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LETTER TO THE EDITOR

Cost-minimization analysis of the continuous real-time pressure sensing technology in parturients requesting labor epidural analgesia

Dear Editor,

Epidural analgesia and anesthetic techniques are routinely used in the perioperative setting, including the labor and delivery unit and for chronic pain management. The success of these procedures relies on the correct identification of the epidural space by the operator. Globally, approximately 140 million births occur every year. Epidural labor analgesia is used in most births either alone or as a component of a combined spinal epidural technique.

Surface landmarks, tactile feedback from the needle, and Loss-Of-Resistance (LOR) to saline or air injection are traditionally used to guide the needle into the epidural space. Epidural analgesia, based on successful identification, successfully finding of the epidural space, is an integral part of the practice of anesthesia. This traditional LOR technique has undergone major modifications as a result of improvement in the needle, catheter, and technique following the first demonstration by Dogliotti in 1931.[1] However, reported epidural failure rates using LOR for epidural space identification vary greatly and have been reported to range from 1.5% up to 23%.[2]

In addition, complications such as Accidental Dural Puncture (ADP) are an important and common complication of epidural block with reported rates of 0.5% to 4%.[3] ADP occurs if the dura is perforated by the epidural needle or by the epidural catheter.[4] Following ADP, the incidence of Postdural Puncture Headache (PDPH) has been reported to be more than 25% in young patients. Pregnant women are particularly prone to PDPH,[5] which is frequently severe or incapacitating, markedly postural, and of at least several days duration. It often interferes with maternal-infant interaction. It is a substantial source of higher anesthetic burden, extended hospitalization, and the necessity for further therapy and procedures such as epidural blood patch.[4]

The use of continuous, real-time pressure sensing technology has been recently validated as a tool to identify the epidural space. To date, there is no published data showing cost of the continuous real-time pressure sensing technology technique. Therefore, the aim of this study was to conduct a cost-minimization analysis of real-time pressure sensing technology in parturient requesting labor epidural analgesia.

The study protocol was approved by the Institutional Review Board of the University of Texas Medical Branch at Galveston (UTMB) (IRB # 19-0056, 4 April 2019). In order to estimate the costs on Labor Epidural Analgesia (LEA) and the downstream complications for the cost-minimization analysis, we used data from Electronic Health Records (EHR) (Epic Clarity Database, Epic Systems Corporation, Verona WI) at the UTMB to identify parturient aged between 18 and 50 who had epidural anesthesia for planned vaginal delivery between November 2015 and February 2019.

For the cost-minimization analysis, we estimated the total cost, from the hospital perspective, for the hospital stay for delivery and readmission for EBP, if any. We first categorized patients into two groups by the presence of epidural replacement. Successful epidural placement is defined as baby delivered without epidural replacement or additional analgesia technique or medications. Within each group, we further categorized the patients into three groups: 1) No PDPH or EBP; 2) With PDPH but no EBP; 3) With EBP. Patients who had multiple epidural procedures for epidural anesthesia during hospitalization were considered to have epidural replacement. PDPH after epidural anesthesia was identified using the International Classification of Diseases (ICD), 10th Revision, Clinical Modification (ICD-10-CM) codes O74.5 and O89.4. All costs were adjusted to the same time period (February 2019), using the Consumer Price Index for medical care.

The decision model framework for cost-minimization analysis comparing real-time pressure sensing technology and traditional LOR technique is presented in a supplemental figure. This hospital perspective analysis was performed using TreeAge Pro 2019 (TreeAge Software, Inc., Williamstown, MA). The effectiveness was pain during delivery estimated by patients on a Numerical Rating Scale (NRS), ranging from 1 to 10. We assumed these two methods are equally effective in managing pain during labor, which has a

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Table 1 Cost# associated with epidural anesthesia for planned vaginal delivery.

Epidural replacement	PDPH	EBP	n	Mean ± SD	Median§
No	No	No	3928	17,414.53 ± 6335.22	16,272.40
	Yes	No	66	19,201.23 ± 13686.01	17,026.01
		Yes	20	23,772.33 ± 6856.11	21,359.12
Yes	No	No	454	22,452.14 ± 13038.52	20,457.53
	Yes	No	8	24,935.07 ± 5093.90	24,212.93
		Yes	7	25,700.02 ± 4157.85	25,279.51

Total cost for the hospital stay for spontaneous vaginal delivery and readmission for EBP, if any.
§ Median costs were used in the cost-minimization analysis model. SD: Standard Deviation; PDPH: Post-dural-puncture headache; EBP: Epidural blood patch.

Table 2 Incremental cost of the traditional method compared to the real-time pressure sensing technology method.

Method	Cost	Incremental cost	Effect (pain score)	Dominance
Study device	16,363.02	0.00	2.00	
Traditional	16,866.96	503.94	2.00	Dominated

NRS of 2. The parameters used in the model are listed in supplemental Table 1, including the aforementioned cost estimates from the six scenarios. The probabilities of epidural replacement and PDPH for the real-time pressure sensing technology were obtained from our prior publication. The same cost estimates were used on the arm of real-time pressure sensing technology with the additional cost of using this device.

For cost estimation, we included 4483 deliveries among 4353 parturient. We examined parturient characteristics, including age, Body Mass Index (BMI), gravidity, parity, and race at the inpatient visit for delivery. Our population was mean age of 27.4 years, mean BMI of 32.3, mean gravidity of 2.7 and parity of 1.7. Majority race/ ethnicity was Hispanic or Latino (57.8%), followed by White (26.7%) and African American (11.3%). In the 4483 deliveries, 469 (10.5%) had epidural replacement and 101 (2.25%) had postdural puncture headache. Not surprisingly, those who had epidural replacement and epidural blood patch had the highest cost, while those without, had the lowest cost (median cost $25,279.51 vs. $16,272.40) (Table 1). These cost estimates were used in the cost-minimization analysis comparing the real-time pressure sensing technology and the traditional LOR method. Parameters used in the cost-minimization analysis model are presented in the supplemental Table 1. The decision model is presented in the Supplemental Figure 1. Using real-time pressure sensing technology as the comparison reference, the incremental cost of the traditional method is presented in Table 2. Compared to the traditional LOR technique, real-time pressure sensing technology costs about 504 US dollars less per hospital stay on average. Given that we used the same cost estimate for delivery and complication treatment on both arms in each of the six scenarios, the cost savings achieved by the real-time pressure sensing technology was due to the lower likelihood of epidural replacement and PDPH (Table 1).

To our knowledge, this is the first, large-scale study in the literature comparing costs of the traditional LOR technique and real-time pressure sensing technology in parturient requesting Labor Epidural Analgesia (LEA). In this cost-minimization analysis study, we found that compared to the traditional LOR technique, real-time pressure sensing technology saves about 504 US dollars in parturient requesting labor epidural analgesia per hospital stay on average.

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Conflicts of interest

Rovnat Babazade, declared that he received one-time honoraria for delivering lectures on use of continuous real-time pressure sensing technology in parturients for Milestone Scientific. Other listed authors declare that they have no conflicts of interest.

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Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.bjane.2022.06.004.

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