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Obstetric Anesthesia

**Hospital-Level factors associated with anesthesia-related adverse events in cesarean deliveries, New York State, 2009–2011**

DOI: 10.1213/ANE.0000000000001341
Guglielminotti J, Deneux-Tharaux C, Wong CA, Li G

**Abstract**

**Purpose** The purpose of this study was to examine the relationship between hospital-level factors and anesthesia-related adverse events during cesarean delivery in New York from 2009 to 2011.

**Background** Cesarean delivery is one of the most common surgical procedures performed in the United States. Unfortunately, there is an up-to 6-fold difference in anesthesia-related adverse events between good-performing and bad-performing hospitals for cesarean delivery. Previous studies on medical and surgical inpatients suggest hospital-level factors such as procedure volume, nursing staffing, teaching status, and proportion of minority patients are associated with adverse events. Previous research found that lower hospital procedure volume was associated with higher rates of anesthesia-related adverse events during childbirth. However, hospital-level factors, such as anesthesia provider type (MD or CRNA), teaching status, and other factors were not examined. This study sought to use advanced statistical analysis techniques to identify hospital-level factors, patient-level factors, and delivery characteristics that were associated with anesthesia-related adverse events during cesarean delivery.

**Methodology** This was a retrospective study examining discharge records after cesarean delivery at non-federal hospitals in New York State from 2009-2011. Anesthesia-related adverse events were divided into:

1. **systemic adverse events**, which included
   1.1. pulmonary
   1.2. cardiac
   1.3. central nervous system
   1.4. other unspecified adverse events
2. **adverse events related to neuraxial anesthesia**, including
   2.1. headache after lumbar puncture
   2.2. epidural blood patch
   2.3. adverse events of spinal anesthetics
   2.4. epidural, extradural, or subdural abscesses
3. **adverse events related to anesthetic drugs**.

An anesthesia-related adverse event was considered major if it was associated with death; cardiac arrest; or severe cardiac, respiratory, or neurological morbidity.

Investigators examined patient-level and hospital-level factors to determine if they were associated with anesthesia-related adverse events.

**Patient-level factors included:**

a. Charlson comorbidity index
b. multiple gestation
c. delivery and anesthesia characteristics
   e.g. postpartum hemorrhage and administration of general anesthesia
Hospital-level factors included:

a. Joint Commission accreditation status  
b. teaching hospital status  
c. rural location  
d. proportion of nonwhite patients  
e. proportion of Medicaid patients  
f. ICD-9-CM reporting index  
g. cesarean delivery rate  
h. number of full-time equivalent nurses and physicians  
i. anesthesia provider density (estimated with the number of CRNAs or Anesthesiologists working in the county where the hospital was located)

Hospital outliers were defined according to the American College of Surgeons National Surgical Quality Improvement Program definitions of good or bad performing hospitals. Hospital performance on anesthesia-related adverse events was evaluated with the Hospital Odds Ratio*, with a higher rate indicating poorer performance. Bad-performing hospitals are those with a HOR >1. Good-performing hospitals are those with a HOR <1.

Result  
There were 236,960 cesarean deliveries at 141 non-federal hospitals in New York from 2009 to 2011. A total of 3,046 adverse events were recorded during 1,557 cesarean deliveries and 67 major anesthesia-related adverse events during 47 deliveries (Table 1).

There were 1,557 deliveries which included at least 1 anesthesia-related adverse event. The rate of anesthesia-related adverse events was 6.57 per 1,000 discharges and 1 major anesthesia-related adverse event in 47 discharges (0.2 per 1,000 discharges). Multilevel modeling identified four patient-level and delivery-related characteristics that were associated with increased risk of anesthesia-related adverse events (P < 0.05):

- Charlson comorbidity index >1  
- multiple gestation  
- general anesthesia  
- postpartum hemorrhage

Two hospital-related factors were identified which were predictive of an increased risk of anesthesia-related adverse events: hospitals with average cesarean delivery <200 and reporting index (Table 2).

Anesthesia provider type was not associated with an increased rate of anesthesia-related adverse events after controlling for hospital delivery rate.

Hospitals with fewer than 200 deliveries had a higher rate of anesthesia-related adverse events, with a crude rate of Anesthesia-related adverse events between 10-20 per 1,000 deliveries. Hospitals with more than 200 deliveries had a lower rate of Anesthesia-related adverse events, between 5-7 per 1,000 discharges. Hospital performance ranged from a HOR of 0.38 to 5.4. (A higher HOR indicates bad performance.) A total of 20 hospitals had a HOR >1 indicating bad performance (20.6%), while 8 hospitals had a HOR <1 indicating good performance (5.7%). The remaining 113 hospitals were average performing (73.7%). Compared to good-performing hospitals,

<table>
<thead>
<tr>
<th>Table 1. Rate of Anesthesia-Related Adverse Events</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systemic Adverse Event</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulmonary</td>
<td>79</td>
<td>2.6%</td>
</tr>
<tr>
<td>Cardiac</td>
<td>40</td>
<td>1.3%</td>
</tr>
<tr>
<td>Central Nervous System</td>
<td>17</td>
<td>0.56%</td>
</tr>
<tr>
<td>Other and unspecified</td>
<td>1,238</td>
<td>40.6%</td>
</tr>
<tr>
<td>Adverse event related to neuraxial anesthesia</td>
<td>1,644</td>
<td>54%</td>
</tr>
<tr>
<td>Adverse event related to anesthetic drugs &amp; local anesthetics</td>
<td>28</td>
<td>0.9%</td>
</tr>
<tr>
<td>Major adverse event</td>
<td>67</td>
<td>2.2%</td>
</tr>
</tbody>
</table>
patients having a cesarean delivery at a bad-performing hospital were 5.92 times more likely to experience an anesthesia-related adverse event.

**Conclusion**  A cesarean delivery rate of <200/year was the strongest hospital-level predictor of Anesthesia-related adverse events.

**Comment**  It is not surprising that hospitals that have very low annual cesarean delivery rates (<200/year), deliver patients with more comorbidities, higher multiple gestation and postpartum hemorrhage rates, and general anesthesia rates had higher rates of Anesthesia-related adverse events. If you are not delivering a lot of babies; providers, nurses, and facilities get rusty and may be prone to higher rates of complications. Additionally, facilities with <200 deliveries/year are typically in rural settings and have limited resources to manage postpartum hemorrhage and other peripartum complications.

So what can you do? If you do not administer a lot of obstetric anesthesia, then consider finding a facility where you can keep your skills up or attend workshops to help improve your knowledge and skills. Two of the most important things are to champion the implementation of TeamSTEPPS and the American College of Obstetricians and Gynecologists Obstetric Hemorrhage Bundle. Everyone at your facility needs to embrace a culture of safety and be vigilant. Multidisciplinary teams should conduct obstetric hemorrhage simulation drills and identify areas for improvement.

**Dennis Spence, PhD, CRNA**

§**Reporting Index** was defined as the ratio of the sum of ICD-9-CM diagnoses and procedure codes recorded for each discharge to the number of discharges.

*Hospital Odds Ratio* - the ratio of observed to expected rate of anesthesia-related adverse events in each hospital.


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<table>
<thead>
<tr>
<th>Table 2. Risk Factors for Anesthesia-Related Anesthesia Events</th>
<th>Adjusted Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient Comorbidities</strong></td>
<td></td>
</tr>
<tr>
<td>- Charlson comorbidity index &gt;1</td>
<td>1.22</td>
</tr>
<tr>
<td>- Multiple gestation</td>
<td>1.23</td>
</tr>
<tr>
<td><strong>Delivery and Anesthesia Characteristics</strong></td>
<td></td>
</tr>
<tr>
<td>- General anesthesia</td>
<td>1.29</td>
</tr>
<tr>
<td>- Postpartum hemorrhage</td>
<td>1.48</td>
</tr>
<tr>
<td><strong>Hospital Characteristics</strong></td>
<td></td>
</tr>
<tr>
<td>- Cesarean delivery rate &lt;200/y</td>
<td>2.35</td>
</tr>
<tr>
<td>- Reporting index§ (per 1 increase per discharge)</td>
<td>1.13</td>
</tr>
</tbody>
</table>
The Effect of Combined Spinal-Epidural Versus Epidural Analgesia in Laboring Women on Nonreassuring Fetal Heart Rate Tracings: A Systematic Review and Meta-Analysis

Anesth Analg 2016;123:955-64
10.1213/ANE.0000000000001412
Hattler J, Klimek M, Rossaint R, Heesen M

Abstract

Purpose This meta-analysis sought to compare the incidence of nonreassuring fetal heart rate tracings (NRFHR) after placement of a combined spinal-epidural (CSE) vs. an epidural alone for labor analgesia. Secondarily, the study compared differences in the need for cesarean delivery indicated by NRFHR tracing.

Background Neuraxial analgesia is the gold standard for labor pain relief. Anesthesia providers will initially administer a dilute local anesthetic with or without opioid for an epidural. Alternately, a CSE with or without local anesthetic combined with subarachnoid opioid may be instituted, followed by patient-controlled epidural analgesia or a continuous epidural local anesthetic infusion. Some previous investigators have reported higher rates of NRFHR tracings associated with CSE analgesia compared to epidural analgesia. A 2002 meta-analysis reported a higher rate of fetal bradycardia with subarachnoid opioids; however, no differences in cesarean delivery were found.

It has been hypothesized that CSE analgesia induces more frequent and stronger uterine contractions due indirectly to the rapid onset of analgesia. The rapid onset of analgesia may result in a sudden decrease in epinephrine. Beta agonists, including epinephrine, occupy uterine β receptors and reduce uterine muscle activity. Suddenly removing epinephrine’s uterine relaxation effect may result in a temporary increase in uterine tone. This increased uterine tone may increase uterine vascular resistance and reduce fetal oxygenation, leading to NRFHR tracings.

Methodology This was a systematic review and meta-analysis of randomized controlled trials that reported on the incidence of NRFHR tracings in laboring women undergoing CSE or epidural analgesia. Trials were included if a CSE was administered with initial injection of subarachnoid local anesthetic and/or opioid or an epidural alone was administered with local anesthetics and/or opioid. The definition of NRFHR or fetal bradycardia was based on the individual study’s definition. The investigators conducted a meta-analysis on studies that did not blind the assessor to FHR tracings and then repeated the analysis excluding studies in which FHR outcome assessors were not blinded to group allocation. Additionally, the investigators conducted a subgroup analysis including only studies that used low-dose epidural bupivacaine regimens (≤ 0.125% bupivacaine). The investigators also compared differences in cesarean delivery with...
the indication being NRFHR tracing after neuraxial analgesic placement.

**Result** There were 17 studies with 3,947 parturients included. Ten of the 17 studies did not provide details on the definition of NRFHR abnormalities. Only 10 of 17 studies blinded the outcome assessor to FHR tracings group assignment. Five of 17 studies used a low-dose bupivacaine solution and had a blinded assessor of the FHR tracing. Study characteristics included:

**CSE Spinal Dose**
- 8 of 17 studies used a combination of bupivacaine 2.5 mg with fentanyl 20-25 µg
- 3 studies used a combination of bupivacaine 2.5 mg with sufentanil 1.5-5 µg
- 2 studies used 25 µg fentanyl
- 2 studies used 5 µg fentanyl
- 2 studies used 10 µg sufentanil
- 1 study each added 2.5 µg ephedrine, 5 µg epinephrine, or 0.20 mg morphine to the bupivacaine/fentanyl for the spinal injection

**Epidural Bolus Doses:**
- 7 of 17 studies bolused the epidural with 0.25% bupivacaine with or without opioid
- 10 of 17 used a dilute bupivacaine/opioid bolus solution ≤ 0.125%

Three of seventeen studies reported no cases of NRFHR tracings. Analysis of cases with NRFHR tracings after neuraxial dosing showed that CSE analgesia was associated with a higher rate of NRFHR tracings than epidural analgesia alone (RR = 1.3, P = 0.03). Analysis of the six studies that did not blind the assessor to the FHR tracing found a higher rate of NRFHR tracings after CSE placement (RR = 1.6, P = 0.01). Fetal bradycardia was reported in 4 studies; 10% (64 of 610) of patients in the CSE group had NRFHR tracings, compared to 5% (32 of 606) in the epidural group (RR = 1.9, P = 0.002).

Without assessor blinding of FHR tracing, no difference was found (RR = 2.2, P = 0.06).

A subgroup analysis of the 10 studies using low-dose bupivacaine found no increased risk of NRFHR tracings with the CSE technique (RR = 1.12, P = 0.24). In the six studies that blinded the assessor to FHR tracing, no difference between the two techniques was found (RR = 1.4, P = 0.06). One study reported that 40% (6 of 15) of patients in the CSE group compared to only 20% (2 of 10) in the epidural group required cesarean delivery. This difference was not significantly different (P = NS).

**Conclusion** Combined-spinal epidural labor analgesia was associated with a higher rate of NRFHR tracings compared to epidural analgesia alone.

**Comment**
Before I comment on the results, I must disclose that I am a strong advocate of the CSE technique for labor analgesia. When I teach students about the technique, I always discuss the potential for rare NRFHR tracings and fetal bradycardia after the subarachnoid injection. Older studies found NRFHR tracings/fetal bradycardia were more common when subarachnoid sufentanil was used. Usually the NRFHR/fetal bradycardia tracing is short lived and responds easily to conservative measures. Rarely does it lead to cesarean delivery. In my mind this outcome, the need for cesarean delivery, is the more clinically relevant...
outcome. This meta-analysis could not determine if CSE techniques increase the risk for cesarean delivery or not. One of the largest studies comparing CSE vs. epidural analgesia\(^1\) (N = 800) found CSE analgesia with 3.125 mg of bupivacaine + 5 µg fentanyl vs. epidural analgesia with 15 mL 0.125% bupivacaine + 2 µg/mL fentanyl did not increase the risk of cesarean delivery.

There are a few weaknesses with this study. Most of the studies did not define NRFHR tracings or have blinded assessors of the tracings. When NRFHR tracings were defined, the timing of evaluation varied between 15-30 minutes. This would bias towards finding NRFHR tracings in the CSE groups because abnormalities would take longer to manifest with epidural techniques. Also the definition of NRFHR varied across studies that defined it. And finally, there were multiple different subarachnoid drug cocktails, making it difficult to determine if there is a dose-response relationship or if NRFHR tracings are due exclusively to the opioid or the combination of local anesthetic and opioid.

Therefore, I am not that impressed by the study findings, given these limitations and lack of increased need for cesarean delivery with CSE techniques. My recommendation is to monitor the patient closely after initial CSE or epidural placement and be prepared to intervene as needed.

**Dennis Spence, PhD, CRNA**

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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.
Abstract

Purpose  The purpose of this study was to evaluate the analgesic efficacy of an ultrasound-guided transverse abdominis plane block (US-TAP) with 0.5% ropivacaine in parturients undergoing cesarean delivery under spinal anesthesia without duramorph.

Background  Poor pain control after cesarean delivery can delay recovery and increase the risk of postoperative complications. In the United States it is common to administer subarachnoid duramorph with spinal bupivacaine in patients undergoing elective cesarean delivery. Unfortunately, subarachnoid duramorph is associated with pruritus, nausea and vomiting, and rarely delayed respiratory depression. Also, if a patient requires general anesthesia or has a morphine allergy, it may not be possible to administer spinal duramorph. Some, but not all, previous studies of the ultrasound-guided transverse abdominis plane block have shown that it provided effective postoperative analgesia after cesarean delivery. This study examined the analgesic efficacy of an ultrasound-guided transverse abdominis plane block with 0.5% ropivacaine in women undergoing cesarean delivery who receive a spinal anesthetic without duramorph. Tramadol (Ultram) was administered as needed for postoperative breakthrough pain.

Methodology  This was a prospective, randomized, double-blind, placebo-controlled trial in 60 non-obese women undergoing elective cesarean delivery under spinal anesthesia with 10 mg of 0.5% hyperbaric bupivacaine. The study protocol included administration of an ultrasound-guided transverse abdominis plane block after skin closure with either 30 mL 0.5% ropivacaine in the treatment group or 30 mL of normal saline in the control group. After surgery all patients received a single dose of 1 gram paracetamol [Editor’s Note: acetaminophen in the USA], and rescue analgesia consisted of tramadol 2 mg/kg IV every 4 hours as needed. The study was conducted in India.

The primary outcome was the difference in 24-hour total tramadol consumption. The secondary outcomes consisted of time to first request for analgesic, total tramadol, and visual analogue pain scores at 2, 4, 6, 8, 12, 18, and 24 hours. The investigators’ sample size was based on finding that a US-TAP block with 30 mL of ropivacaine would decrease total tramadol consumption in 24 hours by 25%. Statistical analysis was appropriate. A P < 0.05 was considered significant.

Result  Sixty women completed the study; 30 in each group. No significant difference in baseline
demographics was found. Average weight of patients was approximately 63 kg. The time to first tramadol request was almost 5 hours longer in the ultrasound-guided transverse abdominis plane block group; 9.5 hours vs. 4.1 hours (P = 0.01). Patients in the US-TAP group required 43% less total tramadol in 24 hours than the saline group; 140 mg vs. 247 mg (P < 0.00001). Pain scores at every time point were lower in the ultrasound-guided transverse abdominis plane block group (Figure 1). No complications were reported in either group.

**Conclusion**  An ultrasound-guided transverse abdominis plane block with 0.5% ropivacaine reduced analgesic consumption in the first 24 hours after cesarean delivery.

**Comment**  I like reading studies from other countries because it makes me appreciate the variety of anesthesia and analgesia options available to me in the United States. It also allows me to see how anesthesia providers in other countries tackle similar clinical situations with limited resources. In this study, investigators in India used a US-TAP with 0.5% ropivacaine and tramadol as needed for postoperative pain relief after cesarean delivery. What they found was that a US-TAP decreased analgesic consumption by over 40%. This is a rather large treatment effect and suggests that US-TAP may be an effective option when one does not have duramorph available. This technique would be especially useful on mission trips if you have some long-acting local anesthetic available and an ultrasound machine. If no ultrasound machine is available, the block is fairly easy to do by landmark technique. There are numerous videos on YouTube that you can review.

**Dennis Spence, PhD, CRNA**

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