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Allowable blood loss calculator for caesarean section: proof of concept

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Introduction

Allowable blood loss (ABL) estimates the maximum permitted loss of blood to reach a transfusion threshold and is commonly used for surgery where major haemorrhage is expected. A validated version of this formula is not available for pregnant patients ahead of caesarean section (CS) who have altered physiology and an anticipated autotransfusion of uterine blood. We aimed to build a statistical model that could accurately predict ABL for CS.

Methods

CSs in 2019 undertaken in our hospital were reviewed from a Caldicott approved database. The variables included were: maternal age (years), booking weight (kg), body mass index (BMI) (kg/m^2), preoperative haemoglobin concentration (g/L), lowest postoperative haemoglobin concentration, and estimated blood loss (mls) were included in a linear regression model to predict blood loss.

Results

928 caesarean sections (52.5% elective) were reviewed. The median [IQR] BMI was 27 kg/m^2 [24, 33], estimated blood loss 700mls [500, 1000], preoperative haemoglobin concentration 116 g/L [109, 122], lowest postoperative haemoglobin concentration 100g/L [93, 108], change in haemoglobin 14 g/L [9.0, 15.2], booking weight 83 kg [72, 98], and age 31 years [26, 34]. The linear model intercept was 1313, with coefficients (95% CI) of 22.8 (20.0, 25.5) for change in haemoglobin, -9.59 (-12.2, -7.01) for preoperative haemoglobin, 6.64 (4.10, 9.18) for weight, and -10.9 (-18.1, -3.75) for BMI at booking. All variables added to the model at the 5% significance level. The root mean square error was 374, indicating that the model predictions are on average out by 374ml. The R value for the model was 0.252 indicating the model accounted for 25.2% of variation in estimated blood loss. Examples of predicted ABL are shown in Table 1.

Pre-op Hb (g/L)	Booking Weight (kg)	Booking BMI (kg/m^2)	Allowable Blood Loss (ml) (95% CI)
85	60	23	759 (673, 846)
100	100	35	1092 (1034, 1149)
110	60	23	1089 (1024, 1154)
125	100	35	1421 (1338, 1505)

Table 1. Example linear regression model predictions for ABL with a transfusion trigger of 80g/L haemoglobin concentration.

Discussion

The model predicted blood loss with an acceptable accuracy and its use is particularly relevant in patients with low BMI, with a resultant lower circulating volume, and anaemia. The study was retrospective and several confounding factors were uncontrolled for including the timing of blood sampling following haemorrhage and the use of blood transfusion. Nonetheless, these results show proof of concept and a well designed prospective study could provide a robust, validated, and useful clinical tool in the future.

References

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2. Surbeck D, Vial Y, Girard T. Patient blood management in pregnancy and childbirth: a literature review and expert opinion. Arch Gynecol Obstet 2020; 301: 627-641