A review of epidural anesthesia for the laboring parturient

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The author reviews the pain of labor and delivery and explains the technique for performing an epidural and the placement of the epidural catheter. He explains how to choose local anesthetics for epidurals, how to give a proper test dose, and how to maintain the epidural anesthetic during labor and delivery. A discussion of possible complications and their treatment is also provided.

The anesthetist's role in labor and delivery is increasingly becoming more active in the United States today. Not long ago, anesthetists were only called to the delivery room to provide general anesthesia for an emergency cesarean section or retained placenta. Now at many centers anesthetists are requested to perform regional anesthesia not only for cesarean sections but to provide epidurals for laboring parturients.

Review of pain during labor and delivery

There are three stages of labor: (1) encompasses the time the patient begins contractions until she is fully dilated to 10 cm, (2) is the delivery of the fetus, and (3) is the delivery of the placenta. Friedman in 1955 analyzed the labor pattern of 500 primigravidas and derived the mean labor curve (cervical dilation versus time). Studying the derived graph (Figure 1), one can see that the first stage of labor can be divided into a latent phase and an active phase. Most obstetricians will wait until the parturient is well into the active phase of labor before requesting an epidural anesthetic.

Shnider suggests that the cervix be dilated 6-8 cm in nulliparas and 4-6 cm in multiparas. However, if the obstetrician is committed to delivering the parturient because of ruptured membranes and has augmented the labor with oxytocin or is inducing the patient, the epidural catheter can be placed earlier without threat of slowing down labor.

The pain of labor originates in the sensory nerves of the uterus and cervix. The nerve fibers transmit the pain sensation to the dorsal horn of the 10th, 11th, 12th thoracic and 1st lumber spinal segments. As labor progresses and the parturient enters the late first stage and second stage of labor, the pain originates from the stretching of the perineum, travels in the pudendal nerve and enters the dorsal horn of the 2nd, 3rd, and 4th sacral segments.

The epidural anesthetic is increasing in popularity. This is because, unlike the caudal and spinal which block only the pain of the second stage of labor, the epidural anesthetic, if properly managed and performed, can block the afferent sensory pain impulses for both the first and second stages of labor.

Preparation

Anesthesia for labor and delivery is no differ-
ent from that given for surgery in main operating rooms. When considering the use of epidural anesthesia, the anesthetist should not approach the parturient with a nonchalant cavalier attitude. An epidural anesthetic can be very dangerous in the hands of one not prepared to resuscitate and institute resuscitative measures. A resuscitative cart should be set up. (Table I lists the items required on such a cart.)

Oxygen must be available to oxygenate and if necessary ventilate the patient. Early in the labor stage, the risks and complications of epidural anesthesia should be discussed with the parturient. After the patient's permission has been granted, an intravenous line should be started and the patient should be hydrated with 750-1000 cc of crystalloid fluids (10-15 cc/kg). A history should be taken and a pre-anesthetic blood pressure and pulse rate need to be taken and recorded.

The anesthetist should wait until the patient is in the active phase of labor before initiating an epidural anesthetic, unless the patient is being induced or augmented with oxytocin. Once the patient has been hydrated and the obstetrician has informed the anesthetist that the parturient is in

Figure 1
The mean labor curve (cervical dilation versus time) based on a graphicostatistical analysis of 500 primigravidae at term.

Figure 2
Pathways of pain of labor

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an active phase of labor, the epidural can be instituted.

Technique
There are many acceptable variations for performing an epidural. The following is a technique that has worked well for the author. From the left lateral decubitus position, the patient is instructed to lie in a modified fetal position. This is often difficult for the parturient because of the gravid uterus. However, with help from an assistant, the patient should be able to position herself so that the spaces between the spinous processes are easily palpated. Interspace L4-5 is located by drawing an imaginary line between the superior iliac crests and placing one's fingers at the interspace where the line dissect. The anesthetist then

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<tr>
<td><strong>Resuscitative cart</strong></td>
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<tr>
<td>Positive pressure breathing apparatus</td>
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<td>Oxygen supply</td>
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<td>Laryngoscope: adult and infant</td>
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<td>Endotracheal tubes:</td>
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<td>Stylets: adult and infant</td>
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<td>Nasal airways</td>
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<td>Suction catheters: adult and infant</td>
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<td>Board for closed chest massage</td>
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<td>Nasogastric tubes</td>
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<tr>
<td>IV supplies:</td>
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<tr>
<td>plasma expanders and electrolyte solutions, syringes, needles, and plastic indwelling catheters</td>
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Each labor room should contain an oxygen supply, suction equipment and a bed that can rapidly be tilted to place the patient in the Trendelenburg position. An ECG and defibrillator should be readily available.

(From Table 8.2 Anesthesia for Obstetrics by Sol M. Shnider and Gershon Levinson, pg 99, copyright 1979, The Williams and Wilkins Company, Baltimore, MD. Reprinted by permission.)

chooses the interspace which is easiest to palpate (L2-3, L3-4, or L4-5).

The anesthetist first prepares the epidural tray, tears several strips of waterproof tape and pours the chosen local anesthetic solution. Once gloved, the anesthetist prep's the patient's back with an antiseptic solution. A sterile drape is then placed over the patient so as to expose the interspace that has been chosen. After forewarning the parturient, the midline of the interspace is anesthetized first subcutaneously and then deeper with approximately 1 cc of 1.0-1.5% lidocaine. (The lateral and paramedian approach can be used, but one encounters a greater number of blood vessels using this approach.) The guard on the glass syringe is then removed and the syringe "wetted" with local anesthetic so that the plunger slides easily.

At this point it is important to reinforce to the parturient that she must not move because the epidural needle is going to be placed in her back. If the anesthetist waits until a contraction has just passed, the parturient will be more cooperative and there is less chance of the epidural needle being placed in an engorged epidural vein. A 16-18 gauge tuohy needle with its stylet in place is then advanced until the anesthetist can feel it entering the supraspinous ligament. At this point, the stylet is removed and the glass syringe with 3-4 cc of air is placed on the epidural needle. The bevel of the needle is directed so that it is aimed at the patient's right side.

While applying constant pressure to the plunger with one hand, the anesthetist slowly advances the epidural needle with the other hand. The needle then passes through the supraspinous ligament, the interspinous ligament and the ligamentum flavum. Once the bevel of the needle passes the ligamentum flavum a distinct loss of resistance is felt and the anesthetist is able to inject the volume of air into the epidural space. The bevel of the needle is then redirected cephalad and again 3-4 cc of air are injected to assure that the needle is still in the epidural space. The needle is then aspirated for blood if it is intravascular or aspirated for cerebrospinal fluid (CSF) if subarachnoid. If blood or CSF is obtained on aspiration, the needle must be removed and placed in another interspace.

Once the epidural needle is properly placed, the epidural catheter can then be threaded through the epidural needle 2.5-3.0 cm and the needle removed. The anesthetist must take care to hold the epidural catheter so that it does not pull out with the needle. One should never pull the
catheter out of the needle, as this could cause shearing of the catheter in the epidural space. Once the needle is removed, the stylet is withdrawn out of epidural catheter. The injection port provided in the epidural tray is then connected to the epidural catheter. The catheter is meticulously taped to the patient's back so that the injection port is near her shoulder for easy access should she require more medication. Some claim that the epidural catheter enters the epidural space easier if a test dose is first given through the needle. Others, including the author, feel that this is not required as long as a proper test dose is given through the catheter after its placement.

Many feel that it is easier, especially with very obese patients, to place the epidural with the patient in the sitting position. If one is to use this approach, an assistant must be present to hold the patient. With either position there will still be some obese patients whose interspaces and even iliac crests cannot be felt. Without landmarks, the anesthetist must attempt to “walk off” the spinous process in a blind approach to the epidural space. Of course, the rate of successful blocks is decreased with such patients.

Choice of local anesthetics

When one is faced with the decision of choosing a local anesthetic drug for the patient in labor undergoing epidural anesthesia, there are several factors to consider. Firstly, that our goal is an effective block of the sensory fibers conducting the pain of labor. Secondly, we want to provide this anesthetic safely to both the parturient and the fetus. Thirdly, the anesthetic must be provided without altering the ability of the parturient to push during the second stage of labor.

For a detailed discussion of the local anesthetics and their use in epidural anesthesia for the laboring parturient, the reader is referred to the numerous abstracts available. In most centers there seem to be three primary drugs used for epidurals: lidocaine HCl, 2-chloroprocaine and bupivacaine.

Lidocaine HCl has recently received renewed interest for its use in epidural anesthesia in labor. This drug provides excellent analgesia with a duration of action of about 60 minutes without epinephrine and 75 minutes when 1/200,000 epinephrine is added. For years lidocaine was a standard agent. Appar scores were high. However, in 1976, Scanlon and Ostheimer reported lower neurobehavioral scores in infants after epidural lidocaine anesthesia when compared to infants after epidural 2-chloroprocaine or bupivacaine anesthesia.

With these reports, lidocaine HCl lost popularity and 2-chloroprocaine became the drug of choice. For some years, 2-chloroprocaine was felt to be the safest agent in obstetrics. This was due to the speed of its hydrolysis in the presence of normal pseudocholinesterase. It has a fast onset and the quality of its sensory block is considered excellent. Its only drawback was that it, like lidocaine HCl, has a very short duration of action, 35-50 minutes without epinephrine and 50-60 minutes with 1/200,000 epinephrine. Therefore, like lidocaine, frequent injections are required when prolonged analgesia is desired. A concentration of 1.5-2.0% is adequate for the first stage of labor but a 3.0% solution is needed for the second stage.

Much has been written about 2-chloroprocaine and neurotoxicity. Such reports have caused many former proponents of 2-chloroprocaine to denounce its use. As a result, lidocaine HCl has again become a popular drug of choice, not so for the maintenance of laboring patients under epidural anesthesia, but as the agent for test doses, sitting doses and cesarean sections.

Bupivacaine has become the most popular drug used in epidural anesthesia for a number of reasons. It is highly protein bound, hence little drug is available to cross the placenta. The sensory block is excellent in comparison to the motor block achieved at low concentrations. The duration of the block is long, eliminating the need for frequent “top up” doses. For relief of pain in the first stage of labor, various concentrations of bupivacaine have been used from 0.125-0.500%. Since the sensory block achieved using the lower concentrations seems to be as effective as 0.50% bupivacaine, the 0.25% strength of bupivacaine seems to be the most popular for maintenance of the epidural during labor. Intermittent doses of 4-8 cc of bupivacaine seem to be adequate for the first stage of labor. A bolus of 10-12 cc of bupivacaine administered to the parturient in the semi-sitting position provides excellent anesthesia for the second stage of labor. Recent reports have appeared in the literature concerning the cardio-toxicity of bupivacaine. Most continue to use bupivacaine despite these reports and feel that with a proper test dose, monitoring and preparation prior to the block, any problem encountered using bupivacaine can be readily treated.

At this point the use of epinephrine should be discussed. Its use has been controversial for some time. Some believe that epinephrine reduces uterine blood flow, decreases uterine contractility and slows progress of labor. Others conclude that epinephrine in dilute solutions of 1/200,000...
prolongs the motor block and improves the quality of sensory blockade by reducing the vascular uptake of the local anesthetic.

Moore urges the use of epinephrine in the local anesthetic to prophylactically prevent the anesthetic-induced myocardial depression. He states that it is time to reevaluate the in-depth use of small quantities of epinephrine (0.015-0.100 mg) during labor and delivery, particularly in the normal, healthy patient with an uncompromised fetus. His conclusions are that when a regional block is employed in which systemic toxicity is known to occur with some frequency (epidural block, for example), the addition of epinephrine to the solution should be considered.

When bradycardia and/or cardiac arrest occur, Moore concludes that drug of choice is epinephrine 0.1-0.2 mg IV rather than ephedrine sulphate. The positive inotropic effects of the epinephrine reverse the myocardial depressant effects of the local anesthetic. The anesthetist should use epinephrine in the severely pre-eclamptic parturient with caution, understanding that the use of epinephrine in these patients is controversial.

**Test dose**

Despite a negative aspiration, a test dose must be injected. It is the most important step in achieving safe epidural anesthesia. When administering "top up" doses for the continuous epidural, a test dose should be injected each time since the catheter can migrate into a blood vessel or through the dura. The effective test dose should contain 10-15 μg of epinephrine. If injected into a blood vessel, this amount of epinephrine will produce an increased pulse, blood pressure and nervousness in the patient in approximately 45 seconds. If the parturient is beta-blocked, she may not respond to this amount of epinephrine with an increased heart rate, though an increase in blood pressure should be realized. Therefore, in such a patient, blood pressure should be taken after the test dose.

To test whether or not the epidural needle or catheter is in the subarachnoid space, the test dose should also contain a dose of local anesthetic which will produce (if injected in the subarachnoid space), a spinal block within two minutes. Signs of decreased sensation of the buttocks or paralysis of the legs should warn the anesthetist of possible spinal block. If there is no evidence of intravascular or subarachnoid injection within that time, the anesthetist may proceed to give the full anesthetic dose. A test dose of 3 cc of 1.5% lidocaine with 1/200,000 epinephrine allows both the inadvertent intravascular injection and the subarachnoid injections to be detected.

**Maintenance of anesthesia for labor and delivery**

Most anesthetists maintain the epidural for the laboring parturient by injecting "top up" doses of local anesthetic whenever the parturient begins to experience discomfort and pain. If the test dose fails to produce extensive blockade from the subarachnoid injection or a sign of an intravascular injection, a full 4-6 cc of local anesthetic is injected through the epidural catheter. Along with the 3 cc test dose, this volume is usually sufficient enough to produce sensory analgesia during the first stage of labor. "Top up" doses consist of reinjections similar to the original volume given when the contractions first become painful.

Once the parturient begins the second stage of labor, a larger volume of local anesthetic is administered with the patient in a semi-sitting position. A dose of 10-15 cc in this position will produce the desired block with perineal anesthesia as well. Though a dose of 1.5% lidocaine with epinephrine is most often used because of its quick onset, a dose of 0.5% bupivacaine can serve just as well.

Several articles have described the use of continuous epidural infusions for obstetric analgesia. Rosenblatt concluded that:

1. Continuous epidural infusion for labor and delivery is technically feasible by means of an epidural infusion with a volumetric infusion pump.
2. The pain relief provided by this method is equivalent or better than that produced by bolus technique since there is no regression of analgesia.
3. The safety is comparable to the intermittent bolus technique.
4. It appears to be more effective in its use of manpower. (This fourth point could have dramatic implications in obstetrical anesthesia.)

After the birth of the child and delivery of the placenta, the episiotomy repair can be accomplished without local infiltration when the epidural has been effective. Once the patient has been moved off the delivery table, the epidural catheter should be removed and the catheter checked to ensure that it came out intact without shearing. A notation should be made on the patient's chart of these findings.

**Complications of epidural anesthesia and their treatment**

Phillip points out that the major potential complications of regional anesthesia are systemic toxic reactions, hypotension, headache and neurologic sequelae.

Toxic reactions may be caused by an uninten-
ional intravascular injection of a therapeutic dose of a local anesthetic. This intravenous injection may be directly through a needle or indirectly through the epidural catheter which may find its way into a vein either at the time of initial placement or anytime thereafter.

Steen and Michenfelder have described the early signs and symptoms of local anesthetic toxicity, stating that drowsiness is noted first. The patient may complain of lightheadedness, dizziness, a metallic taste, nausea, tinnitus, tingling and numbness. The observer will notice the patient becoming confused, her speech slurred, and nystagmus, muscle twitches or tremors may start. Drowsiness proceeds to unconsciousness and muscle twitches to generalized tonic-clonic seizures. Ventilation may be labored and the patient may become cyanotic. Pulse and blood pressure often rise initially due to the sympathetic response to hypoxia and hypercarbia, although hypotension may develop due to the myocardial depressant effect of the local anesthetic.

The clinical picture is that of cardiac collapse with or without convulsions. If untreated, death will occur due to respiratory arrest. The best treatment for systemic toxic reaction is prevention. One must inject only after careful aspiration. Injection of local anesthetic should be done slowly in a dose that is the minimum concentration and volume for the desired effect. If the patient undergoes a mild reaction, observe her closely because the reaction may progress. Administer oxygen by face mask.

If a convulsion occurs, maternal and fetal hypoxia must be prevented. Ventilation should be assisted with 100% oxygen by bag and mask, and the parturient should be turned to the left lateral decubitus position to maintain maternal and fetal blood flow. Anti-convulsive drugs should be readily available; thiopental 50-100 mg and diazepam 5-10 mg may prevent seizures in the mother, however, their use should be with reservation. These drugs can cause adverse effects on the neonate’s muscle tone and thermal regulation; also, both of these drugs are myocardial depressants which may further decrease the maternal cardiac output. Convulsions usually are self limiting and last less than 60 seconds but if prolonged, succinylcholine and endotracheal intubation may be necessary to assure an adequate airway and oxygenation.

The fetal heart rate should be monitored and a scalp pH obtained if indicated. Immediate delivery may be required, but if possible, the anesthetist should recover the infant in utero, as drugs can be eliminated faster with the placenta filtering them out from the fetus.

If cardiorespiratory collapse occurs in the parturient, all of the above measures may be required. In addition, the circulation must be supported with fluids, and closed chest cardiac massage and drugs for resuscitation should be administered as indicated. Moore and associates have demonstrated the development of profound hypoxia and acidosis (both metabolic and respiratory) shortly after the onset of a convulsion, further predisposing the patient to cardiac arrest. Aortocaval compression may compromise the resuscitation of the parturient in cardiorespiratory collapse; in this case, emergency cesarean section may be life saving.

The major cardiovascular complication of regional anesthesia is hypotension. The causes of hypotension under regional anesthesia can be due to the following: (1) the negative inotropic effect of the local anesthetic on the heart; (2) vasodilation due to the sympathectomy caused by the epidural or inadvertent subarachnoid injection; (3) hemorrhage; and (4) the supine hypotensive syndrome (aortocaval compression).

Hypotension causes the frequency and contractility of the uterus to decrease and has a deleterious effect on the fetal heart rate. Mild to moderate decreases in maternal blood pressure have no appreciable effect on uterine contractions, but a severe drop in pressure will decrease the frequency and intensity of uterine contractions secondary to hypoxia of the myometrium. Aortocaval compression may be one of several causes for a transient decrease in uterine activity. Craft found that by placing the parturient on her side following epidural anesthesia that the incidence of this decreased uterine activity was lessened.

Epidural anesthesia in the absence of factors such as aortocaval compression has been shown not to have an adverse effect on fetal heart patterns. However, severe drops in maternal blood pressure result in decreased uteroplacental flow with a drop in oxygen and nutrient transfer to the fetus and metabolic waste from the fetus. Maternal hypotension causes changes in fetal heart rate, usually bradycardia. After birth the newborn often has respiratory depression, decreased reflexes and loss of muscle tone.

Hypotension under epidural anesthesia must be prevented. The minimal dose of local anesthetic needed to achieve a successful block should be employed. An intravenous infusion is mandatory for all patients receiving an epidural, and approximately 1 L of crystalloid should be given before instituting the block. Regional anesthesia for labor should be administered so that the sensory level is
to T-10 and ideally no higher. The full supine position should be avoided in all gravidas.

The treatment of hypotension under epidural is the same regardless of its cause. Since the majority of gravidas are at risk for supine hypotension, first relieve aortocaval compression. The patient should be turned on her side, preferably left side down. Intravenous crystalloid should be rapidly administered to the hypotensive gravid to increase intravascular volume. Oxygen should be supplied by face mask. If hypotension persists despite these measures, vasopressors may be needed. Ephedrine in increments of 5-10 mg IV is the drug most commonly used. Caution should be used when administering a vasopressor concomitantly with oxytocin as severe hypertension can result. This is seldom seen with the new synthetic oxytociques.

Headache is a common complaint in parturients. Though there are numerous causes of headache in the obstetric patient, not to be ruled out are spinal headaches due to an inadvertent wet tap while the epidural is being performed. The typical spinal headache begins during the second postpartum day and lasts usually one to four days, but headaches of longer duration have been reported. It is hypothesized that cerebral spinal fluid (CSF) leaks out through a hole in the dura made by the needle, with a consequent decrease in CSF pressure. With decreased CSF pressure, the brain loses its natural cushioning and traction occurs on the pain sensitive blood vessels and supporting parts of the dura.

The incidence of spinal headache is greater in postpartum patients than in female surgical patients. It is felt that this is due to less water available for CSF production in the parturient and enhanced loss of CSF through the dural tear as a result of bearing down efforts and peripartum vomiting which increase CSF pressures and cause an increased loss of CSF. Conservative therapy for the treatment of the spinal headache includes bedrest, hydration, analgesic drugs and psychological support. If conservative therapy fails and the headache persists into the third postpartum day, an epidural blood patch is the treatment of choice.

This technique, first described by Gormley, consists of identification of the epidural space at the level where the dural puncture was performed and injection of 10 cc of autologous blood into the epidural space. Relief is often immediate. The success rate for epidural blood patch has been reported as 91% to 100%. It seems that the epidural blood patch works by forming a tamponade which prevents leakage of CSF, allowing the dural tear to undergo normal healing.

Before performing an epidural blood patch the anesthetist should identify the headache as spinal in origin, not a migraine or other chronic headache. Other characteristics of a spinal headache are as follows: (1) it should have lasted at least two or three days; (2) it should be severe enough to interfere with the patient's ability to function at her daily activities; and (3) conservative therapy should have been unsuccessful. The prophylactic administration of an epidural blood patch following an inadvertent "wet tap" is not recommended because it is of limited effectiveness; also, the majority of headaches will resolve with conservative therapy.

There are many reasons why a neurologic complication could occur following epidural anesthesia. Neurologic sequelae can be caused by trauma from the needle or catheter; ischemic injury to the spinal cord due to hypotension; compression of the cord from either an epidural abscess or hematoma; exposure to chemical toxic agents or the use of excessively high concentrations of local anesthetics. If neurological sequelae are suspected after regional anesthesia, the cause must be investigated immediately. This is done not only for medico-legal reasons but for the patient's well being. The first step that should be taken is a complete neurological examination.

In 1969, Dawkins reviewed over 32,000 lumbar epidural anesthetics and found that 0.02% of the cases developed permanent paralysis and 0.1% of the cases developed transient paralysis. Reports have been made of neurological deficits after regional anesthesia utilizing the gamut of modern local anesthetics. Several cases of prolonged neurological complications were reported after the unintentional subarachnoid injection of relatively large volumes of 2-chloroprocaine. The cause of these neuropathies has not been elucidated, but the safety of 2-chloroprocaine—particularly for epidural use—is an issue still requiring further research.

To avoid possible neurological sequelae following attempted epidural blockade, care should be taken not to place large volumes of 2-chloroprocaine or other local anesthetics in the subarachnoid space. This can be avoided by the proper use of a test dose and the use of fractional small doses of local anesthetics rather than a large bolus dose for maintenance of the epidural. If a large dose is given intrathecally, it is suggested that at least 10 cc of CSF be withdrawn and replaced with preservative free normal saline. If an inadvertent
“wet tap” occurs, the anesthetist should probably not use 2-chloroprocaine.

**Conclusion**

Epidural anesthesia can be a rewarding experience not only for the laboring parturient but for the anesthetist as well. The author has presented a review of the literature and presented a safe, tested technique for the administration of an epidural anesthetic for the laboring parturient.

**REFERENCES**


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The opinions or assertions contained in this article are the personal views of the author and are not to be construed as official or as reflecting the views of the Department of Anesthesiology, Naval Hospital, Jacksonville, Florida; The Nurse Corps, The Department of the Navy; or The Department of Defense.