Journal of Anesthesia (2025) 39:476–477
https://doi.org/10.1007/s00540-024-03448-9

LETTER TO THE EDITOR

Errors and omissions in GA predictors for cesarean delivery

Grace Townsend[1] · Lily Robistow[1] · Amir L. Butt[2] · Aimee Pak[2]

Received: 10 December 2024 / Accepted: 12 December 2024 / Published online: 20 December 2024

Keywords Cesarean delivery · General anesthesia · Predictors · Regional anesthesia · Risk factors

We were quite interested in the paper published by Raghavan et. al. which identified independent risk factors for general anesthesia (GA) [1]. The authors concluded that inadequate regional anesthesia (RA), abnormal fetal heart rate (aFHR), and cord/fetal prolapse are the most modifiable risk factor for GA during cesarean delivery (CD) [1]. However, the failure to identify maternal risk factors because of the selected methodological and statistical approaches does justify a closer examination of the study findings.

First, the sample size was calculated for ten potential risk factors without discussing the variable selection criteria for univariate analysis. However, the study lists 25 variables as indications of GA for CD (Table 3) [1]. As a result, the study excluded some known risk factors from the final analysis or grouped multiple risk factors into broader categories (Table 6) [1], prohibiting the relationship evaluation of independent individual maternal risk factors with GA. Maternal risk factors such as morbidly adherent placenta (MAP), preeclampsia, and HELLP syndrome are the top three independent risk factors associated with GA [2] and are well-known to be associated with preterm delivery, further influencing the choice of GA [2]. The exclusion of maternal risk factors from the final analysis would have resulted in an incorrect risk estimation for GA due to gestational age. After adjusting for maternal risk factors, Ring et al. concluded that for every one-week reduction in gestational age at delivery, the odds of GA are increased by 13% [3]. Similarly, age, BMI, nulliparity, prior cesarean delivery, and gestational hypertension are known risk factors for GA that were not included in the final analysis [4]. As already stated, the study does not include patients' racial and ethnic data. The role of race extends beyond a standalone risk factor and demonstrated to be an "effect modifier" for the relationship between other risk factors and GA [4]. The risk of GA for patients with postpartum hemorrhage, severe maternal morbidity, and labor without an epidural catheter in situ significantly vary by race [4].

Second, the study identified fetal bradycardia and cord/fetal prolapse as potentially modifiable risk factors for use of GA in CD. However, according to the American Society of Anesthesiology (ASA) Practice Guideline for Obstetric Anesthesia, GA may be the most appropriate choice in some circumstances such as profound fetal bradycardia, ruptured uterus, severe hemorrhage, severe placental abruption, or umbilical cord prolapse [5]. Categorizing emergent intrapartum events, such as fetal bradycardia or cord/fetal prolapse as "modifiable" risk factors for GA does not seem to adequately account for these multifactorial and nuanced situations that require immediate decision and intervention for the health of the mother and fetus. The study results show a 17% conversion rate from neuraxial anesthesia to GA, which is substantially higher than the less-than-4% rate reported in the literature [6]. Munro et al. published results demonstrating large variations in the choice of anesthesia for CD between community and tertiary care hospitals in Canada [7]. They concluded that the observed difference in GA rate between community and tertiary care hospitals can be attributed to level of training, confidence, and skill in placement and management of neuraxial blocks, thereby directly influencing the rate of GA for CD [7]. Perhaps, the high neuraxial anesthesia conversion rate reported by the authors can be attributed to inter-institutional variation and is an area for improvement of modifiable risk factors.

This comment refers to the article available online at https://doi.org/10.1007/s00540-024-03411-8.

✉ Aimee Pak
Aimee-Pak@ouhsc.edu

[1] College of Medicine, University of Oklahoma Health Sciences Center, Oklahoma City, USA

[2] Department of Anesthesiology, University of Oklahoma Health Sciences Center, 920 Stanton L. Young Blvd, Oklahoma City, OK WP114073104, USA

Finally, there are some discrepancies and errors in the data presented in the paper. The number of abnormal fetal heart rates in the GA group is 54 in Table 2 [1], while the number of abnormal fetal heart rates in the GA group is 38 in Table 3 [1]. Similarly, the number of cord/fetal prolapse are 13 in Table 2 vs. 14 in Table 3 [1]. A clarification for these discrepancies is needed, as well as a correction in Table 5, where the N for the GA and RA are incorrectly assigned to their respective groups [1]. The statistical modelling used in the study may not be the best approach as it underestimates the number of potential risk factors. The study is underpowered due to small sample size, resulting in the exclusion of important risk factors from the final model. An alternative strategy could have been to obtain up to 10 controls for each case, which would have sufficiently powered the study without the exclusion of important risk factors from the final model [8]. The backward elimination method to build the multivariable logistic regression model may not be the best variable selection approach used in the study. Instead, a stepwise variable selection approach would have resulted in a more robust and reliable statistical model [9].

In conclusion, we congratulate the authors for highlighting an important topic. However, due to above mentioned limitation the study findings lack widespread application. There is a strong need for a well-designed study to understand the risk factors associated with the use of GA in CD.

Author contributions GT and LR conceptualized the letter and wrote up the first draft; AB and AP have helped to write the letter and approved the final manuscript.

Funding None.

Declarations

Conflict of interest None.

References

1. Raghavan G, Siddiqui N, Whittle W, Downey K, Ye XY, Carvalho JCA. Anesthetic and obstetric predictors of general anesthesia in urgent or emergent cesarean delivery: a retrospective case-control study. J Anesth. 2024. https://doi.org/10.1007/s00540-024-03411-8.
2. Bao Y, Zhang T, Li L, Zhou C, Liang M, Zhou J, Wang C. A retrospective analysis of maternal complications and newborn outcomes of general anesthesia for cesarean delivery in a single tertiary hospital in China. BMC Anesthesiol. 2022;22(1):208. https://doi.org/10.1186/s12871-022-01753-y.
3. Ring L, Landau R, Delgado C. The current role of general anesthesia for cesarean delivery. Curr Anesthesiol Rep. 2021;11(1):18–27. https://doi.org/10.1007/s40140-021-00437-6.
4. Thomas CL, Lange EMS, Banayan JM, Zhu Y, Liao C, Peralta FM, Grobman WA, Scavone BM, Toledo P. Racial and ethnic disparities in receipt of general anesthesia for cesarean delivery. JAMA Netw Open. 2024;7(1): e2350825. https://doi.org/10.1001/jamanetworkopen.2023.50825.
5. Practice Guidelines for Obstetric Anesthesia. An updated report by the american society of anesthesiologists task force on obstetric anesthesia and the society for obstetric anesthesia and perinatology*. Anesthesiology. 2016;124(2):270–300. https://doi.org/10.1097/aln.0000000000000935.
6. Palanisamy A, Mitani AA, Tsen LC. General anesthesia for cesarean delivery at a tertiary care hospital from 2000 to 2005: a retrospective analysis and 10-year update. Int J Obstet Anesth. 2011;20(1):10–6. https://doi.org/10.1016/j.ijoa.2010.07.002.
7. Munro A, Sjaus A. General anesthesia for cesarean delivery: can interinstitutional variation in practice offer deeper insights into our choice of anesthetic modality? Can J Anaesth. 2024;71(2):169–74. https://doi.org/10.1007/s12630-023-02634-9.
8. Katki HA, Berndt SI, Machiela MJ, Stewart DR, Garcia-Closas M, Kim J, Shi J, Yu K, Rothman N. Increase in power by obtaining 10 or more controls per case when type-1 error is small in large-scale association studies. BMC Med Res Methodol. 2023;23(1):153. https://doi.org/10.1186/s12874-023-01973-x.
9. Bursac Z, Gauss CH, Williams DK, Hosmer DW. Purposeful selection of variables in logistic regression. Source Code Biol Med. 2008;3:17. https://doi.org/10.1186/1751-0473-3-17.