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ORIGINAL RESEARCH

Evaluation of association factors for labor episodic pain during epidural analgesia

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Purpose: Epidural analgesia provides safe and effective labor pain relief. However, labor episodic pain can occur during epidural analgesia, requiring epidural top-ups, and may result in decreased patient satisfaction. The primary aim of our study was to investigate the factors associated with labor episodic pain during epidural analgesia.

Patients and methods: Electronic and hardcopy records of labor deliveries between January 2012 and December 2015 were reviewed at KK Women's and Children's Hospital, Singapore. The primary outcome was the prevalence of episodic pain. Demographic, clinical and anesthetic data were retrieved. Univariate and multivariate logistic regression analyses were used to identify associated risk factors for labor episodic pain experienced by parturients while receiving epidural analgesia. Model performance was assessed by area under the curve (AUC) from the receiver operating characteristic curve.

Results: The prevalence of labor episodic pain was 14.2% (2,951 of 20,798 parturients). The risk factors associated with labor episodic pain, which are given here as factor (OR, 95% CI), are the following: need for epidural resiting (11.4, 7.53–17.28), higher pain scores intrapartum (1.34, 1.32–1.36), higher Bromage scores (1.12, 1.02–1.22), the need for instrumental delivery (1.32, 1.16–1.52), the need for cesarean delivery (1.41, 1.26–1.59), the presence of venous puncture (1.29, 1.03–1.62), the presence of dural puncture (14.28, 5.92–34.43), the presence of high block (6.05, 1.39–26.35), the need for a urinary catheter (1.17, 1.17–1.34), larger volumes of local anesthetics used (1.01, 1.01–1.01) and higher body mass index (1.01, 1.01–1.02), and decreased maternal satisfaction (0.97, 0.97–0.98). The AUC was 0.80.

Conclusion: Knowledge of these factors may allow for future interventions in management to prevent labor episodic pain. Further research is needed to validate these association factors.

Keywords: epidural, labor, labor pain, factors, anesthesia, model

Introduction

The pain experienced during childbirth can be excruciating. Epidural analgesia has been shown to be the most effective method for pain relief during labor.[1] Though the majority of paturients remain comfortable receiving it, labor episodic pain will occur in some paturients, leading to pain and discomfort, resulting in the need for additional epidural top-ups. The occurrence of labor episodic pain could adversely affect the childbirth experience, decrease patient satisfaction and increase the workload for anesthetists.

The prevalence of labor episodic pain during epidural analgesia could go up to 55.5%.[2] At our center, the number was between 6.7% and 15%.[3,4] Several demographic, anesthetic and obstetric factors could be associated with inadequate pain relief and labor episodic pain,[2,5–10] whereas labor episodic pain could be associated with dys-

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functional labor.[3] Hence, investigating the parturients' risk for labor episodic pain may allow for potential pain management strategy to be developed.

Hess et al found several independent risk factors for labor episodic or "breakthrough" pain (nulliparity, higher fetal weight, smaller dilatation at epidural placement and pure epidurals used).[2] Agaram et al found four factors (cervical dilatation >7 cm, opioid tolerance, history of previous failed epidural, less-experienced operator) in their study with significant association with inadequate pain relief in labor epidurals.[8] Sng et al described seven factors (presence of dysfunctional labor, higher body mass index [BMI], lower successful demand-to-bolus ratio, longer duration of labor, lower duration of effective analgesia, higher total volume of epidural infused and lower patient satisfaction).[3]

However, these previous studies have been based on relatively small sample sizes with a limited set of variables and no association modeling has been performed. We sought to investigate the prevalence of labor episodic pain and its independent association factors in a large cohort of 20,798 parturients undergoing labor epidural analgesia. An association model using the receiver operating characteristic (ROC) analysis was developed based upon clinically relevant factors. According to our knowledge, this analysis is the largest cohort study ever reported on labor epidural analgesia. The association model would be useful in developing a clinically relevant decision-making strategy.

Patients and methods

The study protocol was reviewed and approved by the SingHealth Centralized Institutional Review Board (CIRB Ref 2014/540/D [2012–2013 data] and Ref 2017/2023 [2014–2015 data]). The SingHealth CIRB determined that this study was qualified for waiver of patient consent according to its policies because this study analyzed a large dataset without identifiers. This is a retrospective cohort study utilizing data obtained from all parturients who received neuraxial analgesia (epidural or combined spinal-epidural [CSE] analgesia) in KK Women's and Children's Hospital, Singapore, between the period of January 1, 2012 and December 31, 2015. All patient identifiers were removed prior to analysis of the data. Labor episodic pain was defined as maternal complaints of pain or pressure that required and were successfully treated with one or more doses of unscheduled supplemental epidural medications.[2]

The technique of epidural placement and the choice of analgesia were decided by the anesthetist performing the procedure. Patient-controlled epidural analgesia was used for the maintenance of epidural analgesia at our center. The epidural regimens consisted of 0.1%–0.125% of local anesthetics (ropivacaine or bupivacaine) plus 2 mcg/mL of fentanyl with a basal infusion between 5 and 10 mL/h and bolus of 5 mL for each successful demand as determined by the attending anesthetist.

Electronic records of parturients were retrieved from the database of the Department of Women's Anesthesia at our institution. This database captured all information from the labor neuraxial analgesia form. Missing data and absurd entries were identified and the corresponding hardcopy records were reviewed to rectify these information. Subsequently, demographics, obstetric and anesthetic data were analyzed, and this was performed without patient identifiers.

Demographic data included maternal age, height, weight, race and gestational age. Obstetric data included parity, cervical dilatation prior to epidural insertion, use of prostin for induction of labor, presence of oxytocin for augmentation of labor and mode of delivery. Anesthetic data included American Society of Anesthesiologists score, pre- and post-epidural pain score, usage of entonox or intramuscular pethidine, type of neuraxial analgesia (epidural or CSE, choice of local anesthetic), number of insertion attempts of the catheter, number of anesthetists attending to the parturient, seniority of anesthetists, level of sensory blockade, presence of motor blockade and local anesthetic consumption. The complications and side effects associated with neuraxial analgesia (hypotension, shivering, nausea, vomiting, catheter dislodgement, inability to obtain cerebrospinal fluid and venous puncture) and the presence of labor episodic pain were also recorded. Additionally, the reasons for labor episodic pain, number of times of labor episodic pain that occurred and cervical dilatation at the first labor episodic pain were also documented.

Statistical analyses

The primary outcome prevalence of labor episodic pain was analyzed as a binary data with the categories "yes" or "no". Parturients who experienced labor episodic pain were defined as "yes", while those without labor episodic pain were defined as "no". Demographic, obstetric and anesthetic data were summarized as mean with SD or median with IQR, whichever was applicable, for continuous variables and frequency with corresponding proportions for categorical variables.

Univariate and multivariate logistic regression models were used to determine the association between labor episodic pain and other potential covariates. Associations

from the logistic regression model were characterized using ORs and the corresponding 95% CI. Variables with *P*-value <0.20 in the univariate analysis were selected for the multivariate logistic regression model. Then forward, backward and stepwise variable selection methods were used to find final multivariate model. Model performance was assessed by area under the curve (AUC) from the ROC curve to assess the strength of the model. Significance level was set at 0.05 and all tests were two-tailed. SAS version 9.3 software (SAS Institute, Cary, NC, USA) was used for the analysis.

Our study was adequately powered (>90%) with 20,798 parturients based on the following assumptions: proportion of labor episodic pain as 14.2%, OR of 1.22 (or 0.82), two-sided α or type I error rate as 5% and Fisher' exact test. We had 20,798 eligible parturients. Our primary objective was to find associative factors for parturients with labor episodic pain. Peduzzi et al,[11] Concato and Feinstein[12] and Vittinghoff and Mcculloch[13] recommended that multivariable logistic regression models should be used with at least ten events per predictor variable.[11–13] We had 25 clinically meaningful variables to account for in the multivariate model, and hence, we needed at least 10×25=250 parturients with labor episodic pain in the data. In our data, prevalence of labor episodic pain was 14.2%, that is, we had 2,951 parturients with labor episodic pain.

Results

Figure 1 shows the flowchart of this study. A total of 20,798 parturients received neuraxial analgesia at our center in the 4-year period (between January 2012 and December 2015) and were included for analysis after rectifying missing data and absurd entries.

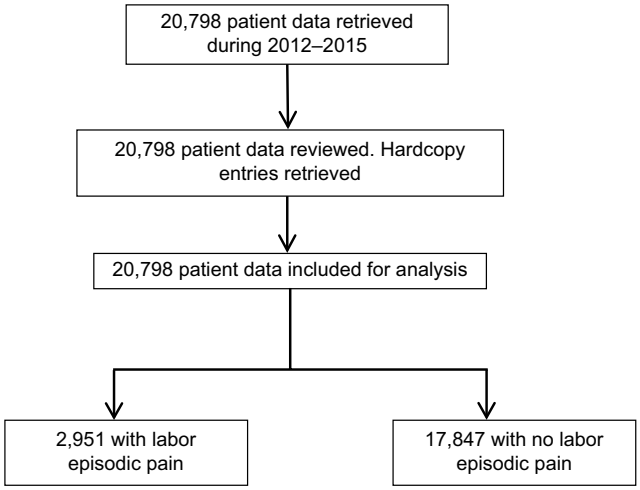

Figure 1 Study flowchart.

The mean (SD) cervical dilatation during the first episode of labor episodic pain was 5.7 (2.3) cm. Of the parturients who experienced labor episodic pain, 2,294 (77.7%) had a single episode of labor episodic pain, 469 (15.9%) had two episodes of labor episodic pain and 188 (6.3%) had three or more episodes of labor episodic pain or recurrent episodic pain. Inadequate block height was the most common reason for the first episode of labor episodic pain, affecting 1,074 (48.6%) parturients. This was followed by perineal pain, which affected 793 (35.9%) parturients. Unilateral block, lower back pain and patchy block were the sites of labor episodic pain for 163 (7.4%), 88 (4.0%) and 65 (2.9%) parturients respectively. The remaining 27 (1.2%) parturients had other reasons for labor episodic pain. A summary of the demographic and obstetric characteristics is presented in Table 1.

Univariate logistic regression analysis showed no significant association between race and labor episodic pain. Younger age, greater maternal height, weight and BMI were associated with labor episodic pain. Labor episodic pain was also associated with higher quantity of prostin used for induction of labor, lower infusion rates of oxytocin and smaller pre-anesthesia cervical dilatation. The instrumental delivery and cesarean delivery were found to be associated with labor episodic pain, too. Nulliparous paturients and those with higher birth weight were more likely to have labor episodic pain.

A summary of the anesthetic data is presented in Table 2. The significant factors associated with labor episodic pain, analyzed by univariate regression, included pre-epidural intramuscular pethidine use, higher depth to epidural space, epidural only technique instead of CSE technique, higher volume of epidural local anesthetic used, higher post-epidural reported pain scores (immediate post-procedure and higher pain scores recorded), higher Bromage scores and lower maternal satisfaction scores. In relation to complications and side effects associated with epidural analgesia (Table 3), univariate analysis found association of labor episodic pain with the following factors: post-epidural hypotension, failure in attaining spinal component with CSE, presence of venous puncture, difficulty passing the epidural catheter, presence of paresthesia, presence of high block, post-epidural shivering, nausea and vomiting, need for urinary catheterization, the presence of maternal pyrexia and the need for epidural resiting.

The independent factors associated with labor episodic pain found on using the multivariate logistic regression model

Table 1 Demographic and obstetric characteristics based on the presence of labor episodic pain

Variables	Labor episodic pain		Univariate logistic regression	
	No (n=17,847)	Yes (n=2,951)	Unadjusted OR (95% CI)	*P*-value
Age (years), mean (SD)	30.1 (5.0)	29.7 (5.0)	0.98 (0.98–0.99)	<0.0001
Race, n (%)				0.0156+
Chinese	8,469 (47.5)	1,309 (44.4)	Reference	
Malay	4,008 (22.5)	703 (23.8)	1.17 (1.03–1.32)	0.1826
Indian	2,251 (12.6)	406 (13.8)	1.14 (1.03–1.25)	0.3977
Others	3,119 (17.5)	533 (18.1)	1.11 (0.99–1.23)	0.8979
Maternal height (cm), mean (SD)	160 (0.1)	160 (0.1)	1.37 (0.85–2.21)	0.1913
Maternal weight (kg), mean (SD)	68.3 (12.8)	70.6 (14.2)	1.01 (1.01–1.02)	<0.0001
BMI (kg/m^2), mean (SD)	27.2 (5.7)	28.1 (7.7)	1.02 (1.02–1.03)	<0.0001
Quantity of prostin, mean (SD)	0.4 (0.8)	0.5 (0.9)	1.16 (1.11–1.21)	<0.0001
Nulliparous, n (%)				
No	7,253 (40.6)	898 (30.4)	Reference	
Yes	10,594 (59.4)	2,053 (69.6)	1.57 (1.44–1.70)	<0.0001
Multiparous, n (%)				
No	10,595 (59.4)	2,057 (69.7)	Reference	
Yes	7,252 (40.6)	894 (30.2)	0.64 (0.58–0.69)	<0.0001
Pre-anesthesia pain score, mean (SD)	6.3 (3.32)	6.3 (3.25)	1.00 (0.99–1.01)	0.9583
Pre-anesthesia cervical dilatation (cm), mean (SD)	3.5 (1.1)	3.3 (1.0)	0.80 (0.77–0.83)	<0.0001
Pre-anesthesia oxytocin (mL/h), mean (SD)	2.8 (7.93)	2.6 (7.58)	1.00 (0.99–1.00)	0.1058
Delivery mode, n (%)				<0.0001+
NVD	13,274 (74.6)	1,884 (63.9)	Reference	
Instrumental delivery	1,657 (9.3)	412 (14.0)	1.75 (1.56–1.97)	<0.0001
LSCS	2,871 (16.1)	652 (22.1)	1.60 1.45–1.76)	0.0003
Birth weight (g), mean (SD)	3,105.9 (427.8)	3,182.2 (437.9)	1.0 (1.0–1.0)	<0.0001

Note: + represents type III *P*-value.
Abbreviations: BMI, body mass index; LSCS, lower segment cesarean section; NVD, normal vaginal delivery.

are shown in Table 4. Higher BMI, need for epidural resiting, use of larger volume of local anesthetics, higher pain scores recorded, higher Bromage scores recorded, presence of dural and venous punctures, presence of high block (higher than T1 dermatomal level), the need for urinary catheterization and lower maternal satisfaction scores were independently associated with labor episodic pain. The most significant risk factor for labor episodic pain was the need for epidural resiting (adjusted OR: 11.41, 95% CI: 7.53–17.28). Those with labor episodic pain were also more likely to require instrumental delivery (adjusted OR: 1.32, 95% CI: 1.16–1.52) or cesarean delivery (adjusted OR: 1.41, 95% CI: 1.26–1.59). Figure 2 shows the ROC of the association model for the risk factors of labor episodic pain during neuraxial analgesia with an AUC of 0.80.

Discussion

This cohort study showed that the prevalence of labor episodic pain during epidural analgesia was 14.2% (2,951 out of 20,798 paturients). The independent factors associated with labor episodic pain were higher BMI, need for epidural resiting, higher volume of local anesthetics used, higher pain scores recorded, higher Bromage scores, the need for instrumental or cesarean delivery, the presence of venous puncture or dural puncture, the presence of high block, the need for urinary catheterization and lower maternal satisfaction scores.

The prevalence of labor episodic pain was 14.2% and it was well comparable with our center's previous experience.[3] The association model had a good performance with an AUC of 0.80. The use of AUC analysis investigates the contribution of the identified associated factors in explaining the outcome of interest.[14,15] Several clinical studies and medical research have utilized this technique to assess clinical outcome scoring.[16–18]

The association of higher BMI and labor episodic pain had been found in previous studies.[3,19,20] This could be attributed to the potential risk of prolonged difficult labor and possible tachyphylaxis of epidural medications administered.[3] The increased BMI could also lead to increased difficulty in epidural insertion and higher likelihood of epidural failure.[19]

In our center, pain scores are documented routinely by the nursing staff at 1–2-hour intervals throughout the

Table 2 Anesthetic data based on the presence of labor episodic pain

Variables	Labor episodic pain		Univariate logistic regression	
	No (n=17,847)	Yes (n=2,951)	Unadjusted OR (95% CI)	*P*-value
Analgesia before neuraxial block, n (%)				
No	9,315 (52.2)	1,608 (54.5)	Reference	
Yes	8,532 (47.8)	1,343 (45.5)	0.91 (0.84–0.99)	0.0207
Entonox use before neuraxial block, n (%)				
No	9,017 (50.5)	1,458 (49.4)	Reference	
Yes	8,830 (49.5)	1,493 (50.6)	1.05 (0.97–1.13)	0.2609
Pethidine use before neuraxial block, n (%)				
No	16,705 (93.6)	2,703 (91.6)	Reference	
Yes	1,142 (6.4)	248 (8.4)	1.34 (1.16–1.55)	<0.0001
Total time taken for neuraxial block (minutes), mean (SD)	7.3 (5.24)	7.7 (5.7)	1.01 (1.00–1.02)	0.0031
Depth to epidural space (cm), mean (SD)	4.7 (1.0)	4.8 (1.0)	1.17 (1.13–1.22)	0.0031
Number of anesthetists, n (%)			1.32 (1.01–1.72)	0.0399
1	17,545 (98.3)	2,887 (97.8)		
2	291 (1.6)	62 (2.1)		
3	5 (0.0)	2 (0.1)		
Neuraxial block catheter technique, n (%)				
CSE	16,791 (94.1)	2,720 (92.2)	Reference	
Epidural	1,046 (5.9)	231 (7.8)	1.36 (1.18–1.58)	<0.0001
Neuraxial block loss of resistance technique, n (%)				
Air	486 (2.7)	93 (3.2)	1.16 (0.93–1.46)	0.1922
Saline	17,351 (97.3)	2,858 (96.8)	Reference	
Volume of local anesthetic delivered (mL), mean (SD)	52.3 (39.2)	85.5 (57.6)	1.02 (1.01–1.02)	<0.0001
Immediate post-epidural pain score, mean (SD)	0.1 (0.7)	0.2 (0.9)	1.08 (1.04–1.13)	0.0006
Highest pain score post-epidural, mean (SD)	0.9 (1.9)	3.4 (3.3)	1.41 (1.39–1.43)	<0.0001
Highest Bromage score post-epidural, mean (SD)	0.2 (0.4)	0.3 (0.6)	1.44 (1.34–1.56)	<0.0001
Maternal satisfaction %, mean (SD)	89.6 (8.8)	86.2 (11.4)	0.96 (0.96–0.97)	<0.0001

Abbreviation: CSE, combined spinal-epidural.

duration of labor epidural analgesia. The association between higher pain scores and labor episodic pain might be an indicator of technical issues of the epidural, such as catheter misplacement, migration, dislodgement or loss of function. The need for epidural resiting and the presence of venous or dural puncture during insertion are all indicators of catheter malposition that could be associated with a higher risk of labor episodic pain.

Parturients with labor episodic pain could require higher total amount of epidural local anesthetic medications, with the potential for higher block height and motor block with higher Bromage scores from epidural top-up boluses. This positive independent factor was found in a previous study in our center.[3] Hess et al also found an association between severity of maternal pain and labor episodic pain.[2] The possible mechanisms included peripheral or central sensitization and possible tachyphylaxis to the epidural medications. In addition, they also found evidence that dysfunctional labor was associated with repeated labor episodic pain, and this was associated with higher risk of cesarean or instrumental delivery,[21] which is congruent to our findings. Labor episodic pain was associated with poorer maternal satisfaction scores, though the satisfaction scores may be affected by multiple factors other than pain relief during labor.[22]

Epidural analgesia is known to carry increased risk of urinary retention which can affect up to 80% of women with labor epidural analgesia.[23,24] Although urinary retention could slow the course of labor and fetal descent, studies also found that a full bladder did not affect the course of established labor.[25,26] Prolonged difficult labor and dysfunctional labor could influence the decision made for urinary catheterization. Higher top-up doses of local anesthetics given for labor episodic pain and increased labor episodic pain from dysfunctional labor could also explain the association of the need for urinary catheterization.

Previously, a number of cohort studies looking at factors associated with labor episodic pain have been reported.[2,3,8,27] However, there is limited research in developing an ROC curve and an association model. Although significant in previous studies, a smaller cervical dilatation before epidural insertion, seniority of the anesthetist, use of pure epidurals instead of CSE, nulliparity, longer duration of labor and

Table 3 Complications and side effects of neuraxial analgesia based on the presence of labor episodic pain

Variables	Labor episodic pain		Univariate logistic regression	
	No (n=17,847)	Yes (n=2,951)	Unadjusted OR (95% CI)	*P*-value
Hypotension, n (%)				
No	17,732 (99.4)	2,919 (98.9)	Reference	
Yes	115 (0.6)	32 (1.1)	1.69 (1.14 to –2.51)	0.0090
Unable to get cerebrospinal fluid for CSE, n (%)				
No	17,578 (98.5)	2,873 (97.4)	Reference	
Yes	269 (1.5)	78 (2.6)	1.77 (1.38–2.29)	<0.0001
Venous puncture, n (%)				
No	17,319 (97.0)	2,814 (95.4)	Reference	
Yes	528 (3.0)	137 (4.6)	1.60 (1.32–1.94)	<0.0001
Unable to pass catheter, n (%)				
No	17,792 (99.7)	2,932 (99.4)	Reference	
Yes	55 (0.3)	19 (0.6)	2.10 (1.24–3.54)	0.0055
Paresthesia, n (%)				
No	17,415 (97.6)	2,847 (96.5)	Reference	
Yes	432 (2.4)	104 (3.5)	1.47 (1.186–1.83)	0.0005
Dural puncture, n (%)				
No	17,837 (99.9)	2,935 (99.5)	Reference	
Yes	10 (0.1)	16 (0.5)	9.71 (4.40–21.41)	<0.0001
High block, n (%)				
No	17,841 (100)	2,948 (99.9)	Reference	
Yes	6 (0.0)	3 (0.1)	3.03 (0.76–12.11)	0.1175
Shivering, n (%)				
No	13,690 (76.7)	2,172 (73.6)	Reference	
Yes	4,157 (23.3)	779 (26.4)	1.18 (1.08–1.29)	0.0002
Pruritus, n (%)				
No	11,680 (65.4)	1,855 (62.9)	Reference	
Yes	6,167 (34.6)	1,096 (37.1)	1.12 (1.03–1.21)	0.0064
Nausea, n (%)				
No	16,991 (95.2)	2,770 (98.9)	Reference	
Yes	856 (4.8)	181 (6.1)	1.30 (1.10–1.53)	0.0020
Vomiting, n (%)				
No	16,260 (91.1)	2,603 (88.2)	Reference	
Yes	1,587 (8.9)	348 (11.8)	1.37 (1.21–1.55)	<0.0001
Urinary catheterization, n (%)				
No	3,417 (19.1)	358 (12.1)	Reference	
Yes	14,430 (80.9)	2,593 (87.9)	1.72 (1.53–1.93)	<0.0001
Maternal pyrexia >37.5°C, n (%)				
No	8,317 (91.1)	1,279 (85.4)	Reference	
Yes	814 (8.9)	218 (14.6)	1.74 (1.48–2.05)	<0.0001
Epidural resiting, n (%)				
No	17,810 (99.8)	2,810 (95.2)	Reference	
Yes	37 (0.2)	142 (4.8)	24.32 (16.90–35.00)	<0.0001

Abbreviation: CSE, combined spinal-epidural.

higher fetal weight were associated with higher prevalence of labor episodic pain in our univariate analysis, but were not found as independent risk factors in the multivariate analysis. Cervical dilatation at the first episode of labor episodic pain was not found to be significant.

Observational studies cannot establish any causal relationship, but could suggest the association which requires further investigations. While a prospective randomized controlled study would be ideal, performing one in such a large scale would be challenging. Our aim was to investigate the prevalence and the factors associated with labor episodic pain reflected in day-to-day clinical practice. The data were obtained from a single center with a predominantly Asian population, and women may have different pain perception from other populations due to various genetic, cultural and psychological factors.[28–30] Our center uses patient-controlled

Table 4 Results of multivariate logistic regression on the risk factors associated with labor episodic pain

Variable	Adjusted OR (95% CI)	*P*-value
BMI (kg/m^2)	1.01 (1.00–1.02)	0.0004
Composite outcome: resiting epidural and CSE (ref. = no)	11.41 (7.53–17.28)	<0.0001
Volume of local anesthetic delivered (mL)	1.01 (1.01–1.01)	<0.0001
Highest pain score	1.34 (1.32–1.36)	<0.0001
Highest Bromage score	1.12 (1.02–1.22)	0.0144
Delivery mode (ref. = NVD)		<0.0001+
Instrumental delivery	1.32 (1.16–1.52)	0.1271
Lower segment cesarean section	1.41 (1.26–1.59)	0.0008
Venous puncture (ref. = no)	1.29 (1.03–1.62)	0.027
Dural Puncture (ref. = no)	14.8 (5.92–34.43)	<0.0001
High block (ref. = no)	6.05 (1.39–26.35)	0.0165
Side effect: urinary catheter (ref. = no)	1.17 (1.03–1.34)	0.0182
Maternal satisfaction	0.97 (0.97–0.98)	<0.0001

Note: + represents type III *P*-value.
Abbreviation: BMI, body mass index; CSE, combined spinal-epidural; NVD, normal vaginal delivery.

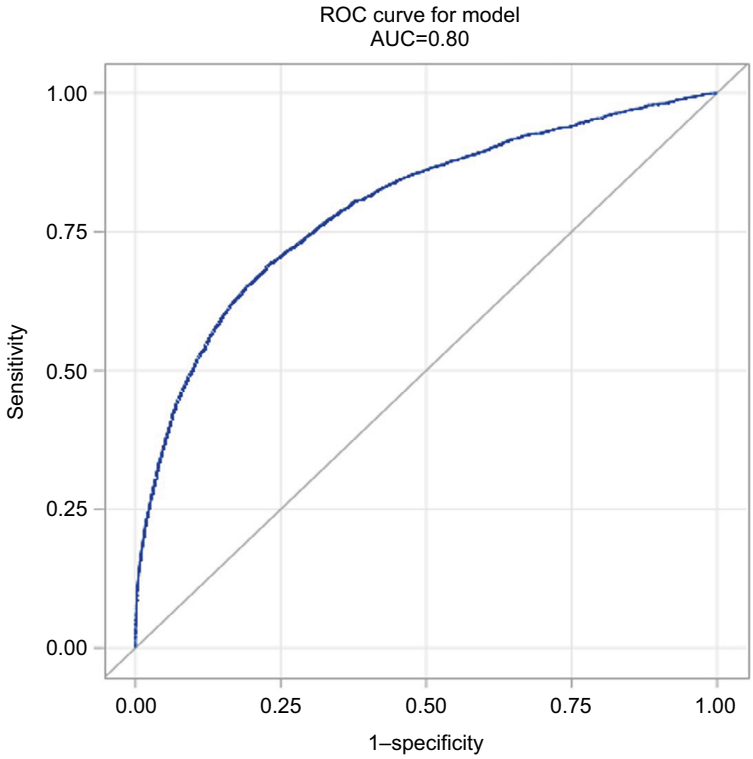

Figure 2 The ROC curve for multivariate logistic regression of factors associated with labor episodic pain.
Abbreviation: AUC, area under the curve; ROC, receiver operating characteristic.

epidural analgesia system routinely. Parturients are able to self-titrate boluses for epidural breakthrough pain during labor epidural infusions.[3] The data obtained on labor episodic pain reflect a clinician's intervention in the event that self-titrated boluses are inadequate in providing pain relief. This could lead to a lower reported prevalence of labor episodic pain in our center. The quality assessment of labor epidural analgesia could include labor episodic pain, prevalence of failed analgesia, need for epidural catheter resiting and local anesthetic consumption.[31,32]

In conclusion, our study found several independent factors associated with labor episodic pain, of which the need for epidural resiting was the most significant. Future research should include the validation of these factors and the development of risk stratification strategies to prevent and treat potential labor episodic pain earlier, in order to improve maternal outcomes and satisfaction.

Patient data confidentiality statement

The SingHealth Centralized Institutional Review Board has determined that this study is qualified for waiver of patient consent according to its policies because this study analyzed a large dataset without patient identifiers, which is in compliance with the Declaration of Helsinki on patient data confidentiality.

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Author contributions

All authors contributed to data analysis, drafting or revising the article, gave final approval of the version to be published, and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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