Check the Blood Pressure!: An Educational Tool for Anesthesiology Trainees Converting Epidural Labor Analgesia to Cesarean Delivery Anesthesia

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Recognition and treatment of maternal hypotension during epidural anesthesia administration for intrapartum cesarean delivery preserves maternal-fetal perfusion. A case that required quality assurance review uncovered lapses in maternal hemodynamic monitoring during the transition to intrapartum cesarean delivery anesthesia. To address this, a practice outline was designed for trainee's education describing intrapartum epidural dosing for cesarean delivery and adequate blood pressure monitoring. The time-lapse between epidural dosing and subsequent blood pressure was evaluated before and after the introduction of our educational tool. The time-lapse between blood pressure measures decreased to <10 minutes (10.78–13.92 vs 8.8–9.76 minutes). (A&A Practice. 2020;14:e01174.)

GLOSSARY

ASAP = as soon as possible; **BP** = blood pressure; **CD** = cesarean delivery; **CI** = confidence interval; **DBP** = diastolic blood pressure; **HTN** = hypertension; **IQR** = interquartile range; **IRB** = institutional review board; **IV** = intravenous; **LDR** = labor and delivery room; **LR** = lactated ringers; **MAP** = mean arterial pressure; **OB** = obstetrics; **OK** = okay; **OR** = operating room; **SBP** = systolic blood pressure; **SD** = standard deviation

Ensuring that baseline maternal blood pressure (BP) is maintained during the initiation of neuraxial anesthesia and throughout intrapartum cesarean delivery is essential for adequate maternal-fetal perfusion. A majority of women undergoing intrapartum cesarean delivery have indwelling epidural catheters providing labor analgesia, which can be converted into anesthesia for cesarean delivery. While maternal hypotension is believed to occur less frequently and to be less severe after induction of intrapartum epidural anesthesia than the hemodynamic changes with de novo spinal anesthesia, data are lacking regarding the incidence, timing, and severity of maternal hypotension following conversion from labor epidural analgesia to surgical anesthesia before and during transfer to the operating room.

Review of a case for quality assurance, unrelated to anesthetic management, revealed an unintended gap of 25 minutes in maternal hemodynamic monitoring during the transition from labor analgesia to surgical anesthesia. Subsequent review of cases performed over a 1-month period established that 25- to 45-minute time gaps between local anesthetic dosing and next BP measurement were not uncommon. Our institutional practice entails initiation of surgical anesthesia in the labor room before transfer to the operating room, which may contribute to prolonged periods without patient monitoring. All labor rooms are located in proximity to and on the same floor as the cesarean delivery operating rooms. As a quality improvement initiative, a practice outline about the process of conversion of low-dose epidural analgesia to surgical anesthesia for cesarean delivery was added to the resident education documents. The practice outline explains how to dose local anesthetic to convert intrapartum epidural analgesia to surgical anesthesia, and how to conduct appropriate BP monitoring from initiation of anesthesia in the labor room to arrival in the operating room.

The goal of this project was to decrease lapses in hemodynamic monitoring of patients having intrapartum cesarean deliveries with an indwelling epidural catheter. Institutional review board (IRB) approval was obtained for the data analysis of this quality improvement project.

EDUCATIONAL INTERVENTION

A practice outline for hemodynamic monitoring after induction of cesarean delivery anesthesia was created based on expert consensus. The practice outline was circulated by e-mail to every resident rotating on obstetric anesthesia at the beginning of their 4-week-long rotation (Figure 1). The intervention was initiated in July 2017. Obstetric anesthesia rotations have 6 anesthesiology residents; 2 novice, 2 junior, 2 senior trainees, and 2 fellows. The anesthesia residents or fellows initiate intrapartum cesarean delivery anesthesia under the direct or indirect supervision of the obstetric anesthesiology attending. Trainees were not enrolled as study subjects.

Cases of intrapartum cesarean deliveries with epidural anesthesia 18 months before the intervention (January 1,

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Practice Outline
Conversion of Labor epidural analgesia (LEA) to Cesarean delivery anesthesia (CDA)

The purpose of this practice outline is to emphasize that **monitoring** and **management** of maternal blood pressure is important when converting from low dose epidural analgesia to surgical anesthesia (up to T4) for cesarean delivery.

Untreated maternal hypotension can result in decreased uteroplacental perfusion and fetal bradycardia, which may (if untreated) result in an emergent delivery, and unnecessary maternal morbidity.

Steps:

1. Confirm with OB team indication (fetal indication, arrest of labor, maternal indication) and the timing/urgency of CD and convey this information to your attending.
2. Grab lidocaine 2% 20ml and chloroprocaine 3% 20ml, ephedrine and phenylephrine.
3. Do we have time for epidural lidocaine 2%-bicarb (given in 5ml increments will take up to 10-15 minutes) to provide CDA? If we have time for lidocaine, also bring fentanyl 100 mcg for synergy with the epidural local anesthesia.
4. Or should we give chloroprocaine 3% (given at once will provide anesthesia within 2-3 minutes, usually the time it takes to get the patient to the OR, so start injecting in the LDR, and go to the OR immediately. (skip steps 5-12) We use chloroprocaine in STAT situations not only because the block onset is fast but because although this is a toxic dose if given IV all at once, the half-life of chloroprocine is less than a minute so if a seizure occurs, the seizure will not last long.
5. If not emergent, confirm with OB and nursing that they are committed to go to the OR within the next 5 minutes, and inform then that we are now starting CDA.
6. Check that catheter was providing adequate LEA, and if any doubt, do not load and notify your attending immediately.
7. Obtain baseline BP and set the BP cuff to cycle q 2.5 minutes –the expectation is that we are now staying with the patient until she gets to the OR.
8. Check that the aspiration test is negative (use small syringe—3 ml) and start dosing the epidural catheter (5 mL lidocaine 2% + epi (if no contraindications i.e. HTN) + bicarb with fentanyl 100 mcg unless already given within the last 2 hours)
9. Check BP, and give additional lidocaine 2% 5ml.
10. Check BP again, and give additional lidocaine 2% 5-10ml either in LR or in OR
11. Help transfer the patient to OR (no monitoring on the way is OK), take with you ephedrine and phenylephrine in case patient becomes symptomatic
12. End anesthesia record in labor room and transport to OR. Keep BP cuff on patient!
13. On arrival to OR, BP cuff should be the first monitor connected and should be cycled ASAP and set to cycle q 1 minute. The time between last BP reading in the LDR and first BP reading in the OR should be under 10 minutes.
14. Dose the epidural catheter with an additional 5 mL lidocaine 2% (if still needed).
15. Transfer patient to OR table and connect all other monitors.
16. Check a level and dose the remaining lidocaine as needed.

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Figure 1. Practice outline. ASAP indicates as soon as possible; BP, blood pressure; CD, cesarean delivery; HTN, hypertension; IV, intravenous; LDR, labor and delivery room; LR, lactated ringers; OB, obstetrics; OK, okay; OR, operating room.

2016 to June 30, 2017) and 12 months after the intervention (July 1, 2017 to July 2018) were analyzed. Data regarding intrapartum cesarean deliveries were extracted from the electronic medical records. For each case, we identified: (1) the time between the last BP reading in the labor room and the first BP reading in the operating room; and (2) the time between the initial local anesthetic epidural dose and the first BP reading in the operating room.

An improvement science approach was adopted to examine the extent to which variability, means, and medians of time gaps in BP monitoring were reduced over time for providers against the "ideal target," following the strategic intervention.[1]

The primary behavioral outcome was measured in aggregate across patients treated by quarter, as the lower of the 2 time differences for each patient case. Secondary outcomes were the incidence of maternal hypotension, defined as a first systolic BP in the operating room <90 mm Hg, use of vasopressors before delivery, fetal bradycardia, change in urgency of cesarean delivery from nonurgent or urgent to emergency (based on fetal heart rate tracing category), and Apgar score ≤7 at 1 and 5 minutes.

BP monitoring data were analyzed by quarter and pre- and postintervention periods compared. Descriptive statistics and graphical displays were utilized to compare BP monitoring time gaps (by quarter). BP gaps in the pre- and postintervention periods were evaluated for equivalence with *t* tests (for continuous variables) and χ^2 tests (for categorical variables). Cohen *d* (effect size) was calculated on the BP monitoring variable using all cases in the pre- and postintervention periods. All statistics were calculated using SPSS (IBM SPSS Statistics for Windows, version 25.0, Armonk, NY).

RESULTS

There were 571 preintervention intrapartum cesarean delivery cases and 392 postintervention cases between January 2016 and July 2018. After exclusions, 551 cases were included in the preintervention analysis and 384 in the postintervention analysis (Figure 2). There were no significant differences on baseline characteristics of the pre- and postintervention patient groups (Table 1). Pre- and postintervention data for the primary outcome are presented by quarter (Tables 2 and 3). In the postintervention period, there was reduced variability for the primary outcome, targeted to a mean of 10 minutes (Figure 3). The overall pre- and postintervention BP monitoring time gaps on all patient cases were 11.80 minutes (standard deviation [SD] 5.89) and 9.96 minutes (SD 5.70), respectively, yielding a Cohen *d* of −0.315 ($P < .01$). This is a moderate-sized effect in the desired direction.[2] Box plots are presented in Figure 3.

There were no significant differences in maternal BP after anesthetic dosing, neonatal Apgar scores, or percentage of patients requiring vasopressor before delivery (Table 4). In both pre- and postintervention groups, 2 cases were converted from nonurgent or urgent to emergency.

DISCUSSION

We have demonstrated that the introduction of a practice outline emphasizing hemodynamic monitoring during the conversion of labor epidurals for cesarean delivery anesthesia to anesthesiology trainees reduced the mean and median time gaps between BP readings from the labor room to the operating room. After the intervention, the variation, means, and medians of time gaps in BP monitoring were reduced to our goal of <10 minutes between BP readings. Initial analysis of data following implementation of the practice outline revealed that a reduction in time intervals did not occur in the third quarter (January to March). This regression in clinical practice may be attributed to the time of year because resident burnout may increase in winter months.[3] By identifying the trainees who entered postoperative orders in the outlier cases, we noted 2 trainees (out of 26 during the quarter) who may account for the lack of improvement. This highlights that, while the practice outline may be implemented by most trainees, some may require reinforcement by other methods.

Secondary outcome analysis demonstrated no changes after the intervention in urgency of status of cesarean deliveries or use of vasopressors before delivery. There was no difference in preintervention and postintervention BP measurement or Apgar scores. Although our study was not designed to examine the issue, it is interesting to note that over 80% of these intrapartum cesarean delivery patients received a vasopressor before delivery. It seems likely that, if implemented across all institutions, improving hemodynamic monitoring may prevent maternal-fetal adverse events, but our study was not designed to demonstrate such effects.

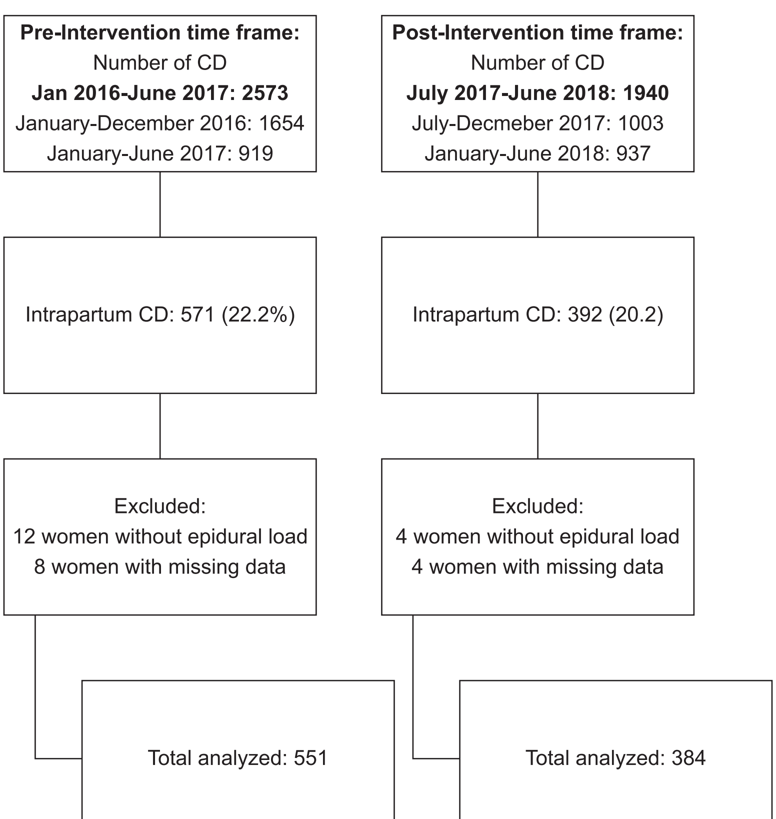

Figure 2. Flowchart of cases analyzed. CD indicates cesarean delivery.

Table 1. Baseline Patient Characteristics

	Preintervention	Postintervention	*P*	95% CI
Maternal age	31	30	$t_{(923)}$ = 1.494 *P* = .136	(−0.193 to 1.424)
% Nulliparous	77	76	$\chi^2_{(1)}$ = 0.144 *P* = .703	…
% with hypertensive disorder	18	19	$\chi^2_{(1)}$ = 0.113 *P* = .735	…
Indication for cesarean delivery (%)			<.001[a]	…
Arrest of cervical dilation	34	37	…	…
Failed induction of labor	14	9	…	…
Nonreassuring fetal heart tracing	40	38	…	…
Fetal bradycardia	5.0	5.0	…	…
Cord prolapse	1	2	…	…
Failure to progress	0.4	6	…	…
Failed second stage	0.2	0	…	…
Maternal request	0.9	0.3	…	…
Failed vacuum	1.1	0.3	…	…
Previous cesarean delivery	0.2	0.0	…	…
Failed forceps	0.5	0.0	…	…
Failed trial of labor after cesarean delivery	0.7	1.0	…	…
Uterine rupture	0.4	0.0	…	…
Abruptio placentae	0.5	0.5	…	…
Macrosomia	0.2	0.0	…	…
Pre-eclampsia	0.0	0.3	…	…
Malpresentation	1.6	1.0	…	…
Active herpes simplex virus	0.2	0.0	…	…
Chorioamnionitis	0.2	0.0	…	…
Last SBP in labor room (mm Hg)	120.1	120.58	$t_{(921)}$ = −0.467 *P* = .640	(−2.730 to 1.680)
Last DBP in labor room (mm Hg)	70.9	69.8	$t_{(920)}$ = 0.919 *P* = .358	(−1.093 to 3.018)
Last MAP in labor room (mm Hg)	81.8	81.2	$t_{(915)}$ = 0.201 *P* = .940	(−1.770 to 2.179)
% Female fetus	45	46	$t_{(921)}$ = −0.347 *P* = .728	(−0.773 to 0.054)

Abbreviations: CI, confidence interval; DBP, diastolic blood pressure; MAP, mean arterial pressure; SBP, systolic blood pressure.
[a]Note that Fisher exact test was used here.

Table 2. Preintervention Time Gaps for BP Measurement in Minutes, Descriptive Statistics

Quarter-Start Date:	January 1, 2016 (N = 68)	April 1, 2016 (N = 73)	July 1, 2016 (N = 74)	October 1, 2016 (N = 61)	January 1, 2017 (N = 120)	April 1, 2017 (N = 156)
Mean	12.56	12.74	13.92	11.61	10.78	10.87
Median	13	12	13.5	11	10	10.5
SD	5.22	6.02	5.79	6.02	5.38	5.48
IQR (min;max)	7 (0;23)	8 (0;28)	7 (0;32)	5 (0;33)	6 (0;34)	5.25 (0;42)

Abbreviations: BP, blood pressure; IQR, interquartile range; SD, standard deviation.

Table 3. Postintervention Time Gaps for BP Measurement, Descriptive Statistics

Quarter-Start Date	July 1, 2017 (N = 76)	October 1, 2017 (N = 55)	January 1, 2018 (N = 112)	April 1, 2018 (N = 140)
Mean	9.74	8.8	11.55	9.26
Median	9	8	9	8
SD	4.52	4.32	*8.1*	4.67
IQR (min;max)	6.25 (4;22)	5 (2;22)	7 (2;59)	4 (0;28)

Not only did the mean decline, but there is smaller variance as well in the postintervention time period, that is, doctors were acting more consistently after training.
Abbreviations: BP, blood pressure; IQR, interquartile range; SD, standard deviation.

Limitations of this study include the inability to measure changes of individual trainees because the anesthesiology trainee who initiated the epidural dosing is not routinely noted on the anesthesia record. This is a modified time-series design with BP time gap measures serving as the behavioral outcome in trainees, before and after the intervention.[4] Residents were unaware of the study, lowering the risk of a Hawthorne effect. The introduction of this teaching tool alone may have changed behavior based on the fact that practice related to BP management was being observed. Firm causal claims cannot be made because we were unable to mount a quasi-experiment or randomized

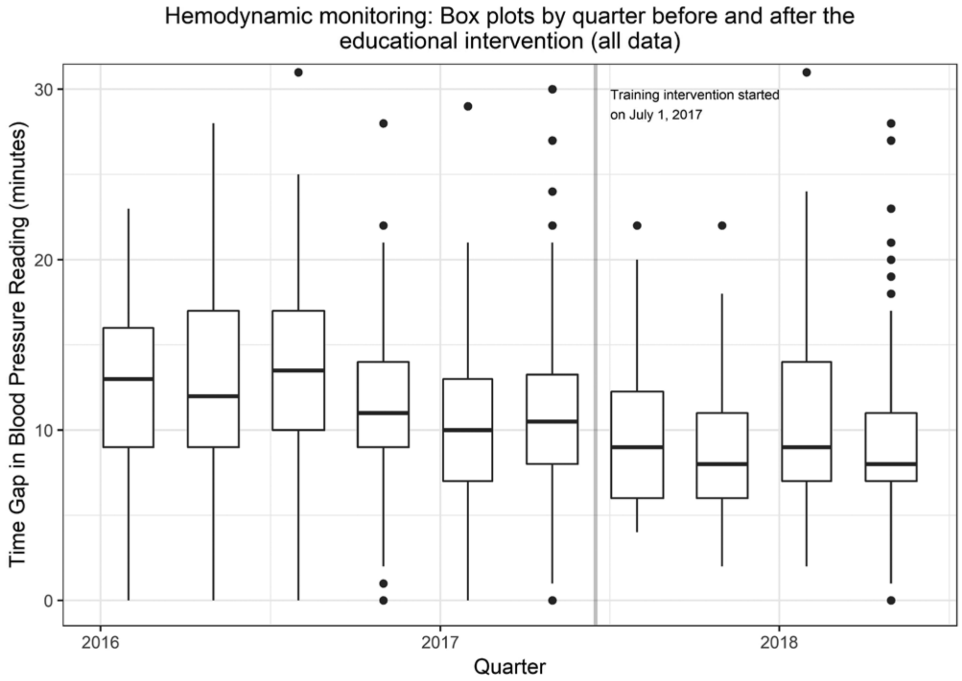

Figure 3. Hemodynamic monitoring. Box plots by quarter before and after the educational intervention (all data).

Table 4. Secondary Maternal and Fetal Outcomes

	Preintervention	Postintervention	*P*	95% CI
First SBP in operating room	120.3 (120.58)	119.4 (119.21)	$t_{(899)} = 0.927$ $P = .349$	(−1.497 to 4.233)
First DBP in operating room	71.45	70.59	$t_{(918)} = 0.749$ $P = .454$	(−1.934 to 4.320)
First MAP in operating room	82.21	81.67	$t_{(921)} = 0.231$ $P = .817$	(−2.525 to 3.199)
% Maternal tachycardia	20.7	22.4	$\chi^2_{(1)} = 0.392$ $P = .531$	...
% Required vasopressor before delivery	81	85	$\chi^2_{(1)} = 3.677$ $P = .055$	...
Apgar at 1 min	7.75	7.88	$t_{(927)} = -1.117$ $P = .264$	(−0.359 to 0.098)
Apgar at 5 min	8.71	8.74	$t_{(927)} = 0.495$ $P = .621$	(−0.155 to 0.092)
Change in urgency of cesarean delivery	2	2	...	...

Abbreviations: CI, confidence interval; DBP, diastolic blood pressure; MAP, mean arterial pressure; SBP, systolic blood pressure.

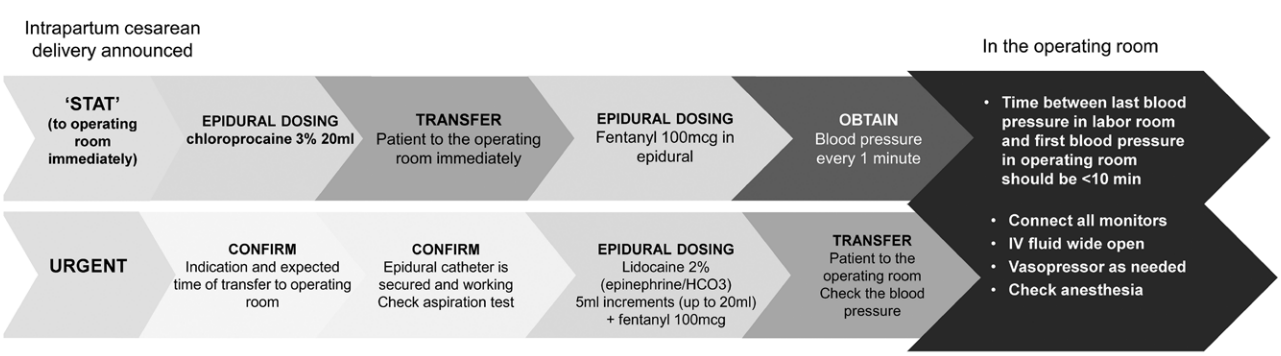

Figure 4. Infographic for conversion of intrapartum epidural analgesia to cesarean delivery anesthesia. IV indicates intravenous.

trial with providers as units of analysis. However, the data show a clear correlational pattern suggesting a distinct and sustained practice change toward the desired target, following the intervention. We also did not provide data about whether the training intervention effects faded beyond a year or whether the effect was a 1-time, sudden improvement in BP measurement practices in the beginning of a 4-week rotation which lapsed at the end of the 4-week rotation. However, the methods and analyses implemented are consistent with technical criteria for rigor that apply to trend analyses utilized for studies in health care systems under the rubric of improvement science.[4] The results would likely generalize for similar interventions implemented with trainees in university-based hospital settings with urban patient populations.

This project highlights the importance of routine quality assurance at training institutions to identify areas for improvement. Continued reinforcement of orientation materials may be necessary to reach trainees who rely on bedside teaching rather than reading. To this end, we have created an infographic for the conversion of epidural analgesia to cesarean delivery anesthesia (Figure 4). Resident education and reinforcement are crucial in large academic institutions, where new trainees are frequently integrated into unfamiliar surroundings. Practice outlines may be useful ways to teach practices that should be standard.

DISCLOSURES

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