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Neuraxial blockade for external cephalic version: Cost analysis

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Abstract

Aim—Neuraxial blockade (epidural or spinal anesthesia/analgesia) with external cephalic version increases the external cephalic version success rate. Hospitals and insurers may affect access to neuraxial blockade for external cephalic version, but the costs to these institutions remain largely unstudied. The objective of this study was to perform a cost analysis of neuraxial blockade use during external cephalic version from hospital and insurance payer perspectives. Secondly, we estimated the effect of neuraxial blockade on cesarean delivery rates.

Methods—A decision–analysis model was developed using costs and probabilities occurring prenatally through the delivery hospital admission. Model inputs were derived from the literature, national databases, and local supply costs. Univariate and bivariate sensitivity analyses and Monte Carlo simulations were performed to assess model robustness.

Results—Neuraxial blockade was cost saving to both hospitals (\$30 per delivery) and insurers (\$539 per delivery) using baseline estimates. From both perspectives, however, the model was sensitive to multiple variables. Monte Carlo simulation indicated neuraxial blockade to be more costly in approximately 50% of scenarios. The model demonstrated that routine use of neuraxial blockade during external cephalic version, compared to no neuraxial blockade, prevented 17 cesarean deliveries for every 100 external cephalic versions attempted.

Conclusions—Neuraxial blockade is associated with minimal hospital and insurer cost changes in the setting of external cephalic version, while reducing the cesarean delivery rate.

Keywords

breech; cesarean delivery; cost; external cephalic version; neuraxial blockade

Introduction

Breech presentation occurs in 3–4% of term pregnancies. Following publication of the Term Breech Trial,¹ the number of vaginal breech deliveries in the USA rapidly declined.² External cephalic version (ECV) has been shown to decrease the number of non-cephalic births and cesarean deliveries (CD).³ A growing interest in reducing the CD rate in the USA

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Disclosure

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has resulted in ECV receiving renewed attention.⁴ Predictors of ECV success include multiparity, non-engagement of the breech, uterine relaxation, a palpable fetal head, and maternal weight <65 kg.⁵

Neuraxial blockade (NB), which includes epidural or spinal anesthesia or analgesia, has been shown to increase the ECV success rate, possibly by decreasing abdominal wall muscle tension.⁶ A 2012 Cochrane review found NB to be associated with a significant decrease in ECV failure (RR, 0.67; 95% CI: 0.51–0.89).⁷ Similarly, a 2011 meta-analysis found that NB was associated with a significantly higher ECV success rate of 59.7% versus 37.6% (95% CI: 1.29–1.93).⁸

External cephalic version itself has been shown to be a cost-effective intervention.^{9,10} In addition, the cost-effectiveness of NB use with ECV was examined by Carvalho *et al.*, who reported mean delivery costs of ECV with NB to be \$276 lower than ECV without NB from a societal perspective.¹¹ Less is known regarding the costs to hospitals and insurance payers in the USA. These costs, however, are relevant to patient care because they may influence hospital and payer policies, affecting access to NB with ECV. This study used a decision model to explore hospital and insurance payer costs of NB in the setting of ECV. A secondary outcome of the model compared the number of CD following ECV with NB and ECV without NB.

Methods

We created a decision-tree model using TreeAge Pro 2013 (Tree Age Software, Williamstown, MA, USA) to evaluate the cost of NB during ECV at 36 weeks based on (i) hospital costs; and (ii) insurance payer costs. Physicians are most commonly reimbursed for obstetrical care through a single global payment for the entire pregnancy. Therefore, we considered costs from the initiation of prenatal care through the delivery hospital admission. This study qualified for exemption from Human Studies Program Review from the University of Hawaii Institutional Review Board.

The decision tree model is shown in Figure 1. The outcome for each ECV attempt was categorized as successful, unsuccessful, or emergency CD. We presumed that the ECV was performed during a separate admission from the delivery hospitalization, with the exception of emergency CD due to ECV. Following successful ECV, a fetus could spontaneously revert to a non-cephalic presentation, while following an unsuccessful ECV a fetus could undergo spontaneous version to cephalic presentation. If the fetus reverted to a non-cephalic presentation after a successful ECV, a second ECV would be attempted. In this scenario we assumed that the clinician would repeat use or non-use of NB consistent with the first ECV. Outcome data on a second ECV following reversion to non-cephalic were unavailable; therefore the probability of success was presumed to be the same as that of the prior ECV.

Clinical probabilities (Table 1) and complication rates (Table 2) were derived from the literature. PubMed searches from 2002 to 2012 with key words including external cephalic version, neuraxial anesthesia, regional anesthesia, spinal, epidural, second attempt, and repeat, complications, vaginal delivery, cesarean section, labor, and emergency were

performed. These searches were supplemented with a review of the references in the retrieved articles. Randomized controlled trials and observational studies were included and the most recent meta-analyses preferentially used. If no meta-analysis was available, a composite value was calculated using pooled data.

Delivery costs in 2012 US dollars are described in Table 3. Hospital delivery costs were retrieved from 2010 national data compiled by the Agency for Health-care Research and Quality (AHRQ).²⁶ This database, the Healthcare Cost and Utilization Project (HCUP), is one of the largest publically available databases of inpatient care.³⁴ Within this database, hospital costs per diagnosis-related group (DRG) are calculated from hospital charges and the institutional cost-to-charge ratio. Mean hospital costs for DRG codes 774 (vaginal delivery with complicating condition), 775 (vaginal delivery without complicating condition), 765 (CD with complicating condition), and 766 (CD without complicating condition) were obtained. HCUP DRG-based costs reflect hospital charges for all deliveries submitted under a particular DRG and include complication costs. The costs of pre-labor and in-labor CD were differentiated based on complication rates and costs obtained from the literature and the HCUP (Table 2). In addition, \$2814 was added to the in-labor CD cost to represent the cost of 10 h of labor time prior to the CD.³¹ The combined complication and labor time costs indicated that an in-labor CD cost, on average, \$3198.75, or 56% more than a pre-labor CD. The complication rate of emergency CD was considered to be the same as that of a CD in labor, congruent with findings from the literature.³⁵

Payer costs were assessed at the 2012 Medicare reimbursement rates without geographic adjustment. Obstetric physician reimbursement included reimbursement for prenatal care through delivery, which was calculated as the global obstetrical fee minus the fee for postpartum care only.³⁰ Anesthesia reimbursement was calculated based on Medicare-assigned base units, time units, and conversion factors. Time units for NB for a vaginal delivery was assigned at 4 h (the maximum allowable charge), and for CD and ECV at 1 h. Anesthesia charges for vaginal deliveries were calculated assuming a 70.7% epidural use during labor.³⁶

Hospital costs of ECV with and without NB were calculated through individual cost components, while insurance payer costs were derived from hospital and physician reimbursements (Table 4). We presumed that ECV would be performed under tocolysis, given that current evidence supports the use of tocolysis in this setting.⁷ The length of labor unit and fetal monitoring time required for the ECV did not vary with the use of NB, which is consistent with protocols from previous studies examining NB with ECV.^{40,41}

The most common complication of obstetrical spinal or epidural anesthesia is the postdural puncture headache, for which 0.2% of those who receive NB will require a blood patch.⁴² Therefore, the cost of a blood patch in 0.2% of NB cases was calculated and added to the cost of NB. For hospital costs, this amounted to the cost of the NB tray used for the blood patch, and for Medicare costs, the physician reimbursement fee. Other complications of NB that would incur significant costs occur in 1/5537–1/500 000 cases,^{42–46} and were not included due to the rarity of these events. Conversely, we did not include costs of rare complications of general anesthesia with an emergency CD following ECV without NB.

Sensitivity analyses to assess model robustness were performed with univariate analysis on clinical probability inputs ranging from the lowest to highest reasonable values in the literature. If no value range was available from the literature, a range of 50–200% of the baseline value was assigned. Cost inputs ranged from 50% to 200% of base estimates. Bivariate analyses were performed on key model variables. Monte Carlo simulation of 10 000 trials was used to assess the robustness of the model to simultaneous variation of all clinical and cost inputs sampled within a triangular distribution.

Results

Neuraxial blockade during ECV is expected to save \$29.76 per delivery in hospital costs. Univariate sensitivity analysis, however, showed the model to be sensitive to several variables. Threshold values for these variables are described in Table 5. Using the baseline ECV with NB cost of \$751.97 (NB cost of \$23.79), NB use was cost saving when the ECV success rate with NB exceeded 47.8% (Fig. 2). Maintaining the baseline ECV with NB success rate of 59.7%, NB was cost saving up to an ECV with NB cost of \$780.71 (NB cost of \$52.53). NB was also cost saving using baseline values if the CD rate after successful ECV remained <28%. On Monte Carlo simulation, NB was cost saving in 49.5% of scenarios with mean costs per delivery of \$7325.55 for ECV with NB (range, \$2707.85–18 500.75, SD \$2574.51) and \$7366.57 for ECV without NB (range, \$2708.25–18 700.70, SD \$2330.28), a difference of \$41.02.

Baseline estimates demonstrated that NB with ECV is cost saving from an insurance payer perspective, with savings of \$538.74 per delivery. Univariate sensitivity analyses also showed sensitivity to multiple inputs (Table 5). From a payer perspective, NB was cost saving if the ECV success rate exceeded 43.5% and the incremental cost of NB remained below \$172.52. At a baseline ECV with NB success rate of 59.7%, ECV with NB was cost saving if the cost of the NB remained below \$649.78. Monte Carlo simulation again showed ECV with NB to be cost saving in 47.8% of scenarios. As with hospital costs, the Monte Carlo simulation showed mean costs per delivery to be lower for ECV with NB (\$15 140.10; range, \$5786.07–32 532.66, SD 4506.66) compared to ECV without NB (\$15 781.39; range, \$5615.20–30 349.95, SD 4529.35), a difference of \$641.39.

Using baseline estimates, the present model demonstrated that universal use of NB with ECV, compared to ECV without NB, would prevent 17 CD for every 100 ECV performed. Univariate sensitivity analyses demonstrated that NB use was associated with a lower CD rate compared to NB non-use across the range of clinical probability inputs.

Discussion

This paper is among the first to perform a cost analysis of NB in the setting of ECV from multiple perspectives. From both hospital and insurance payer perspectives, baseline estimates and Monte Carlo simulations suggest minimal cost differences relative to total delivery costs with NB use.

Although NB with ECV may not be universally cost saving through the time interval of this model, the cost savings is likely to increase with an expanded time horizon secondary to the

risks and morbidities of CD with postpartum recovery and future pregnancies. Using baseline estimates, the present model predicts that NB use with ECV would prevent 17 CD per 100 ECV attempted, compared with ECV without NB. If one-half of women with breech fetuses at term undergo a trial ECV, a rate consistent with that reported in the literature,⁴⁷ the routine use of NB over non-use would translate into >10 000 CD avoided each year in the USA.^{48,49} Although this number will vary with the ECV rate, a reduction in the primary CD rate has important cost implications. Given that morbidity increases with repeat CD,⁵⁰ by avoiding the first CD substantial cost savings could be anticipated in future pregnancies through reductions in repeat CD, uterine rupture, and placentation abnormalities.

Limitations of this study are similar to those of many cost analyses. Probabilities and costs are estimated, and study results are extrapolated from one population to a broader context. Not all complications were accounted for, but, in particular, there is no evidence that NB increases the complication rate of ECV. Concern with NB and ECV centers around the theoretical risk of excessive force applied to the abdomen. NB, however, has been shown to reduce the force required to perform ECV,⁵¹ and meta-analyses do not support differences in fetal bradycardia,⁸ placental abruption,^{6,8} non-reassuring fetal heart tones requiring CD,⁶ and emergency CD.⁸

Another limitation of this study is the omission of neonatal outcomes and costs. Case-control studies, however, demonstrate a very low rate of ECV-related complications,^{4,15} and pooled data do not demonstrate a difference in neonatal outcomes based on ECV attempts.⁴ In addition, costs associated with the neonatal patient may be less relevant from hospital and insurance payer perspectives due to separate hospital reimbursements and possibly different insurance payers covering maternal and neonatal care. Medicare costs were selected to represent insurance costs, and therefore the present findings may not be consistent with those of other payers. Although a relatively small insurer in obstetrics,²⁶ as a national insurer Medicare reimbursements are applicable nationwide. This study also did not differentiate between epidural and spinal administration or anesthesia and analgesia dosing in the performance of NB, given that there are no studies directly comparing NB dosing on ECV success. While we would not anticipate substantial cost differences, discrepant ECV success rates between these alternatives may be relevant. We also did not include the option of repeat ECV with NB after failed ECV without NB. Including this arm in our model would require incorporation of ECV success rates from an entirely different study population, resulting in potentially misleading comparisons. Data indicate, however, the repeat ECV success rate with NB to be 49% after failed ECV without NB,^{52–54} suggesting that this as a viable option. Using this 49% success rate and other baseline values, our model did indicate that following unsuccessful ECV without NB, attempting a second ECV with NB was cost saving from both the hospital (\$267 per delivery) and insurance payer (\$92 per delivery) perspectives compared with expectant management.

Variation in individual and institutional factors should be considered when applying the present findings to a single patient or institution. For example, institutional CD rates may vary substantially, and could particularly affect model results if CD rates after successful ECV are higher than CD rates with spontaneous cephalic presentation.²³ Finally, only one

factor affecting ECV success rates, NB use, was examined in this cost analysis, and other variables may be considered as well.

The present findings are similar to those of Carvalho *et al.* and Weiniger *et al.* in that NB use with ECV is associated with modest cost savings at baseline values.^{11,55} This paper builds upon these previous findings in several ways. For one, this study was the first to include a detailed analysis to estimate costs of CD before labor and in labor, costs that demonstrated sensitivity in the model. A wider range of costs and probabilities included in the sensitivity analyses also provides additional information on the relationship between these variables and final cost outcomes. In addition, while Carvalho *et al.* examined the costs of NB with ECV from a societal perspective, hospital and insurance payer perspectives were considered in the present study. Weiniger *et al.* also reported hospital costs, although the use of Israeli costing limits extrapolation to the USA. The decision to calculate costs from hospital and insurance payer perspectives was based on the ability of these institutions to affect health care through economically driven policies. Therefore, direct costs alone were included in this study, while indirect costs such as opportunity costs and quality of life were omitted. In addition, the time horizon of this study, which extended through the hospital admission, is not conducive to the assessment of long-term outcomes such as quality-associated life years. Finally, the variable and extensive scope of such indirect costs related to the mother as well as other family members and caregivers, adds an enormous amount of complexity and uncertainty to the analysis that is not easily simplified without the potential for substantial inaccuracy in cost representation.

NB use with ECV may have a role in reducing CD by increasing ECV success, and this study suggests that NB with ECV has minimal impact on hospital and insurer costs. These findings can contribute to evidence-based hospital and insurance payer policies affecting access to NB with ECV.

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Figure 1.
Decision tree for the use of neuraxial blockade with external cephalic version (ECV).

Figure 2.
Bivariate sensitivity analysis of hospital cost savings of neuraxial blockade (2012 \$US).
ECV, external cephalic version.

Table 1

Estimates of ECV outcome

Outcome	%	Minimum (%)	Maximum (%)
Successful ECV with neuraxial blockade	59.7 ⁸	41.4 ¹²	87.1 ¹³
Successful ECV without neuraxial blockade	37.6 ⁸	30.4 ¹²	52.6 ¹⁴
Emergency cesarean delivery after ECV [†]	0.35 ¹⁵	0.18 ¹⁵	0.70 ¹⁵
Reversion to breech	6 ^{16–19}	2.6 ¹⁷	10 ¹⁹
Spontaneous version after failed ECV [†]	2 ²⁰	1 ²⁰	4 ²⁰
Cesarean delivery after successful ECV	25 ^{21–23}	18.3 ²¹	27.6 ²³

[†]Single value obtained from the literature; minimum, 50% and maximum, 200% of this baseline value. ECV, external cephalic version.

Table 2

Complication rates and costs

Complication	In-labor cesarean delivery rate (%)	Pre-labor cesarean delivery rate (%)	Cost per complication (2012 \$US)
Hemorrhage	7.1 ^{24,25}	5.6 ^{24,25}	4009 ²⁶
Endometritis	2.6 ^{24,25}	1.4 ^{24,25}	4281 ²⁷
Wound infection	1.8 ^{24,25}	0.9 ^{24,25}	3928 ²⁷
Intraoperative trauma	2.1 ²⁴	0.1 ²⁴	3847 ²⁶
Total cost of complications per cesarean delivery	547	323	

Table 3

Cost by route of delivery (2012 \$US)

Route of delivery	Cost component	Cost
Vaginal delivery	Hospital cost [†]	4 240.59 ^{26,28}
	Medicare cost	
	Hospital	6 351.18 ²⁹
	Obstetrician	1 960.06 ³⁰
	Anesthesia	137.87 ³⁰
	Total	8 448.75
Pre-labor cesarean delivery	Hospital cost ^{†,‡}	5 708.89 ^{26,28,31}
	Medicare cost	
	Hospital	10 645.67 ²⁹
	Obstetrician	2 186.66 ³⁰
	Anesthesia	237.08 ³⁰
	Total	13 069.05
In-labor cesarean delivery	Hospital cost ^{†,‡}	8 907.64 ^{26,28,31}
	Medicare cost	
	Hospital	10 645.67 ²⁹
	Obstetrician	2 186.66 ³⁰
	Anesthesia	344.68 ³⁰
	Total	13 176.65
Emergency cesarean delivery	Hospital cost ^{†,‡}	5 944.75 ^{26,28,31}
	Medicare cost	
	Hospital	10 645.67 ²⁹
	Obstetrician	2 186.66 ³⁰
	Anesthesia	237.08 ³⁰
	Total	13 069.41

[†]The diagnosis-related group for vaginal deliveries with a complicating condition accounts for 91.3% of reported vaginal deliveries, and the diagnosis-related group for cesarean deliveries with a complicating condition accounts for >99.9% of reported cesarean deliveries;²⁸ delivery costs were calculated based on these rates.

[‡]Hospital costs of pre-labor and in-labor cesarean deliveries were calculated based on the mean cost of all cesarean deliveries adjusted for 45% of cesarean deliveries performed before labor and 55% performed in labor.^{32,33} Differential complication costs between pre-labor and in-labor cesarean deliveries (Table 2) were also accounted for. An additional cost of \$2814, the estimated hospital cost of 10 h of labor and delivery time,³¹ was included in the cost of in-labor cesarean deliveries.

Table 4

Cost of external cephalic version (2012 \$US)

Hospital cost		Medicare cost	
Item	Cost	Item	Cost
Labor and delivery time × 3 h	385.35 ⁹	Hospital reimbursement	1630.49 ²⁹
Nursing time × 3 h	97.98 ³⁷	Obstetrician reimbursement	106.02 ³⁰
Fetal heart rate monitoring × 3 h	176.07 ⁹		
Tocolysis	27.68 ⁹		
Intravenous kit	16.61 ⁹		
Complete blood count and type and screen	24.49 ³⁸		
Total for ECV without neuraxial blockade	728.18	Total for ECV without neuraxial blockade	1736.51
Supplies for neuraxial blockade	19.27 [†]	Neuraxial blockade	172.52 ³⁰
Local anesthetic	4.52 ³⁹		
Total for ECV with neuraxial blockade	751.97	Total for ECV with neuraxial blockade	1909.03

[†] Cost consistent with local hospital supply costs, ECV, external cephalic version.

Table 5

Thresholds for which NB with ECV is cost-saving

Variable	Hospital	Medicare
Probability of successful ECV with neuraxial blockade	>47.8%	>43.5%
Probability of successful ECV without neuraxial blockade	<50.4%	<55.2%
Cost of ECV with neuraxial blockade	<\$780.71	<\$2 386.29
Cost of ECV without neuraxial blockade	>\$699.08	>\$1 209.78
Cost of pre-labor cesarean delivery	>\$5568.75	>\$10 567.72
Cost of in-labor cesarean delivery	<\$9467.83	<\$23 184.13
Cost of vaginal delivery	<\$4427.48	<\$11 784.58
Probability of cesarean delivery after successful ECV	<28%	<77.9%

\$. 2012 \$US. ECV, external cephalic version; NB, neuraxial blockade.