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General

**INTRAOPERATIVE TRANSITIONS OF ANESTHESIA CARE AND POSTOPERATIVE ADVERSE OUTCOMES**

Anesthesiology 2014;121:695-706
Saager L, Hesler BD, You J, Turan A, Mascha EJ, Sessler DI, Kurz A

**Abstract**

**Purpose** The purpose of this study was to determine if an increased number of transitions of anesthesia care between providers was associated with adverse postoperative outcomes at a large academic medical center.

**Background** Intraoperative transitions of care are quite common in anesthesia, especially for longer cases and those that start later in the day. Handoff rates have increased with trainee work hour restrictions. The major concern with transitions of care and patient handoffs is that critical information may not be communicated. This lack of communication may increase the risk of patient harm. For example, 65% of all sentinel events reported to the Joint Commission in 2006 were due to communication errors.

Despite numerous studies examining handoff methods, little research has been done to examine if transitions of care in anesthesia are associated with postoperative adverse outcomes. Additionally, in anesthesia, there is no universally accepted method for performing a patient handoff. The authors of this study hypothesized that an increasing number of anesthesia turnovers would be associated with an increase in adverse postoperative outcomes.

**Methodology** The authors examined the Cleveland Clinic Perioperative Health Documentation System for all noncardiac surgeries between 2005 and 2012. They examined the association between the number of anesthesia handoffs and a composite of in-hospital mortality and six major morbidities (cardiac, respiratory, gastrointestinal, urinary, bleeding, and infectious adverse outcomes). The number of turnovers was examined for attending anesthesiologists working alone or medically directing CRNAs or trainees. Breaks of less than 40 minutes were not counted as a handoff. Complication rates were adjusted for age, gender, race, ASA class, principal diagnosis, duration of surgery, and surgery start time. Statistical analysis was appropriate.

**Result** There were 135,810 patients included in the analysis. The frequency of handoffs was as follows:

- 0 handoffs: 61%
- 1 handoff: 21%
- 2 handoffs: 11%
- 3 handoffs: 5%
- ≥4 handoffs: 3%

The overall risk of an adverse outcome increased only slightly following any single handoff and this was true whether it was the 1st handoff or the 4th (Figure 1). But when the number of handoffs added up, so did
the increase in the associated risk of an adverse outcome. Compared to no handoffs:

- 1 handoff was associated with a 6% increase in adverse outcome risk
- 2 handoffs were associated with a 12% increase in adverse outcome risk
- 3 handoffs were associated with a 24% increase in adverse outcome risk
- ≥4 handoffs were associated with a 48% increase in adverse outcome risk

Two or more handoffs were associated with statistically significantly more adverse outcome risk than no handoffs, though one handoff was not. There was no difference in the odds of a complication when an attending anesthesiologist worked alone or medically directed a CRNA or a trainee. There were no differences in complication rates or the number of turnovers between resident-only cases or CRNA-only cases.

Complication rates increased as the number of handoffs increased for cases that started later in the day (after 12 noon), for ASA 3 or 4 patients, and for cases >4 hours in duration (Figure 2). No significant increase was seen in the incidence of adverse outcomes and handoffs for cases <1 hour in duration. Cases that started later in the day with no handoffs had a 14.5% complication rate; however, this rate increased to 20% with four or more handoffs. Similar increases in complication rates were seen with higher ASA physical status classes and cases >4 hours in duration.

Other covariates associated with adverse outcomes included increased ASA status, severity of primary diagnosis, and severity of primary procedure. For every 1 class increase in the ASA status the risk of a complication increased 39%. For every 10% increase in diagnosis severity the risk increased 64%, and for every 10% increase in procedure severity the risk of a complication increased 47%.

The three adverse outcome categories with the highest incidence were gastrointestinal, bleeding, and cardiac.

The rate of adverse outcomes increased as the number of handoffs increased. Examples of gastrointestinal adverse outcomes included postgastric surgery syndrome, vomiting after gastrointestinal surgery, and hepatorenal syndrome.

Cardiac adverse outcomes included postoperative hypotension, cardiorespiratory failure from procedure, and cardiac arrest. Bleeding included hemorrhage or hematoma.
These results show an association between an increasing number of handoffs and higher rates of morbidity and mortality after noncardiac surgery. A formalized handoff process and efforts to minimize the number of handoffs may help improve outcomes.

Comment
Transitions of care are a hot topic in the area of patient safety. The authors present compelling data suggesting that there is an association between an increasing number of patient handoffs and adverse outcomes after noncardiac surgery.

I found it interesting that gastrointestinal adverse events had some of the highest rates of complications, especially as the number of handoffs increased. I would have expected cardiac or bleeding complications to be higher. The authors categorized complications based on the ICD-9 code. When I examined the gastrointestinal complications, vomiting after gastrointestinal surgery was one of the ICD-9 codes, which may have been for postoperative vomiting. This could explain the high rates of gastrointestinal adverse events. One explanation for how increasing number of handoffs could contribute to infectious complications could be that the anesthesia provider who took over the case failed to administer the next dose of antibiotics because the previous provider forgot to pass this information on. It is important to point out that the findings of this study are not causal; there may be other factors that were not examined that could have contributed to the findings.
I have personally seen, as I imagine have many of you, how turning over the patient, especially multiple times, may contribute to adverse outcomes. Inevitably, information gets lost in translation, and critical information can fail to be passed along, which may contribute to a bad outcome. There is something to be said for continuity of care. I personally do not like turning over a long, complicated case to another provider if I can help it. Unfortunately, the requirement that the anesthesia provider must turn over the case because they have exceeded the number of hours they can work, or their shift is over and the institution or group does not want to pay overtime, may make this problem worse. However, provider fatigue can contribute to medical errors and sometimes a fresh set of eyes is good; although, multiple “sets of eyes” may make the problem worse. Finding the right balance is what we struggle with in anesthesia.

**Dennis Spence, PhD, CRNA**

The views expressed in this article are those of the author and do not reflect official policy or position of the Department of the Navy, the Department of Defense, the Uniformed Services University of the Health Sciences, or the United States Government.
Neurosurgical Anesthesia

ProSeal Laryngeal Mask Airway Attenuates Systemic and Cerebral Hemodynamic Response During Awakening of Neurosurgical Patients: A Randomized Clinical Trial


Abstract

Purpose The purpose of this research was to test the hypothesis that emergence from anesthesia following elective supratentorial craniotomy in which the endotracheal tube was replaced with an LMA just prior to emergence provided greater systemic and cerebral hemodynamic stability. A secondary purpose was to evaluate the incidence of coughing compared to emergence with an endotracheal tube.

Background It is a well-established fact that blood pressure and heart rate increase considerably during emergence from anesthesia and extubation following neurosurgical procedures. This leads to increases in intracranial pressure and cerebral blood flow as well as regional brain oxygen saturation ($rS_2O_2$). If coughing occurs, the problem worsens, increasing cerebral venous pressure as well. The reasons for increases in arterial blood pressure include elevated levels of catecholamines, specifically norepinephrine, which may interfere with cerebral autoregulation. Cerebral autoregulation is typically already impaired in this population due to the underlying pathology. When cerebral blood flow depends on systolic arterial blood pressure, there is an increased risk of postoperative intracerebral hemorrhage and cerebral edema as the result of elevated pressures. It is important to maintain hemodynamic control and to avoid anesthetic techniques that increase pressures (e.g. coughing) in these high-risk patients.

During the maintenance phase of anesthesia for supratentorial craniotomy an endotracheal tube is warranted for obvious reasons. The latest extubation guidelines published by the Difficult Airway Society address replacing the ETT with an LMA before awakening patients who are at high risk for cardiovascular instability and/or compromise. The benefits of this maneuver have not been investigated in the neurosurgical population. The researchers sought to determine if emergence with an LMA in this high-risk population minimized hemodynamic instability and/or compromise.

Methodology This clinical trial was carried out as a single-site, randomized, open-label, parallel study. Those having elective supratentorial craniotomy for nonvascular procedures were randomized into one of two groups:
• **Group 1** - LMA group. Subjects had their ETT replaced with an LMA before anesthesia was discontinued. The LMA was removed when awake.

• **Group 2** - ETT group. Subjects were emerged from anesthesia and extubated in traditional fashion when awake.

All subjects received a standardized general anesthetic which included intravenous propofol and remifentanil via a targeted controlled infusion system. Muscle relaxant was reversed at case end with sugammadex. Standard monitoring was applied to all subjects. A transcranial Doppler ultrasound was used during induction and replaced at emergence to measure Middle Cerebral Artery (MCA) flow in the temporal window. The following were recorded in all subjects:

1. blood pressure, heart rate, $rS_{O_2}$, and MCA flow velocity at 8 different time points
   a. prior to induction
   b. before awakening in the ETT group
   c. before ETT replacement in the LMA group
   d. throughout emergence at 1, 5, 10, 15, 30, and 60 minutes after extubation or LMA removal
2. antihypertensive medication urapidil (see notes)
3. norepinephrine plasma concentrations
4. coughing episodes

Statistical computations determined that 21 patients would be needed in each group to detect between-group differences of 10 mm Hg in MAP, which was the primary end point.

**Results**  
Forty-eight patients were initially randomized into the two groups; however, six did not complete the trial leaving 21 in both the LMA and ETT groups. There were no demographic differences between groups. The following differences were statistically significant:

- Systolic BP, HR, and rate pressure product (RPP) at emergence increased compared to baseline in both groups
- Higher MAP, Systolic BP, HR, and RPP in ETT group vs. LMA group at all post-extubation time points
- Higher $rS_{O_2}$ on emergence in both groups – percent increase from baseline was greater in ETT group vs. LMA group
- MCA flow velocity was elevated from baseline at emergence in both groups
- Higher dose of antihypertensive given to the ETT vs. LMA group
- Number of coughing episodes at emergence was greater in ETT group vs. LMA group

**Conclusion**  
For the neurosurgical patient at risk for altered cardiovascular and cerebral hemodynamics at the conclusion of surgery and anesthesia, replacing the ETT with an LMA before emergence was associated with a reduction in MAP, Systolic BP, HR, and Rate Pressure Product compared to a traditional emergence with an ETT. The reduction in these hemodynamic and cerebral variables lessened the effect of cerebral hyperemia which can be catastrophic in some situations. There was also a 3-fold greater need for antihypertensive agents in the ETT group, as well as a higher incidence of coughing during emergence.

**Comment**  
I appreciate the several limitations of this study discussed by the investigators, such as not recording PaCO$_2$ after extubation (did it climb in either group and alter cerebral and CV hemodynamics?) as well as any effect that the antihypertensive agent had on heart rate, that may have influenced the findings. Interesting to note, however, is the absence of data
regarding required analgesics in either group once the remifentanil was discontinued. Remifentanil is rapidly metabolized by hydrolysis by non-specific blood and tissue esterases. Even if the duration of the infusion is long, drug concentrations decline by 50% within approximately four minutes of discontinuing the infusion. No mention of postoperative pain management was made for either group so we do not know how treatment for this was managed within or between groups. Could pain following craniotomy also have influenced the results?

Having said all that, there is an appropriate level of evidence-based knowledge regarding the reduction in sympathetic stimulation associated with LMA use versus the traditional use of the ETT during emergence. This allowed for hypothesis testing specific to this craniotomy population.

**Mary Golinski, PhD, CRNA**

**Urapilil** is an α₁-adrenoceptor antagonist and 5-HT₁A receptor agonist used clinically to treat hypertension in a number of European countries but unavailable in the USA.
Obstetric Anesthesia

AIRWAY CHANGES DURING LABOR AND DELIVERY

Anesthesiology 2008;108:357-362
Kodali B-S, Chandrasekhar S, Bulich LN, Topulos GP, Datta S

Abstract

Purpose The purpose of this study was to look for airway changes between early and late in the labor and delivery process. The study was intended to be exploratory; the foundation for future more detailed investigations of the airway in laboring women.

Background Failed intubation is much more common in pregnant than in nonpregnant individuals. The relative risk of a difficult intubation in pregnant women with a Mallampati class III airway has been shown to be 7.58 times greater than pregnant women with a class I airway. For those with a class IV airway the relative risk is 11.3 times greater than those with a class I airway. Airway problems during general anesthesia for cesarean section are the number one cause of anesthesia-related maternal morbidity and mortality. At least one study has also identified airway obstruction or hypoventilation during emergence and extubation as a cause of maternal death.

Airway soft tissue changes and edema are associated with pregnancy and may contribute to difficult airway management. Some studies have shown that airway edema increases during pregnancy and increases the Mallampati score. Anecdotal reports suggest the airway of pregnant women may also change during the labor and delivery process.

The upper airway has two components, an oral component and a pharyngeal component. Only the oral component is assessed with the Mallampati score. Acoustic reflectometry can be used to assess both components of the airway. Acoustic reflectometry has been shown to correlate well with computed tomography measurements of the upper airway. An airway volume less than about 40 mL has been associated with difficulty viewing the glottis in nonpregnant subjects. And acoustic reflectometry has been shown to predict difficult mask ventilation.

Methodology This prospective, single-blind study included healthy women who underwent labor and spontaneous vaginal delivery. Women who ultimately had an operative delivery were excluded. Two different methods of assessing the airway of laboring women were employed: first using the Mallampati scoring system and second, using acoustic reflectometry.

For the airway classification section of the study, healthy women admitted in early active labor were recruited (2-3 cm cervical dilation). Women with a class IV airway were excluded. The oral airway of women was photographed in a standard manner at admission, 20 minutes after delivery of the placenta, and 36-48 hours postpartum. Photographs were taken with women in the sitting position, with their mouths
wide open, and without phonation. Each photograph was taken from the same angle and from a distance of 10 inches from the uvula or soft palate. Photographs were assigned a numeric code. Each photograph was later assigned a Mallampati classification by a single senior anesthesiologist.

In the second section of the study acoustic reflectometry was used to describe the length and cross sectional area of the oral and pharyngeal portions of the upper airway. Healthy women admitted in early active labor (2-3 cm cervical dilation) were recruited. Airway measurements were made while in early active labor and again 20 minutes after spontaneous vaginal delivery.

Statistical analysis simply used descriptive statistics and Spearman correlation analysis of airway assessments with pregnant weight, patient height, duration of labor, and the volume of intravenous fluids administered during labor and delivery.

**Result** The Mallampati classification section of the study included 61 women. (Seventy women were recruited but nine delivered by cesarean section and were not included in the analysis.) Overall Mallampati class changed significantly between early active labor and post-delivery assessments (P<0.001). In 23 of the 61 women (38%) the Mallampati class increased from early labor to post-delivery. In no cases did the Mallampati class decrease across these two measurements. In 20 women (33%) the Mallampati class increased by one grade. In three women (5%) the Mallampati class increased by two grades. There were 30 women with Mallampati class III or IV at the post-delivery measurement but only 17 in the early labor measurement; an increase of 76% (P<0.001).

Immediately post-delivery, half of the women in the study had class III or IV airways. There were no women with a Mallampati class IV airway during early labor but 8 women had a class IV airway after delivery. Most women whose Mallampati class increased during labor reverted to their early labor airway classification by 48 hours postpartum. There was no correlation between airway changes and weight, height, duration of labor, or IV fluid administered.

The acoustic spectrometry section of the study included 21 women. Twenty of the 21 women received labor epidural analgesia. Both oral (P<0.05) and pharyngeal (P<0.001) volume decreased significantly between early active labor and post-delivery. There was no correlation between the decreases in airway volumes and weight, height, duration of labor, or IV fluid administration.

**Conclusion** There was a significant increase in the Mallampati score and a decrease in total upper airway volume between early labor and immediate post vaginal delivery. An airway exam should be performed immediately prior to endotracheal intubation as it may have changed since the start of labor and delivery.

**Comment** I have always been pretty quick to perform a pre-anesthetic assessment in labor and delivery if
thought a woman might need anesthesia for a cesarean section later on. I am especially interested in looking at their airway so if I had to do a STAT general cesarean section I’d know what to expect during intubation. I never dreamed that the airway could change significantly between that early, “just in case,” assessment and when I actually induced general anesthesia. This article convinced me that it can.

Obstetric anesthetists have long regarded regional anesthesia as safer than general anesthesia for cesarean section. This article gives us even more reason to hold to that belief. Here is the way the authors of this article have laid out the increased risk.

1) Airway problems during cesarean section and general anesthesia are the number one cause of maternal morbidity and mortality
2) In this study, 50% of women had a Mallampati class III or IV airway after delivery
3) The risk of a difficult intubation in those women, half the pregnant women in the study, was between 7 and 11 times greater than a pregnant woman with a class I airway

We don’t know from this study precisely when the airway gets worse during labor and delivery. It may occur only very late in the process, after the woman has pushed for an hour or more. It may occur earlier. We also don’t know if the airway changes this study found are applicable to pregnant women in general or, for some reason, were peculiar to the women in this one study. But this is powerful information; it should give us pause. And, it should give us a reason to reexamine the airway immediately before induction of general anesthesia in a pregnant or early postpartum woman.

Michael A. Fiedler, PhD, CRNA
Determination of the ED95 for Intrathecal Plain Bupivacaine Combined with Fentanyl in Active Labor

Whitty R, Goldszmidt E, Parkes RK, Carvalho JCA

Abstract

Purpose The purpose of this study was to determine the ED95 (effective dose in 95% of the population) for bupivacaine injected into the subarachnoid space for labor analgesia.

Background Combined spinal and epidural (CSE) analgesia effectively relieves labor pain and has some advantages over epidural analgesia alone; notably, spinal analgesia has a much faster onset. Commonly, bupivacaine is used for the spinal component of CSE analgesia in combination with an opioid, usually fentanyl. Current clinically used doses were derived from studies in which the minimum local anesthetic dose or the ED50 were determined. In those studies, the subarachnoid dose of bupivacaine ranged from 0.7 mg with 15 µg fentanyl to 2.4 mg with no fentanyl added. A statistically projected estimate of the ED95 for bupivacaine was 3.3 mg in another study. The ED95 is the dose that has the desired effects in 95% of the population. In clinical obstetric anesthesia practice, 2.5 mg bupivacaine is commonly used. The investigators hypothesized that 2.5 mg bupivacaine was greater than the ED95 and that a more appropriate dose might continue to produce the desired analgesia with fewer undesired effects.

Methodology This single-blind, dose-finding study included 40 ASA I or II term parturients in active labor. To be eligible for the study, parturients carried a single fetus, were at a cervical dilation of ≥5 cm, reported pain ≥6 out of 10 (verbal pain scale), and were at least 18 years of age. The fetal heart rate (FHR) was monitored throughout the study. Subjects with an abnormal baseline fetal heart rate pattern were excluded. All subjects received 250 mL of lactated ringsers IV before their CSE labor analgesia. The CSE was performed at either the L2-3 or L3-4 interspace with subjects in the sitting position. A needle through needle technique was used with a 17g Tuohy and a 26g Whitacre. The subarachnoid injectate included 0.25% plain bupivacaine and 15 µg of fentanyl. (Only the dose of bupivacaine was varied.) Normal saline was added to make the total volume of injectate 2 mL in all subjects. Subarachnoid bupivacaine and fentanyl were injected over 10 seconds. The first patient received 1.75 mg subarachnoid bupivacaine. Thereafter, the bupivacaine dose was changed in increments of 0.25 mg in search of the ED95 dose (in combination with 15 µg fentanyl). Next, an epidural catheter was inserted 3 to 5 cm into the epidural space. Thirty minutes after the subarachnoid injection an epidural infusion of 0.0625% bupivacaine with 2 µg/mL fentanyl was started with no bolus. Effective analgesia was defined as a verbal pain score of 1 out of 10 or less.

Post Hoc, data from this study was pooled with data from two previous studies for further analysis.
Result  Only two different doses of bupivacaine were used during the study. The 1.75 mg bupivacaine dose was effectively an ED\textsubscript{100}, and a 1.5 mg bupivacaine dose was an ED\textsubscript{85}. The statistically estimated ED\textsubscript{95} was 1.66 mg. No subjects experienced motor block, respiratory depression, nausea, or vomiting. Fifty-five percent reported itching. Fetal bradycardia occurred in 3 subjects; none resulted in a cesarean section.

Pooling the data from this study with data from two previous studies, the estimated ED\textsubscript{95} of subarachnoid bupivacaine for labor analgesia was 1.95 mg (95% CI 1.45 mg to 2.95 mg).

Conclusion  The ED\textsubscript{95} for subarachnoid bupivacaine with 15 µg fentanyl was 1.66 mg for labor analgesia. This dose produced a verbal pain score of 0 or 1 out of 10 within 10 minutes of administration in primiparous women with ≥5 cm cervical dilation.

Comment  My impression is that 2.5 mg bupivacaine is most commonly used for the subarachnoid injection when CSE analgesia is used in OB. I’m not sure where this dose came from so I’m glad to see a study that gives us some idea of where the “sweet spot” might be between too much and too little bupivacaine.

To decide what an ED\textsubscript{95} is, one must first define “effective.” In this case, the investigators defined effective labor analgesia as a verbal pain score of no more than 1 out of 10. That strikes me as a pretty tough standard. I don’t know that I’ve ever had a woman in labor rate her pain as a 1. When I get laboring women to the point that they rate their pain as about a 3 they are usually pretty happy. Lower than that and they usually have excessive motor block. That said, if these clinicians can get to a pain score of 1 they may have something to teach the rest of us. And, they apparently did so without undue motor block, so all the better.

It is encouraging that they found the optimal subarachnoid dose of bupivacaine to be between 1.5 and 1.75 mg, rather than the commonly used 2.5 mg. While 2.5 mg usually doesn’t result in too much motor block, I would expect the chance of motor block to be even smaller with the lower dose. The fact that their confidence interval was so wide indicates either that their study was underpowered or had a problem with the methodology. Either way, the clinical results are convincing enough that we can probably overlook that flaw.

The little “mini-metaanalysis” they did after the fact (post hoc) with data from two other studies is an interesting touch. On the one hand, it is factual information that further supports their findings. On the other hand, from a research perspective it is subpar. It is disappointing to see slack research procedures that could be avoided with just a little more expertise, planning, or effort. In this case, had the methodology been slightly improved and/or the number of subjects increased just a little bit, I expect the investigators would have been comparing their study to the other two in the discussion section rather than including data from the other two studies in their results section. This criticism notwithstanding, the information presented is sufficiently convincing and helpful that I’m willing to consider it in my clinical practice.

Michael A. Fiedler, PhD, CRNA
Assessment of Knowledge Regarding Cardiopulmonary Resuscitation of Pregnant Women

Cohen SE, Andes LC, Carvalho B

Abstract

Purpose The purpose of this study was to assess the understanding of pregnancy-specific ACLS protocols amongst anesthesiologists, obstetricians, and emergency physicians; both residents in training and specialty certified.

Background Cardiac arrest is rare in pregnant women but may occur due to complications of pregnancy (e.g. amniotic fluid embolus) or factors unrelated to pregnancy (e.g. trauma or preexisting cardiovascular pathology). Most health professionals have not had firsthand experience with resuscitation of a pregnant patient. Normal physiologic changes due to pregnancy require important changes to Advanced Cardiac Life Support (ACLS). Standard ACLS algorithms and training courses do not usually include modifications to ACLS protocols necessary in pregnant women.

Methodology A 12 question descriptive survey was developed by a group of five subspecialty-trained obstetric anesthesiologists. The survey covered four areas of knowledge key to the successful resuscitation of a pregnant woman. Those four areas were:

1. the need for left uterine displacement
2. ACLS algorithms
3. physiologic changes accompanying pregnancy
4. recommendation to consider immediate cesarean section in arrested women > 20 weeks pregnant after 5 minutes of unsuccessful ACLS

The survey was not validated prior to use. The survey was administered to 75 physicians in a single academic medical center in the presence of an investigator. The medical center logged between 5,000 and 6,000 deliveries a year. All physicians surveyed provided care for pregnant patients. Participants were surveyed in the hospital, during the day, while performing their usual clinical duties. No reference materials were allowed during completion of the survey.

Result One of the 12 questions was excluded from analysis because obstetricians and anesthesiologists failed to agree on the correct answer. Of those who completed the survey, 43% were anesthesiologists, 37% were obstetricians, and 20% were emergency physicians. Sixty-two percent were residents and 38% were attending physicians. About 50% of participants had completed an ACLS course in the previous two years.

Average scores on the 11 item multiple choice exam were 76% for anesthesia, 63% for obstetrics, and 72% for emergency. Residents as a group scored an average of 70% and attending physicians 74%. Those who
participated in an ACLS course in the previous two years did not score significantly differently than those who had not participated in an ACLS course in five years or longer. Only 15% of all participants scored above 85%. Up to 43% of specialty physicians caring for pregnant patients failed to demonstrate adequate knowledge of left uterine displacement or the role of cesarean delivery during resuscitation upon which to base clinical decisions.

**Conclusion**
The anesthesiologists, obstetricians, and emergency physicians surveyed lacked knowledge required for the successful resuscitation of pregnant women. The authors recommended that pregnancy-specific resuscitation information be added to ACLS training for these specialties.

**Comment**
Successful resuscitation of a pregnant woman requires several important changes to widely accepted ACLS protocols. This simple study described the level of understanding of those changes among physicians who cared for pregnant women at a large academic medical center. From a research point of view, the study was somewhat lacking. But what the study lacked in methodologic rigor, it made up in simplicity and in raising awareness. And the results weren’t pretty. Most physicians fell short of what any well-educated person would consider a passing score. And I have no reason to believe that nurse anesthetists would have fared any better.

The group surveyed was probably not representative of anesthesiologists, obstetricians, or emergency physicians as a whole. But I would argue that a more representative sample would probably have performed even worse. On average, over 13 babies a day were delivered at the institution so they cared for a lot of pregnant women. This would not be true for all physicians in a more diverse sample. They all worked at an academic institution and some were in residency training. Education was active and ongoing at such an institution. It seems reasonable to believe that those working in non-academic settings where few pregnant women are cared for might be even less knowledgeable about the resuscitation of pregnant women.

This survey was published in 2008, and, from what I can see, understanding of important changes in ACLS protocol for pregnant women is no better known among health care providers attending to pregnant women now than it was in 2008. I believe that all anesthesia providers, labor and delivery nurses, and obstetricians should be familiar with these simple recommendations. (See the American Heart guidelines in the citation at the end of this abstract and comment.)

So what is this additional critical knowledge needed to successfully resuscitate a pregnant woman? As reported by the authors of the survey it is this.

**Left Uterine Displacement of at least 15°** - the gravid uterus can obstruct the abdominal aorta and/
or inferior vena cava further limiting the limited cardiac output provided by chest compressions.

**Perform Chest Compressions 1-2 cm Higher on the Sternum in the Term Pregnant Woman** – this allows for the proper depth of chest compressions.

**Consider Immediate Cesarean Section at >20 Weeks Gestation if Response is Inadequate to 4 Minutes of ACLS** – left uterine displacement may be inadequate to restore circulation in some women. There are numerous reports of successful maternal resuscitation immediately after delivery of the fetus.

**Use Full Doses of ACLS Drugs** – Limiting vasopressors in an effort to avoid uterine artery constriction is misguided. Without restoration of maternal circulation the fetus will surely die.

This survey effectively raises awareness of the need for additional education of those most likely to be involved in resuscitation of pregnant women. It should really be a simple matter to add this crucial information to ACLS training for the appropriate clinicians. (We already have different “flavors” of ACLS for different provider types.) The recommendations and rationales are well supported by scientific evidence and clinical experience. Whether or not the American Heart Association makes adjustments in ACLS training, I hope all nurse anesthesia programs will make sure this information is included in their curricula.

**Michael A. Fiedler, PhD, CRNA**
Abstract

Purpose  The purpose of this study was to determine if morbidly obese parturients >300 lbs had higher rates of complications and neuraxial anesthesia failure compared to a control group weighing <250 lbs, and to compare these results with those found in 1993.

Background  In 1993, investigators demonstrated that morbidly obese parturients >300 lbs had higher initial epidural failure rates. They also had an increased rate of obstetric complications and more often needed cesarean delivery. This 1993 study highlighted the importance of early epidural placement in morbidly obese parturients.

Since 1993, the prevalence of obesity has increased from 24% to 34%. Advances in neuraxial techniques and experience with providing anesthesia to morbidly obese parturients since 1993 have been hypothesized to be associated with improved outcomes. The authors of this study hypothesized that complication rates would still be higher in morbidly obese parturients compared to a matched group weighing <250 lbs. They expected to find higher rates of combined spinal epidural use for cesarean delivery in morbidly obese parturients. They also expected to find that general anesthesia was less commonly used in morbidly obese parturients than it was in 1993.

Methodology  This was a retrospective cohort study comparing outcomes in morbidly obese parturients >300 lbs. with a matched cohort of parturients <250 lbs. who delivered in the years 2011-2012. The matched cohort was made up of the next patient delivered by any mode by the same obstetrician. This technique was chosen so the results could be compared with those from a 1993 study conducted in at the same institution. Data collected included demographics, maternal complications, type of delivery, anesthetic technique, obstetric management, and complications. Statistical analysis was appropriate. A P < 0.05 was considered significant.

Result  There were 230 morbidly obese parturients and 230 parturients in the matched cohort. Parturients in the matched control group had a greater BMI than the comparison group in 1993 (BMI 31.1 vs. 27.8 P < 0.01). In 1993, 42% of morbidly obese parturients required replacement of their labor epidural compared to only 17% in the current study (P < 0.01). The need for general anesthesia for cesarean delivery decreased from 24% in 1993 to 3% in 2012 (P < 0.01; Figure 1).
Morbidly obese parturients had significantly higher rates of chronic hypertension, hypertensive disorders of pregnancy, diabetes (preexisting and gestational), oxytocin for induction of labor, longer first stage of labor, and cesarean delivery rates compared to the matched control group (Figure 2). The first stage of labor was significantly longer in morbidly obese parturients; 632 ± 420 min vs. 455 ± 290 min (P < 0.001). Oxytocin was used in 85% of women >300 lbs vs. only 61% of women <250 lbs (P < 0.001).
There were differences in neuraxial techniques for labor analgesia between the two groups. Morbidly obese parturients were more likely to receive labor epidural analgesia and less likely to receive a combined spinal-epidural. Morbidly obese parturients needed a greater number of top-up doses and had a higher epidural failure rate compared to the matched cohort (Table 1). The rate of neuraxial anesthesia for cesarean delivery were similar in both groups.

However, combined spinal-epidural was more often used and spinal anesthesia alone was less often used in the morbidly obese (P < 0.01). No differences were found in the need for an alternate anesthetic technique for cesarean delivery after the initial technique failed.

Conclusion The need to replace labor epidural catheters and the need for general anesthesia for cesarean delivery decreased since 1993 in morbidly obese parturients. However, morbidly obese parturients still have higher rates of antenatal complications, failed labor analgesia, longer first stage of labor, and need for cesarean delivery.

<table>
<thead>
<tr>
<th>Table 1. Anesthetic Technique vs. Patient Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Morbidly Obese (&gt;300 lbs.) n = 230</td>
</tr>
<tr>
<td>Matched Cohort (&lt;250 lbs.) n = 230</td>
</tr>
<tr>
<td>P Value</td>
</tr>
<tr>
<td>Labor Analgesia</td>
</tr>
<tr>
<td>Epidural</td>
</tr>
<tr>
<td>86%</td>
</tr>
<tr>
<td>52%</td>
</tr>
<tr>
<td>&lt;0.01</td>
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<tr>
<td>Combined Spinal-Epidural</td>
</tr>
<tr>
<td>12%</td>
</tr>
<tr>
<td>48%</td>
</tr>
<tr>
<td>&lt;0.01</td>
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<tr>
<td>Inadvertent dural puncture</td>
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<tr>
<td>2%</td>
</tr>
<tr>
<td>0%</td>
</tr>
<tr>
<td>NS</td>
</tr>
<tr>
<td>Number of tops-ups</td>
</tr>
<tr>
<td>1 (0,2)</td>
</tr>
<tr>
<td>0 (0,1)</td>
</tr>
<tr>
<td>&lt;0.01</td>
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<tr>
<td>Catheter manipulation for pain</td>
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<tr>
<td>21%</td>
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<tr>
<td>11%</td>
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<tr>
<td>NS</td>
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<tr>
<td>Labor Epidural replacement</td>
</tr>
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<tr>
<td>Cesarean Delivery</td>
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<td>Neuraxial</td>
</tr>
<tr>
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</tr>
<tr>
<td>96%</td>
</tr>
<tr>
<td>NS</td>
</tr>
<tr>
<td>Bolus CLE</td>
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<tr>
<td>43%</td>
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<tr>
<td>22%</td>
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<tr>
<td>NS</td>
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<tr>
<td>Spinal</td>
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<td>74%</td>
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<td>Combined Spinal-Epidural</td>
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<td>18%</td>
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<td>Alternate technique</td>
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<td>General Anesthesia</td>
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<td>4%</td>
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<td>NS</td>
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</table>

Note: CSE = combined spinal epidural; CLE = continuous lumbar epidural; GETA = general endotracheal anesthesia. Numbers are % except for “number of top-ups” which is number (range).
Comment

More and more often we are having to take care of morbidly obese parturients in labor. Results of this study demonstrate that these patients have higher rates of hypertensive disorders of pregnancy, gestational diabetes, and are more likely to require either an elective or urgent cesarean delivery. Fortunately, we have become more adept at taking care of morbidly obese parturients, and as this study confirms, our failed neuraxial technique rate has dramatically decreased, helping to reduce the need for general anesthesia for cesarean deliveries.

What are some important take-home messages from this study? Anesthesia providers should evaluate morbidly obese parturients for comorbid conditions and antenatal complications such as gestational diabetes and hypertensive disorders of pregnancy. Early placement of an epidural is recommended because this allows for anesthesia providers to ensure adequate analgesia and the ability to provide a surgical block if needed for cesarean delivery. Consider placing a combined spinal-epidural for elective or nonurgent cesarean deliveries because this allows for top-up bolusing if the spinal starts to wear off. If you anticipate the patient may be a difficult back, bring an ultrasound in and perform a pre-procedural scan to estimate the depth and optimal insertion point.1 Finally, anesthesia providers should be prepared for a difficult airway. The bed should be ramped, a videolaryngoscope should be available, and backup rescue devices should be immediately available. If you get into trouble, call for help early!

Dennis Spence, PhD, CRNA


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