

Cesarean Section Avoidance based on Obstetric Hemorrhagic Risk: A Decision Support System

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Keywords: Obstetric Hemorrhage, Robson Classification, Cesarean Section, Decision Support System.

Abstract: Introduction: The junction of postpartum hemorrhage (PPH) and cesarean section (C-section) is a potential burden to take into account as a strategy to avoid unnecessary, and dangerous interventions. Despite most of the maternal death could have been prevented, rates are unacceptably high. According to the WHO, the rates of C-section are above recommended. The hypertension and PPH are the leading causes of maternal death worldwide. Aim: This study propose to analyze the association between C-section and PPH in a electronic health record (EHR) database and subsequently implementing an algorithm to assist health professionals in the avoidance of unnecessary C-section based on the estimation of obstetric hemorrhagic risk. Methods: Statistical analysis was performed using SISMater® database within 9,412 records about admissions to childbirth. The C-section rates associated with the occurrence of obstetric hemorrhage reported in the EHR was used to analysis. To implement the algorithm, the WHO and American College of Obstetricians and Gynecologists (ACOG) recommendations were used. The decision rules were developed to estimate the hemorrhagic risk score within the 10 groups proposed by the Robson classification. Discussion: It's expected that the system will help to reduce unnecessary C-section rates and prevent PPH, providing better conditions of prognosis for mother and her newborn.

1 INTRODUCTION

Rising cesarean deliveries is a worrisome reality in the world. Many women worldwide are delivering by cesarean section (C-section) without a clear medical indication (WHO, 2009). Compared with vaginal birth, delivery a child by C-section is independently associated with additional risk of maternal morbidity and mortality, even by elective surgery (Villar, 2006). Last delivery by C-section increases risk of severe maternal morbidity regardless the mode of birth in the current pregnancy, among them postpartum hemorrhage (Villar, 2006).

In accordance with the United Nations' Sustainable Development Goals (SDG) agreed in 2015, the reduction of unnecessary C-sections is supported by 3rd goal, good healthy and well-being. The goal 3 is to ensure healthy lives and promoting the well-being for all at all ages is essential to sustainable development (UN, 2018). Among the actions, the recommendation of the use of quality standards in obstetric care has been proposed as it may improve maternal and child health. The

monitoring of proportion of women undergoing C-section in the health facility according to Robson classification groups is part of the best practices in obstetrician (WHO, 2016). This classification groups pregnant women based on their obstetric characteristics, thus provide the systematic analysis of C-section rates and comparing similar profile institutions (WHO, 2015). The data collection process and C-section rates analysis by clusters helps institutions to evaluate the medical indicated reasons for C-sections and propose actions to avoid unnecessary surgeries (WHO, 2015). The model proposed by Robson classify all women admitted for delivery in ten homogeneous groups, based on distinct characteristics of each individual woman and her gestation instead of focusing on the indication of the operative birth, and takes into account: single or multiple gestation; parity and presence of previous C-Section; presentation; form of onset or C-Section before labor and gestational age at birth (Robson, 2001).

In its turn, hemorrhagic complications in pregnancy are associated with severe maternal morbidity, as well as being one of the frequent

causes of preventable maternal mortality, according to world statistics (WHO, 2015b). The PPH is characterized as cumulative blood loss greater than 1000 mL with signs and symptoms hypovolemia within 24 hours of the labor process (ACOG, 2017). It has been considered the leading cause of maternal mortality in low-income countries and the primary cause of nearly a quarter of all maternal deaths globally (WHO, 2014). In developing countries around 1.2% of deliveries are associated with PPH (WHO, 2015).

In this context, was created Zero Maternal Deaths by Hemorrhage project by the World Health Organization (WHO) and Pan American Health Organization (PAHO), which target to implement in Latin America a set of interventions based on scientific evidence to organize and simplify the care on obstetric hemorrhagic emergencies (PAHO, 2018). In addition to this proposal, the ACOG recommends cautious observation of the variables associated with the risk of PPH, from the history of labor to the puerperium (ACOG, 2017).

The intercession between the risk of PPH and the C-section specific conditions it's still an incipient theme. Computerized solutions that directly support medical decisions in care scenarios have the potential to mitigate risks and consequently reduce the complications associated with PPH.

The aim of this study is to analyze the association between C-section and PPH in a electronic health record (EHR) database and subsequently implementing an algorithm to assist health professionals in the avoidance of unnecessary C-section based on the estimation of obstetric hemorrhagic risk.

2 METHODS

This is an interdisciplinary study between medicine and computer science. It involves two steps: firstly, were statistically analyzed the EHR about admissions to childbirth; subsequently, an algorithm was developed to estimate the obstetric hemorrhage risk within each of the 10 groups proposed in the Robson classification. The study was approved by the Ethics Committee of UFMG (CAAE-Brazil 10286913.3.0000.5149).

2.1 Step 1: Data Analysis

Was made a retrospective EHR database analysis. Comprise all admissions to childbirth occurred from January 2014 to June 2018 (9,412 records), at

Hospital das Clínicas of Universidade Federal de Minas Gerais, Brazil. Statistical analysis was performed using SISMater® database, a non-profit obstetric information system, developed by the same researchers team, used since 2012 in this maternity hospital (Gaspar, 2013).

Figure 1: SISMater Robson Classification Tool.

All admissions to childbirth categorized in the 10 groups proposed by Robson classification and the respective C-section rates were obtained from system (figure 1) and associated with the occurrence of obstetric hemorrhage reported in the EHR. The Pearson chi-square test, Odds Ratio (OR) with 95% confidence interval (95% CI) estimated the association between C-section and obstetric hemorrhage.

2.2 Step 2: Algorithm Implementation

In the second stage was developed and implemented an algorithm to estimate the obstetric hemorrhage risk within each of the 10 groups proposed in the Robson classification, based on the Obstetric Hemorrhage Risk Assessment Table (table 1) (ACOG, 2017).

The risk algorithm is calculated from the sum of the proposed Obstetric Hemorrhage Risk score (OHR) in Table 2. The OHR indicates if the pregnant woman has no previous risk (OHR = 0), with low risk (OHR = 1), medium risk (OHR = 2 or 3) or high risk (OHR = 4) of obstetric hemorrhage (Figure 2).

The PHP and JavaScript languages were used to continue the pre-existing implementations in the legacy software already used in the hospital.

Table 1: Obstetric hemorrhage risk assessment.

Risk Factors	Risk	OHR
Prenatal and antepartum		
Hematocrit < 30%	low	1
Prior cesarean	medium	2
Uterine surgery	medium	2
Multiple laparotomies	medium	2
Multiple gestation	medium	2
More than 4 previous deliveries	medium	2
Postpartum haemorrhage	medium	2
Large fibroids	medium	2
Estimated fetal weight > 4000g	medium	2
Obesity	medium	2
Placenta Previa	high	4
Acretism or Percretism	high	4
Platelet count < 70.000	high	4
Active Bleeding	high	4
Known Coagulopathy	high	4
Two or more medium risk factors	high	4
Labor and intrapartum		
Chorioamnionitis	medium	2
Prolonged use of oxytocin (>24 hours)	medium	2
Extended 2nd stage	medium	2
Magnesium sulfate	medium	2
Recent active bleeding (at delivery)	high	4
Two or more medium risk factors	high	4

Fonte: ACOG, 2018. Obstetric Hemorrhage.
OHR = hemorrhage obstetric risk score

3 RESULTS

3.1 Data Analysis

Between January 2014 and June 2018, occurred 9,412 births in the maternity hospital. Were excluded 69 records due to lack of information. The missing information was vaginal birth or C-section, single or multiple gestation, parity and presence of previous C-section, fetal presentation, form of onset or C-section before labor, gestational age at birth, crucial data for Robson classification algorithm.

Considering the valid records (9343 records), the cesarean rates, the maternal hemorrhage outcomes, maternal death and maternal near miss, fetal death and neonatal death are presented (Table 2).

Table 2: Childbirth record between 2014 and 2018 at the maternity hospital.

Outcomes	N	C-section
Childbirth admissions	9343	3.441 (36.8%)
Obstetric hemorrhage	315	151 (47.9%)
Maternal death	6	5 (83.3%)
Maternal near miss	42	31 (73.8%)
Fetal death	297	50 (16.8%)
Neonatal death	295	143(48.5%)

N = Childbirths admissions number

Table 3 shows the association between cesarean surgery and hemorrhage intrapartum and postpartum in all cases (p<0.001), had the highest chance of PPH (OR=1.539). When analyzing the 10 groups by Robson classification separately, were verified the significant association between cesarean surgery and hemorrhage within groups 3, 4 and 10 (p=0.010, p=0.036 and p<0.001). Lastly, when compared the 1 to 4 combined groups the association also was verified (p<0.001).

Table 3: Association between C-section and obstetric hemorrhage within the 10 Robson classification groups.

Group	N	P-value	Odds ratio	CI 95%
G1	1771	0.186	1.539	0.812 - 2.918
G2	1292	0.920	1.026	0.618 - 1.702
G3	1878	0.010*	3.586	1.347 - 9.549
G4	928	0.036*	2.076	1.049 - 4.109
G5	1443	0.823	0.914	0.416 - 2.007
G6	263	0.749	1.425	0.163 - 12.445
G7	281	0.302	0.448	0.098 - 2.055
G8	192	0.373	0.070	0.418 - 10.249
G9	47	0.915	1.182	0.054 - 25.652
G10	1248	<0.001*	21.293	13.743 - 32.991
All groups	9412	<0.001*	1.599	1.276 - 2.004
G1-G4	5869	<0.001*	1.908	1.398 - 2.622

N = Childbirths admissions, CI = Confidence interval
* Significant association with Pearson Chi-square Test

3.2 Algorithm Implementation

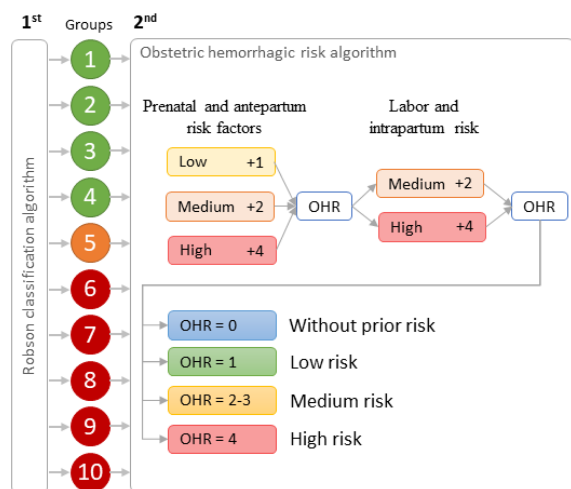


Figure 2: Obstetric hemorrhagic risk algorithm flow.

Figure 2 shows an algorithm scheme that classify the pregnant women in the 10 groups proposed by Robson. The algorithm recommends the avoidability of c-section within each group: lower expectation of c-section (groups 1-4), previous c-section group (5), higher expectation of c-section (groups 6-10). After, based on the factors read, the algorithm calculates the hemorrhage obstetric risk.

Figure 3 presents the developed interface that contemplates the data entry for the obstetric hemorrhagic risk algorithm proposed in this study.

The interface presents the risk factors separated by severity, as well as the calculated Risk Score (0 - 3). At the end, displayed the standard procedures should be taken by the team of professionals.

4 DISCUSSION

Obstetric complications demand well-prepared health professionals identify obstetric risks and manage critical situations using evidence-based bundles (PAHO, 2018). Current data analysis contributed revealing different chances of PPH, according to the Robson Ten Group Classification System (RTGC). So, the junction of already reported variables associated with the risk of PPH, from the history of labor to the puerperium (ACOG, 2017) with the RTGC can be an advantage to support timely decisions at birth.

For instance, pregnant women classified as G3, G4 or G10 had more PPH when delivered by C-

Figure 3: Obstetric hemorrhagic risk interface.

section in comparison with vaginal birth. Special attention for multiparity, independent known risk factor for the uterine atony (Rossen et al., 2010), even if without previous C-section had chance 3.586 (G3) and 2.076 (G4) higher of PPH. Algorithm implementation is supposed to alert PPH risk when term gestation in multiparous women became a C-section prior the labor or during artificially contractions induction. Group 10, all singleton, cephalic, ≤ 36 weeks, (including previous CS) had the highest chance of PPH associated with C-section, OR=21,293. Even with low-avoidability of the cesarean, G10 group deserves more precautions and careful managing to avoid PPH and improve maternal outcomes.

ACKNOWLEDGEMENTS

This project was financially supported by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), Skinage project, Ministério da Saúde do Brasil and Obstetrics and Gynecology Department of Faculdade de Medicina da UFMG.

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