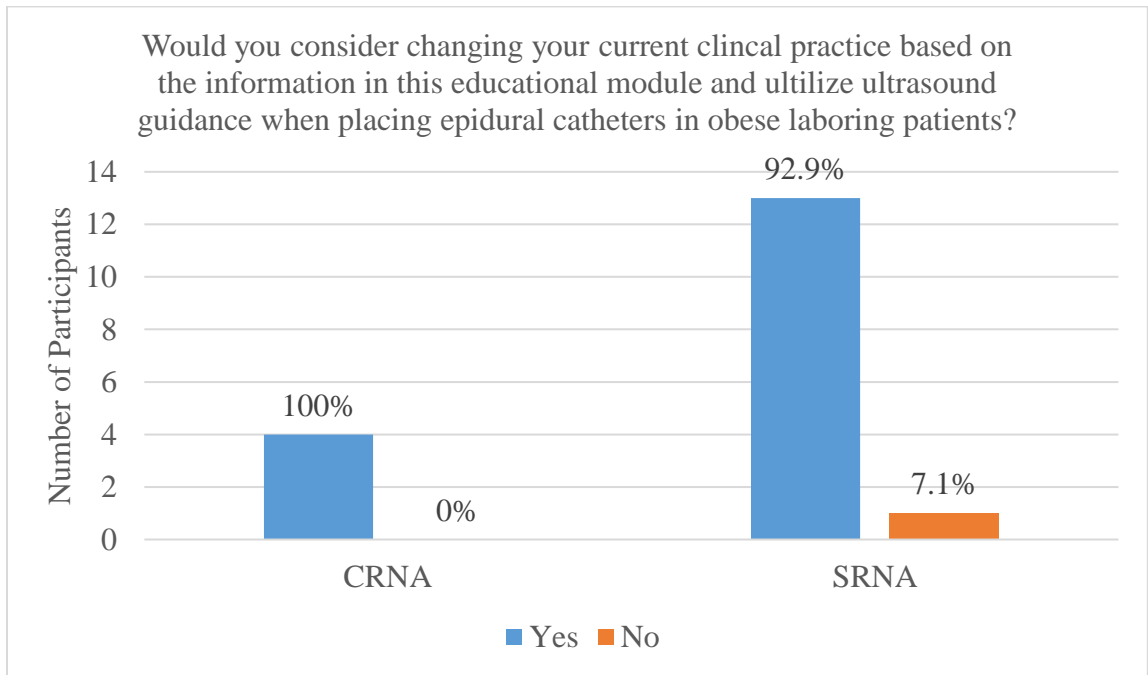


Figure 4. Post-Educational Module Survey Question 4 Responses from CRNAs and SRNAs.

Table 1

Post-Educational Module Survey Question 5 Responses from CRNAs and SRNAs.

Participant	Comments or Suggestions for the Best-Practice Recommendation
CRNA	<ul style="list-style-type: none"> • “An accompanying video would be fantastic to really drive it home, but as is, it is great.”
SRNA	<ul style="list-style-type: none"> • “Amazing topic! I’m looking forward to trying this technique in my own practice.” • “Excellent topic and very useful for the peri-operative setting.” • “Great job in presenting information concerning US use in obese laboring patients.” • “I think technology like ultrasound can help in difficult situations like obese epidural patients. The glidescope helps with difficult intubations.” • “A video demonstration is great”

Note. US = Ultrasound

Each CRNA that served on the expert panel has earned their doctoral degrees. They are considered stakeholders due to their knowledge not only as anesthesia providers, but also as faculty members for the NAP at USM. SRNAs who are currently in their third year of the NAP are also considered stakeholders because of their experience with neuraxial anesthesia in the clinical setting and being future anesthesia providers. The sample size was 18, with 22.2% (n=4) being CRNAs and 77.8% (n=14) being SRNAs. Feedback to the educational module was gathered and analyzed. All stakeholders (n=18) agreed on the effectiveness of the information presented in the educational module (Figure 1), the helpfulness of an ultrasound technique versus the traditional technique (Figure 2), and the safety and outcomes of ultrasound use (Figure 3). The results for question 4 (Figure 4) showed that 100% of the CRNAs (n=4) and 92.9% of the SRNAs (n=13) agreed that they would change their current practice based on the information presented. However, 7.1% SRNA (n=1) answered that they would not change their

current practice. The end of the post-educational module allotted a section that could be utilized for additional feedback and comments on the educational module. Comments were provided by one CRNA and five SRNAs. There was one suggestion for revision of the educational module from the CRNA: “An accompanying video would be fantastic to really drive it home, but as is, it is great.” There were also five positive comments regarding the educational module. One SRNA stated, “I think technology like the ultrasound can help in difficult situations like obese epidural patients. The glidescope helps with difficult intubations.”

Summary

The data collected from the post-educational module survey showed that the best-practice recommendation in regard to utilizing ultrasound technology for epidural placement in obese laboring patients was widely accepted amongst the stakeholders. The panel of experts agreed with the information presented in the educational module and would consider a change in their current practice regarding epidural placement in obese laboring patients. The feedback from the SRNAs also showed how helpful ultrasound can be in the perioperative setting. Finally, the stakeholders offered no feedback for the revision of the best-practice recommendation.

CHAPTER IV – DISCUSSION

Summary

Laboring obese patients are at a higher risk for complications during epidural placement, which can be more difficult to place than in nonobese laboring patients due to the additional anatomical and physiological factors from obesity (Mace et al., 2011). Mace et al. (2011) report obesity being a rising worldwide health concern especially in developed countries, which poses greater risks in the parturient population. The most current survey conducted in 2018 showed that 42.4% of adults in the United States were obese, which was an increase from 30.5% previously in 2000 (Centers for Disease Control and Prevention [CDC], n.d.). Therefore, it is important to ensure patient and fetal safety during labor and epidural placement. Available knowledge from literature reviews has shown that utilizing ultrasound-guided technology for placing an epidural in an obese laboring patient allows for better identification of anatomical landmarks that are otherwise unidentifiable or questionable if using the traditional landmark or blind technique alone (Brodsky et al., 2011). Thus, an educational module for anesthesia providers to use for epidural placement using ultrasound guidance in obese laboring patients can decrease the rate of complications and lead to an increased rate of success in clinical practice.

Interpretation

The responses from the CRNA expert panel and the SRNAs for the post-educational module survey (Appendix E) were used to determine if the educational module (Appendix D) to present a best-practice recommendation on utilizing ultrasound-guidance for epidural placement in obese laboring patients was effective and could be

useful for anesthesia providers. Of the 18 participants, four were CRNAs serving as the expert panel, and 14 were SRNAs in the NAP at USM. All 18 participants (100%) agreed that the educational module provided information on how to utilize ultrasound-guidance for epidural placement in obese laboring patients (Figure 1), that they think using ultrasound to help place the epidural in an obese laboring patient will be more accurate than using the traditional blind technique alone (Figure 2), and that they believe this best-practice recommendation will improve overall patient safety and outcome (Figure 3). On the fourth question of the survey (Figure 4), 94.4% of the CRNA and SRNA participants (n=17) answered that they would consider changing their current clinical practice based on the educational module's information, and the remaining 5.6% was one SRNA (n=1) who answered that they would not consider changing their current practice. At the end of the post-educational module survey, participants were allowed to provide comments or suggestions for the best-practice recommendation. One CRNA and five SRNAs provided comments, where one response suggested providing an accompanying video to the educational module.

Limitations

The small sample size is a limitation for this project. The sample size included 20 SRNAs and four CRNA expert panel faculty members of the NAP at the USM. Invitation for participation was sent to 20 SRNAs in their third year of the NAP to view the educational module and complete the post-educational module survey, but only 14 SRNAs finished it. A larger sample size of participants may have provided more varied feedback on the educational module. Though the sample size was small, the four CRNAs

serving as the expert panel have substantial knowledge and foundation of neuraxial anesthesia in both educational and clinical settings.

Considerations for Future Research

Considerations for research in the future could include the outcomes of the implementation of the best-practice recommendation. A quality improvement study could be performed on the efficiency of epidural placement and adequate relief of pain in an obese laboring patient with epidural placement done with ultrasound. As previously suggested, a full accompanying video may also be incorporated into the educational module. Lastly, the study could be further expanded to other neuraxial techniques such as ultrasound use for spinal anesthesia.

Conclusion

The goal of the best-practice recommendation was to create a standard of care regarding the utilization of ultrasound for epidural placement in obese laboring patients. An extensive review of relevant literature indicates that ultrasound is more accurate than the traditional landmark technique and provides advantages for both patients and anesthetists (Lee, 2014). The utilization of ultrasound for epidural placement in obese laboring patients could provide a safer, quicker, and more comfortable experience for the patients (Kline, 2011). The feedback gathered from the stakeholders showed how members of the expert panel and SRNAs in their third year of NAP at USM would adopt this practice into their current practice. Therefore, providing CRNAs and SRNAs with an educational module that includes videos on how to place an epidural catheter under ultrasound guidance may improve overall patient satisfaction and outcomes in the obese parturient population.

APPENDIX A – DNP Essentials

DNP Essential	How the Essentials Are Achieved
I. Scientific underpinning for practice	This doctoral project has an extensive review of evidence-based literature of the available knowledge of the beneficial use of ultrasound guidance during epidural placement for obese parturient patients.
II. Organizational and systems leadership for quality improvement and systems thinking	Consisted of collaboration with a panel of experts to recommend the changes that are needed for the implementation of a best practice recommendation for the quality improvement of epidural placement in obese laboring patients.
III. Clinical scholarship and analytical methods for evidence-based practice	Extensive research and analysis of current literature on the efficacy of using ultrasound-guidance for epidural placement in obese parturient patients has been performed to formulate a best practice recommendation.
IV. Information systems/technology and patient care technology for the improvement and transformation of health care	A best-practice recommendation online educational module was designed and presented to the panel of experts after researching evidence-based literature to demonstrate how utilizing ultrasound technology during epidural placement for an obese laboring patient is a useful tool and is more accurate than the blind palpation technique.
V. Healthcare policy for advocacy in health care	Addresses a lack of policy and best practice recommendation for epidural placement in obese laboring patients.
VI. Interprofessional collaboration for improving patient and population health outcomes	This essential is met through professional communication and collaboration with anesthesia providers for the development of this best practice recommendation.
VII. Clinical prevention and population health for improving the nation's health	Aims to provide a best practice recommendation for epidural placement in obese maternal patients to improve outcomes for mother and fetus.
VIII. Advanced nursing practice	Demonstrated a best-practice recommendation for anesthesia providers to utilize ultrasound-guidance during epidural placement in obese laboring patients to optimize patient care and outcomes.

APPENDIX B – Literature Matrix

Author/Year/ Title	Design	Sample/Data Collection	Findings	Recommendations
Arnolds et al. (2019) Inadvertent neuraxial block placement at or above the L1–L2 interspace in the super-obese parturient: A retrospective study	Quantitative retrospective study	A retrospective study that included 125 cases of women with a BMI ≥ 50 kg/m ² who delivered by cesarean with an epidural or intrathecal catheter.	1. Super obese maternal patients who are in labor experienced an increased rate of inadvertently high epidural or intrathecal catheter placement.	Radiographs are more accurate for the interspinous level in comparison with ultrasound.
Biel et al. (2017) Maternal body mass index and regional anaesthesia use at term: Prevalence and complications	Qualitative retrospective cohort study	A retrospective cohort study of women in California that gave birth in California from 2007–2010.	1. There is a correlation between increasing BMI and increased rates of anesthesia related complications. 2. Women with a higher BMI used regional anesthesia more frequently for labor pain in comparison to non-obese laboring women.	Presumed epidural complications should be linked directly to the epidural itself and a clearer definition of labored delivery.

Author/Year/ Title	Design	Sample/Data Collection	Findings	Recommendations
Brodsky et al. (2011) Regional anaesthesia in the obese patient: Lost landmarks and evolving ultrasound guidance	Qualitative systematic review	Obese obstetric patients receiving epidural catheter placement for regional anesthesia with ultrasound guidance compared to those without the use of ultrasound guidance.	<ol style="list-style-type: none"> 1. Patient satisfaction of overall experience was high with the use of ultrasound guidance compared to only palpating for anatomical landmarks. 2. Increased success rate of catheter placement and appropriate delivery of local anesthetics. 	Use ultrasound-guided technology for placing epidural catheters especially in obese parturient patients to improve procedure outcome and overall patient quality of care.
Chin et al. (2018) A randomized controlled trial comparing needle movements during combined spinal-epidural anaesthesia with and without ultrasound assistance	Qualitative randomized controlled trial	215 women aged 18 or older that are in their $\geq 37^{\text{th}}$ week of gestation receiving epidural anesthesia with (105 women) and without (110 women) ultrasound guidance.	<ol style="list-style-type: none"> 1. Successful first-pass without needle redirection in 63.8% of the ultrasound group and 38% in the control group. 2. Need for additional needle insertions in 19% of the ultrasound group and 38.2% in the control group. 	Use of ultrasound guidance is superior to the palpation technique for epidurals for first-pass success and less requirement for additional needle insertions for placing epidurals.

Author/Year/ Title	Design	Sample/Data Collection	Findings	Recommendations
Eley et al. (2018) Epidural extension failure in obese women is comparable to that of non- obese women	Qualitative case-control study	300 parturient women with epidurals for labor analgesia and the effectiveness of epidural extensions for cesarean sections: Group O = obese, BMI \geq 40 kg/m ² (100 women) Group C = control, BMI \leq 30 kg/m ² (200 women)	1. No significant difference between epidural extension failures: 20 in Group O and 26 in Group C. 2. Group O required more insertion attempts, epidural re- sites, and intervention for inadequate analgesia than Group C.	The rate of epidural extension failure in both obese and non- obese women can be decreased by inserting during an earlier stage of cervical dilatation, using pre- procedural neuraxial ultrasound, and leaving a longer length of catheter in the epidural space, all while being performed by a senior anesthesiologist.
Kline, J. P. (2011) Ultrasound guidance in anesthesia	Qualitative Study	A summary of the use of ultrasound guidance in central line placement, spinal and epidural placement, and regional blocks.	1. Ultrasound guidance in anesthesia is faster, safer, and cheaper in comparison to traditional methods.	Ultrasound applied to abdominal structures before induction may lead to a decrease in the incidence of aspiration.

Author/Year/ Title	Design	Sample/Data Collection	Findings	Recommendations
Kula et al. (2017) Increasing body mass index predicts increasing difficulty, failure rate, and time to discovery of the failure of epidural anesthesia in laboring patients	Single Center retrospective chart review	2,485 parturients that received labor epidural analgesia for a vaginal delivery with an ASA status of 2 to 4.	<ol style="list-style-type: none"> 1. Patients with a BMI of 30kg/m² had a higher chance of epidural placement failure and difficulty. 2. Difficulty of epidural placement was predicted by BMI alone while epidural placement failure was predicted by BMI and also provider training. 	There needs to be more focus on how obesity correlates with the time needed for labor epidural placement and time to recognize epidural failure.
Lee (2014) Ultrasound in obstetric anesthesia	Qualitative systematic review	Obese and non-obese obstetric patients receiving placement of epidural or spinal catheters for neuraxial anesthesia.	<ol style="list-style-type: none"> 1. Ultrasound guidance increases the functioning of and decreases the rates of catheter complications. 2. Increase in patient comfort throughout the epidural placement due to more accurate needle insertion, including fewer needle punctures required. 	Use of ultrasound to guide epidural placement in obese parturient patients to increase patient safety, patient outcomes, and overall comfort and quality of care.

Author/Year/ Title	Design	Sample/Data Collection	Findings	Recommendations
Mace et al. (2011) Obesity and obstetric anaesthesia	Qualitative systematic review	An overview of physiologic and pharmacologic changes that occur in obese women who become pregnant and the effects on anesthetic techniques and management during labor.	<ol style="list-style-type: none"> 1. Location of landmarks traditionally used for placing the epidural is further obscured due to the anatomical changes that are imposed on by pregnancy in obese patients. 2. Catheters fail and migrate more often in obese parturients. 3. Multiple attempts are usually required for successful epidural catheterization. 	Use ultrasound guidance to place epidural catheters with the patient sitting in an upright position and leave a longer catheter length in the epidural space to decrease the risk of difficult catheter placement or failure of epidural anesthesia.
Singh et al. (2013) Epidural catheter placement in morbidly obese parturients with the use of an epidural depth equation prior to ultrasound visualization	Correlational study	160 morbidly obese parturient patients with a BMI \geq 40 kg/m ²	<ol style="list-style-type: none"> 1. 9 epidural block failures 2. 0 more than one failed epidural block 3. 1 accidental dural puncture 4. 86 epidural attempts without redirection 5. 147 epidural placements without reinsertion 	Using the EDE prior to viewing the transverse and longitudinal ultrasound imaging has better outcomes than using the ultrasound alone.

Author/Year/ Title	Design	Sample/Data Collection	Findings	Recommendations
Soma-Pillay et al. (2016) Physiological changes in pregnancy	Qualitative study	Review of systemic changes during pregnancy such as hematologic, cardiac, renal, respiratory, body water metabolism, endocrine, lipid, and skeletal and bone density changes.	1. Pregnant women go through many physiological changes to prepare for labor and delivery.	The physiological changes and anatomical changes that occur with pregnancy need to be differentiated from normal variance in pregnancy in comparison to medical disease.
Summers & Flett (2019) Neuraxial analgesia in labour – Induction, and maintenance	Qualitative study	The effect of neuraxial analgesia in labor, the different options for neuraxial anesthesia, and a look in the future at the advancement of neuraxial anesthesia.	1. Neuraxial anesthesia is the gold standard for labor pain. 2. Neuraxial anesthesia helps attenuate the adverse physiological effects of labor. 3. Combined spinal- epidural contributes to maternal satisfaction.	Neuraxial anesthesia for labor is associated with short-term effects on a laboring maternal patient, but it is still the ideal intervention in comparison to other interventions for analgesia during labor.

Author/Year/ Title	Design	Sample/Data Collection	Findings	Recommendations
Uyl et al. (2019) Difficult epidural placement in obese and non-obese pregnant women: A systematic review and meta-analysis	Qualitative systematic review and meta- analysis	Eight articles included in the systematic review and four articles included in the meta- analyses.	1. Increasing BMI correlates with increased risk for difficult epidural placement and epidural failure in obese maternal patients.	BMI categories should be standardized to allow better comparisons. Obesity should be managed prior to pregnancy to minimize risks. Weight loss may decrease the incidence of difficult epidural placement.
Vallejo et al. (2010) Ultrasound decreases the failed labor epidural rate in resident trainees	Qualitative randomized controlled trial	370 parturient patients receiving epidural anesthesia during labor: 189 = ultrasound group 181 = control group	1. Failed epidural blocks in one patient in the ultrasound group and 10 in the control group. 2. Insertion attempts of one time in the ultrasound group and 2 in the control group.	Use of ultrasound to measure epidural depth prior to placing an epidural leads to a decreased rate of epidural replacement due to failure of labor analgesia and decreases the number of attempts required to place an epidural.

Author/Year/ Title	Design	Sample/Data Collection	Findings	Recommendations
Vernon et al. (2019) Ultrasound-assisted epidural labor analgesia for landmark identification in morbidly obese pregnant women: A preliminary investigation	Qualitative randomized controlled trial	24 women in labor with a BMI \geq 40	<ol style="list-style-type: none"> 1. Ultrasound guidance took longer for epidural placement, but required fewer attempts, than palpation technique alone. 2. No difference in effect on patient anxiety and satisfaction between ultrasound guidance and palpation. 3. Incidence of paresthesia during epidural placement, unilateral block requiring catheter adjustment, and an unintentional dural puncture leading to post-dural headache resulted from the palpation technique, but none occurred during the ultrasound-guided technique. 	Use of ultrasound guidance to locate landmarks for epidural analgesia for laboring obese patients reduces the time required for epidural placement compared to palpation alone.

Author/Year/ Title	Design	Sample/Data Collection	Findings	Recommendations
Wang et al. (2012) Ultrasound facilitates identification of combined spinal-epidural puncture in obese parturients	Qualitative randomized controlled trial	60 obese parturients scheduled for the caesarean section using combined spinal-epidural (CSE) anesthesia who are ≥ 20 years in age, BMI ≥ 30 kg/m ² , classified as ASA I or II, and has been NPO for 8 hours: 30 patients in the ultrasound group 30 patients in the palpation group	<ol style="list-style-type: none"> 1. The success rate of puncture at the first puncture site: 100% in the ultrasound group and 70% in the palpation group. 2. The success rate of the first attempt of needle insertion: 63.33% in the ultrasound group and 43.33% in the palpation group. 3. Time to determine the puncture site in minutes took longer in ultrasound than palpation. 4. The duration of CSE procedure in minutes was longer in ultrasound than palpation. 	The use of ultrasound imaging to place and deliver anesthesia through CSE is useful in obese parturient patients.

APPENDIX C – IRB Approval Letter

Office of
Research Integrity



118 COLLEGE DRIVE #5125 • HATTIESBURG, MS | 601.266.6576 | USM.EDU/ORI

NOTICE OF INSTITUTIONAL REVIEW BOARD ACTION

The project below has been reviewed by The University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services regulations (45 CFR Part 46), and University Policy to ensure:

- The risks to subjects are minimized and reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered involving risks to subjects must be reported immediately. Problems should be reported to ORI via the Incident template on Cayuse IRB.
- The period of approval is twelve months. An application for renewal must be submitted for projects exceeding twelve months.
- FACE-TO-FACE DATA COLLECTION WILL NOT COMMENCE UNTIL USM'S IRB MODIFIES THE DIRECTIVE TO HALT NON-ESSENTIAL (NO DIRECT BENEFIT TO PARTICIPANTS) RESEARCH.

PROTOCOL NUMBER: IRB-20-273

PROJECT TITLE: Utilizing Ultrasound-Guided Technology for Epidural Placement in Obese Laboring Patients

SCHOOL/PROGRAM: School of LANP, Leadership & Advanced Nursing

RESEARCHER(S): Aimee Hoang, Michong Rayborn, Diamond Forkner

IRB COMMITTEE ACTION: Approved

CATEGORY: Expedited

7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

PERIOD OF APPROVAL: June 23, 2020

Donald Sacco, Ph.D.
Institutional Review Board Chairperson

UTILIZING ULTRASOUND-GUIDED TECHNOLOGY FOR EPIDURAL PLACEMENT IN OBESE LABORING PATIENTS

Diamond Forkner & Aimee Hoang
Spring 2020

DIFFICULTIES ASSOCIATED WITH EPIDURAL PLACEMENT IN OBESE LABORING PATIENTS

- Inability to palpate the spinous processes or identify the midline
- Increased difficulty in placement of epidurals, requiring multiple attempts
- Greater depth of the epidural space which could exaggerate minor needle direction errors
- The presence of fat pockets along with hormonal softening of the ligaments which may result in a false loss of resistance and/or a higher risk for unintentional dural puncture

ULTRASOUND (US) GUIDANCE IS UTILIZED TO IDENTIFY LANDMARKS

The Obese Patient



PRE-PROCEDURE USE OF ULTRASOUND

US-assisted neuraxial block / lumbar puncture

Phase 1: Scanning + skin marking



Phase 2: Needle insertion + handling



GENERAL PRINCIPLES OF US IMAGING

General principles of US imaging in obesity

- Adjust **machine settings** for depth
 - Frequency / focus / gain
- Apply **pressure** with probe
 - Reduces distance to target & improves image quality



GENERAL PRINCIPLES OF US IMAGING

General principles of US imaging in obesity

- Adjust **machine settings** for depth
 - Frequency / focus / gain
- Apply **pressure** with probe
 - Reduces distance to target & improves image quality
- Expect **lower-quality** images
- Practice in normal subjects – **pattern recognition** is key

PARASAGITTAL OBLIQUE (PSO) VIEW

- Always start with the probe in a longitudinal orientation to obtain the parasagittal oblique view
- Allows you to identify which intervertebral level you might be targeting
- Mark potential spaces in case the transverse midline (TM) view is difficult

Parasagittal Oblique (PSO) View

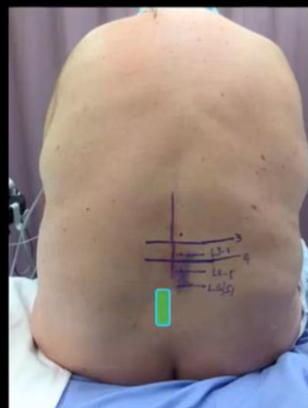
Objectives

- Identify sacrum
- Identify lamina
- Identify interlaminar space
- Identify anterior complex
- Count intervertebral levels
- Mark potential spaces

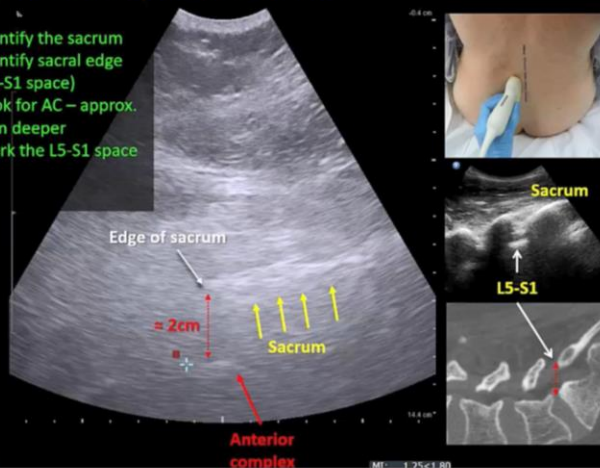


PARASAGITTAL OBLIQUE (PSO) VIEW

Parasagittal Oblique (PSO) view



1. Identify the sacrum
2. Identify sacral edge (L5-S1 space)
3. Look for AC – approx. 2cm deeper
4. Mark the L5-S1 space



IDENTIFY SUCCESSIVE LAMINAE IN THE PSO VIEW

Look for successive laminae in the PSO view

1. Identify laminae
2. Identify interlaminar spaces

L4 Lamina L5 Lamina

L5 Lamina Sacrum

L5-S1 AC

TRANSVERSE MIDLINE VIEW

Transverse Midline (TM) View

Spinous Process View Interspinous View

Spinous Process Lamina Lamina

Midline

Articular process

“Posterior complex”

Ligamentum flavum

Dura

Transverse process

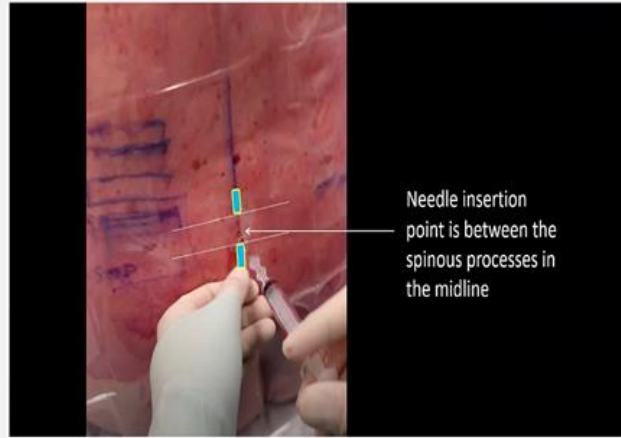
Intrathecal space

“Anterior complex”

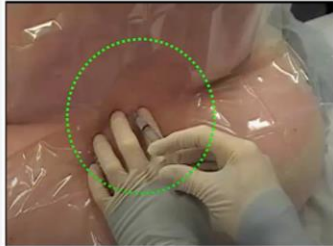
Anterior dura
Posterior longitudinal ligament
Vertebral body

NEEDLE INSERTION

- After landmarks are identified using the PSO and TM view, you are now ready for needle insertion
- Insert the needle in either L3–L4 or L4–L5 interspaces



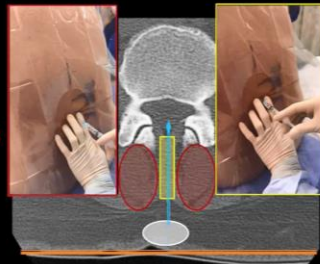
NEEDLE INSERTION TECHNIQUES



- Control the overlying skin with 2 fingers on your nondominant hand for palpation and fixation.

Fundamentals of the midline approach

- Use the 25G LA infiltration needle as a "finder" needle
- Supraspinous or interspinous ligament = **unable to inject fluid**
- Paraspinal muscles = **able to inject fluid**
- Locate the interspinous ligament with **parallel shifts** of the finder needle
- Make a new skin puncture if necessary



ADVANTAGES OF ULTRASOUND UTILIZATION FOR EPIDURAL PLACEMENT IN OBESE LABORING PATIENTS

- Ultrasonography is a pre-procedural tool to aid the anesthesia provider in the assessment of needle insertion, needle angle and estimated depth of epidural space
- Ultrasound imaging guidance can be used to identify the midline, image the epidural space, and measure the distance from the skin to the epidural space
- Ultrasound guidance reduced the number of attempts required for epidural placement in obese laboring patients
- Increase in patient outcomes by providing the patient with adequate analgesia and decrease the risk of complications related to displacement of epidural catheter

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APPENDIX E – Post-Educational Module Survey

Post-Educational Module Survey

Participation in this questionnaire is anonymous and voluntary. There are no repercussions for nonparticipation. Do you agree to participate in this survey?

- a. Yes
- b. No

Are you a certified registered nurse anesthetist (CRNA) or a student registered nurse anesthetist (SRNA)?

- a. CRNA
- b. SRNA

1. Did this educational module provide you with information on how to utilize ultrasound-guidance in placing epidural catheters in obese laboring patients?
 - a. Yes
 - b. No
2. Do you think using an ultrasound to help place an epidural in an obese laboring patient will be more accurate than using the traditional blind technique alone?
 - a. Yes
 - b. No
3. Do you think that this best-practice recommendation will improve overall patient safety and outcome in the obese laboring patient?
 - a. Yes
 - b. No
4. Would you consider changing your current clinical practice based on the information in this educational module and utilize ultrasound guidance when placing epidural catheters in obese laboring patients?
 - a. Yes
 - b. No
5. Please provide any comments or suggestions regarding this best-practice recommendation.

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