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Midwives' ability during third stage of childbirth to estimate postpartum haemorrhage

Ingela Wiklund [a,c,*,1], Soledad Alarcón Fernández [a], Markus Jonsson [b]

[a] Department of Clinical Sciences, Karolinska Institutet, Danderyd Hospital, SE-18288 Stockholm, Sweden
[b] Centre for Cultural Evolution, Stockholm University, SE-10661 Stockholm, Sweden
[c] School of Health & Welfare, Dalarna University, SE- 791 88 Falun, Sweden

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ABSTRACT

Objective: Correctly assessing the amount of blood loss is crucial in order to adequately treat postpartum haemorrhage (PPH) at an early stage and diminish any related symptoms and/or complications.
The aim of our study is to analyse correctness in visually estimated blood loss during labour and to measure the differences between subjectively measured and weighted blood losses (ml).
Design: Cross-sectional study
Setting: A Swedish maternity unit with 6000 annual births
Participants: Midwives employed at a big maternity unit at a hospital in northern Stockholm, Sweden.
Intervention: Midwives assisting 192 vaginal births were asked to visually estimate the blood loss from the assisted delivery. Coasters and sanitary pads were weighed following the birth. We analysed if there were any differences between subjective measured blood loss (ml) and weighted blood loss. These two methods were also compared to quantify concordance between estimated blood volume and the actual volume.
Findings: The number of overestimates of blood loss was 45.3 % ($n = 87$) with an average of 72.9 ml; the number of underestimates was 49.4 % ($n = 95$) with an average of 73.8 ml. Exact correct estimations of blood loss were done in 5.2 % of the cases ($n = 10$).
The largest overestimation of a postpartum bleeding was by 520 ml; the largest underestimation was by 745 ml.
Conclusion: There was both underestimation and overestimation of blood loss. We found small but significant overestimates in PPH < 300 ml (16 ml). In PPH > 300 ml, there was a small but not significant underestimates (34 ml). Based upon our findings, we conclude that it is reasonable to start weighing blood loss when it exceeds 300 ml.

Introduction

Postpartum haemorrhage (PPH) is one of the main reasons behind maternal mortality globally and one of the most common emergencies in clinical practice worldwide requiring prompt recognition and management (Joshua et al., 2017). Major PPH rarely lead to death in those parts of the world where there are good medical resources available but still contribute to morbidity [1,2]. PPH can lead to the need of blood transfusions [3].

Atony, retained placenta/membrane remnants, pelvic floor injuries or a coagulation disorder might cause PPH. The most common of these causes is atony [3,4]. Known PPH risk factors include older first-time mothers, obesity, preeclampsia and other severe coagulation diseases, previous PPH, previous cesarean section, macrosomia, and induction of labour [4].

Perceptions differ regarding how large the bleeding should be in order to receive the diagnosis of PPH. According to the World Health Organization [WHO] [2], a post-partum bleeding of 500 ml or more within 24 h of giving birth is considered a PPH. If that number reaches 1000 ml or more, it is defined as severe PPH. In Sweden, PPH is diagnosed as a blood loss more than 1000 ml [5]. The American College of Obstetricians and Gynecologists' reVitaLize program has another definition that describes PPH as being postpartum haemorrhage with symptoms of hypovolemia within a 24-hour period [6].

* Correspondence to: Department of Clinical Sciences, Karolinska Institutet, Danderyd Hospital, Sweden.
E-mail addresses: Ingela.Wiklund@ki.se, iwi@du.se (I. Wiklund).
[1] Present address: School of Health & Welfare: Dalarna University, Falun, Sweden.

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The basic health and access to health care when giving birth might explain different definition of the diagnosis PPH in childbearing women; therefore, it may be difficult to establish a global definition for PPH [2,4].

Measuring PPH can be challenging as there is currently no consensus in clinical practice on how the measurement of blood loss should be conducted as there are several methods for measuring blood loss at birth. The literature distinguishes between qualitative and quantitative measurement methods. Qualitative measurement methods include the most common way of measuring, which is to visually estimate the bleeding. Materials used include coasters, round bowls, and more. Several studies show a tendency to underestimate bleeding using visual estimation when compared to weighing the bleeding on a scale. Conversely, aids such as plastic bags and round bowls, can lead to overestimating the bleeding compared to weighing the bleeding [6]. Measuring the bleeding by spectrometry and by measuring the haemoglobin in the collected bleeding are other quantitative methods. The measurement has been found to be an adequate method when comparing the bleeding accumulated in the plastic bag with the patient's levels of haemoglobin and haematocrit before and after delivery [7,6,8].

In clinical practice, midwives often visually measure blood loss during the third stage of labour; during which time, the midwife makes a quantitative or semi-quantitative estimate of the amount of blood lost. In direct blood collection, bleeding during the third stage of labour is contained in a disposable plastic placed under the woman's back on the bed. When the bleeding has stopped, there are two options: either the bag could be weighed, or a visual measurement can be done.

In a review from Cochrane with the aim of evaluating alternative methods to estimate blood loss during the third stage of labour, researchers found there is insufficient evidence to support one method over another for blood loss estimation after vaginal birth [1]. There have been several studies on the various methods of measuring bleeding; however, there is no evidence that one method is better than the other. This study aims to establish whether visually estimating bleeding and/or weighing it by hand are reliable methods for measuring PPH.

Ethical Approval

This study was conducted in accordance with the WMA Declaration of Helsinki Ethical Principles for Medical Research involving human subjects. Midwives at the clinic obtained information about the project by email and orally at the start of their shift. Participation in the study was voluntary. The Department Head at the clinic approved the study design. Measuring PPH of women who give birth vaginally does not involve any discomfort to the patient. The measurement of the bleeding was made once the bleeding had stopped, and the patient's general condition was stabilised.

Methods

This study was conducted during January 2020 at a large hospital in Stockholm, Sweden. Midwives who assisted during 200 vaginal births were randomly asked to visually estimate the patient's blood loss.

Participants and setting

Midwives were asked to estimate blood loss during the second stage of labour and following delivery. This could be done both visually and by holding coasters, sanitary pads, and towels in their hands, which were all weighed following their estimation. We analysed if there were any differences between subjective measured blood losses (ml) and that, which was weighed. The two methods were also compared to quantify concordance between estimated blood volume and the actual volume. We collected no data enabling identification of the midwives.

Exclusion criteria

We excluded women from the study with PPH excessive bleeding of more than 1000 ml due to their need of treatment. In accordance with strict hygiene rules, all accumulated material from those women with a known blood infection were discarded. Women who underwent emergency and planned caesarean sections were excluded from the study.

Design and intervention

In January 2020, a total of 560 childbirths took place at the unit, of which 430 were vaginally delivered. The proportion of vaginal births with a bleeding over 1000 ml was 8.6 %. In 2019, the proportion of births with bleeding of more than 1000 ml was 7.2 % (Pregnancy Register).

A total of two hundred vaginal births were included in this study. Information regarding who performed the weighing was missing in eight or 4 % of the cases. These data points have, therefore, been excluded since it could not be determined whether the bleeding was weighed according to the instructions in the study. A total of 192 births constitutes 34.6 % of the total number of births (560) in January 2020 at the clinic. A total of 46 % of the possible vaginal deliveries was included in this study.

Statistical analysis

We sought to assess the midwives' ability to estimate the volume of blood loss following birth. This analysis used a single blood loss estimate for each proposed volume and each respondent. The analysis compares these estimated blood volumes with the measured volumes of the same bleeding (Fig. 1).

We have considered the following as two different methods of measuring postpartum haemorrhage: (i) the midwifes' estimation based upon visual inspection, and (ii) the use of a weighing scale. In technical terms, the measure of interest is not *reliability*; it is *method agreement*. Therefore, we have employed *method agreement analysis* [9].

The method of weighing is a precise standard of measurement in our study: i.e. it provides the "true values". In the literature, this type of measurement is referred to as *gold standard* [10,11]. Hence, we are not assessing the concordance between two approximate measures; rather, we are interested in what degree of confidence we can assign to the midwives' estimations. The presence of a gold standard method is considered in the method agreement analysis that follows.

Results

The number of overestimates of blood-loss was 45.3 % ($n = 87$) with an average of 72.9 ml while the number of underestimates was 49.4 % ($n = 95$) with an average of 73.8 ml. Exact and correct estimates of blood-loss were done in 5.2 % ($n = 10$) of the cases.

The largest overestimate of a postpartum bleeding was by 520 ml. The largest underestimate was by 745 ml. The absolute estimation error was less than 120 ml in 83 % ($n = 160$) of the cases.

The bleeding was overestimated by more than 120 ml in 9.9 % ($n = 19$) of the cases. The bleeding was underestimated by more than 120 ml in 6.8 % ($n = 13$) cases.

See Fig. 1 for a histogram of the estimation errors.

Hypothesis test for systematic error

Fig. 1 suggests that the difference between estimated and measured bleedings is an approximate normal distribution; therefore, we can use a Student's t-test to compare their means. We have used a paired samples t-test since each bleeding is measured twice: once by estimation and once by weighing. A two-sided test on significance level 0.05 shows no significant difference ($t_{n-1} = t_{191} = 0.415, p = 0.679$) between weighed

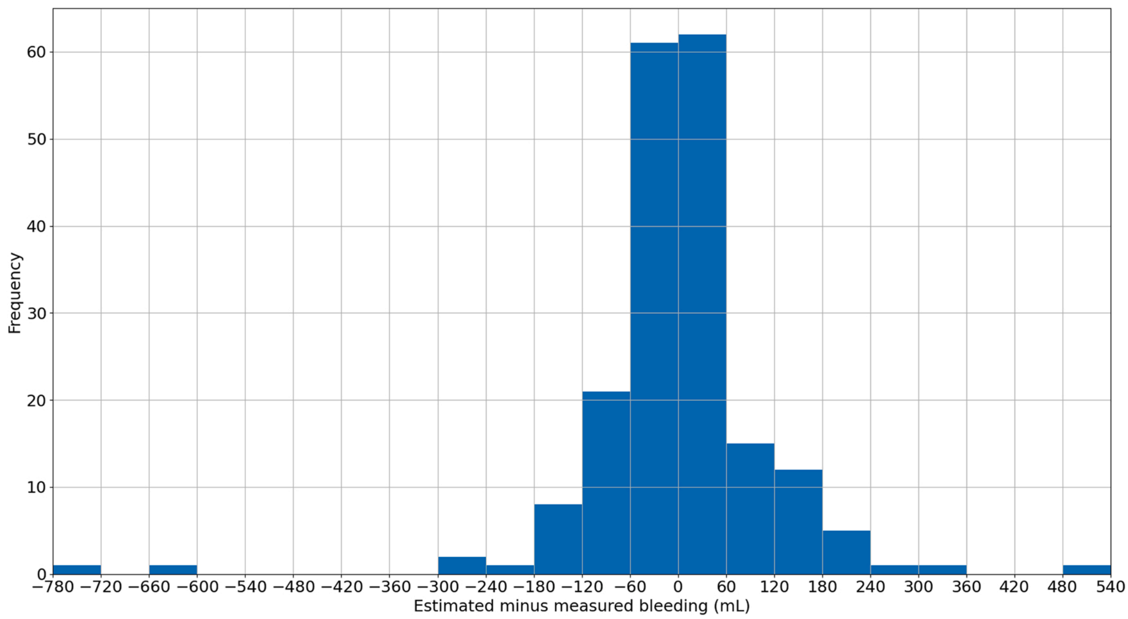

Fig. 1. Histogram of estimation error (estimated minus measured bleeding.

values (mean 302.3 ml, standard deviation 235.6 ml) and estimated values (mean 298.8 ml, standard deviation 210.6 ml). Thus, there is no evidence of a systematic error in the estimated values.

A scatter plot of estimated volumes against measured volumes can be found in Fig. 2, where perfect *correlation* corresponds to points lying along *any* straight line. Conversely, *agreement* looks for concordance with points lying along the line of equality.

Intraclass correlation coefficients (ICCs) are commonly used measures of agreement between two or more methods of measurement [12-14]. We employ a modified one-way random effects model and an associated intraclass correlation coefficient ρ for agreement between an approximate method of measurement and a gold standard [11]. The estimator r_g of ρ based upon this model is $r_g = 0.8962$ with a 95 % confidence interval [0.869, 0.919]. As a guideline, ICC values less than 0.5, between 0.5 and 0.75, between 0.75 and 0.9, and greater than 0.9 are indicative of *poor*, *moderate*, *good*, and *excellent* agreement, respectively [15].

Although our ICC, by this measure, can be regarded as *good to excellent*, it is important to note that the intraclass coefficient is agnostic to our clinically accepted threshold limit of 120 ml.

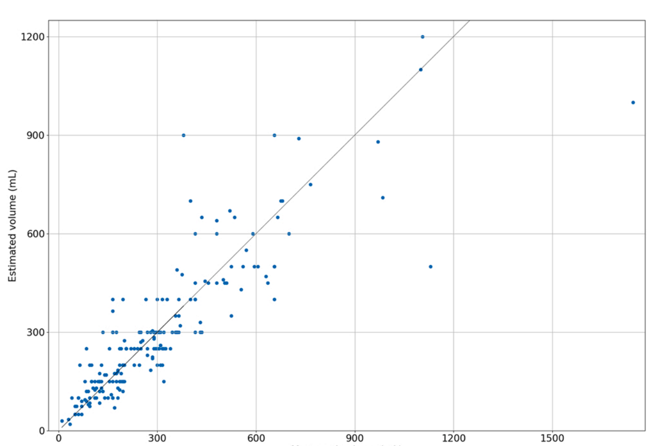

Fig. 2. Scatter plot of estimated volumes against measured volumes. The straight line represents a perfect concordance between the two methods of measurement.

Bland and altman analysis

A display of the differences between the pairs of readings may offer insight into the pattern of the agreement. The Bland and Altman diagram [16] is such a display; the difference between a pair is plotted on the vertical axis of the diagram, against the mean of the pair on the horizontal axis. We indicate for our data that the *limits of agreement*, −231 ml and 224 ml, within which 95 % of the differences between one measurement and the other are included in the Bland and Altman diagram (Fig. 3). Thus, considering the entire data set, the acceptable limit 120 ml is not met. We analyse small bleedings (measured volume ≤300 ml) and large bleedings (measured volume >300 ml) separately.

Comparison between small and large bleedings

We divide the paired data points into groups A and B, where group A is the set of pairs for which the measured volume is ≤ 300 ml ("small" bleedings) and group B is the set of pairs for which the measured volume is > 300 ml ("large" bleedings).

In group A, the average measured value is 166.3 ml and the average estimated value is 182.3 ml. A t-test on group A alone shows that this average overestimation with 16 ml is significantly distinct from zero ($t = -2.78, p = 0.006$).

In group B, the average measured value is 514.5 ml and the average estimated value is 480.5 ml. A t-test on group B alone shows that this average underestimation with 34 ml is not significantly distinct from zero ($t = 1.77, p = 0.08$).

Bland and Altman analyses on these groups gives us the following limits of agreement:

Group A: [−106 ml, 138 ml]Group B: [−356 ml, 289 ml].

Bleedings that are measured to be ≤ 300 ml are systematically overestimated (by 16 ml), but underestimates in this group can be trusted to not exceed 120 ml (according to lower limit of agreement). On the other hand, overestimates may exceed 120 ml. Both overestimations and underestimations of large bleedings (> 300 ml) exceed 120 ml.

Since we cannot conclude that the mean of the estimation errors in group A is zero, and can only barely do so in group B, we do not compute the ICC ρ in these groups separately, as the one-way random effects model we employ cannot be identified unless the mean of estimation errors is zero. (Fig. 4).

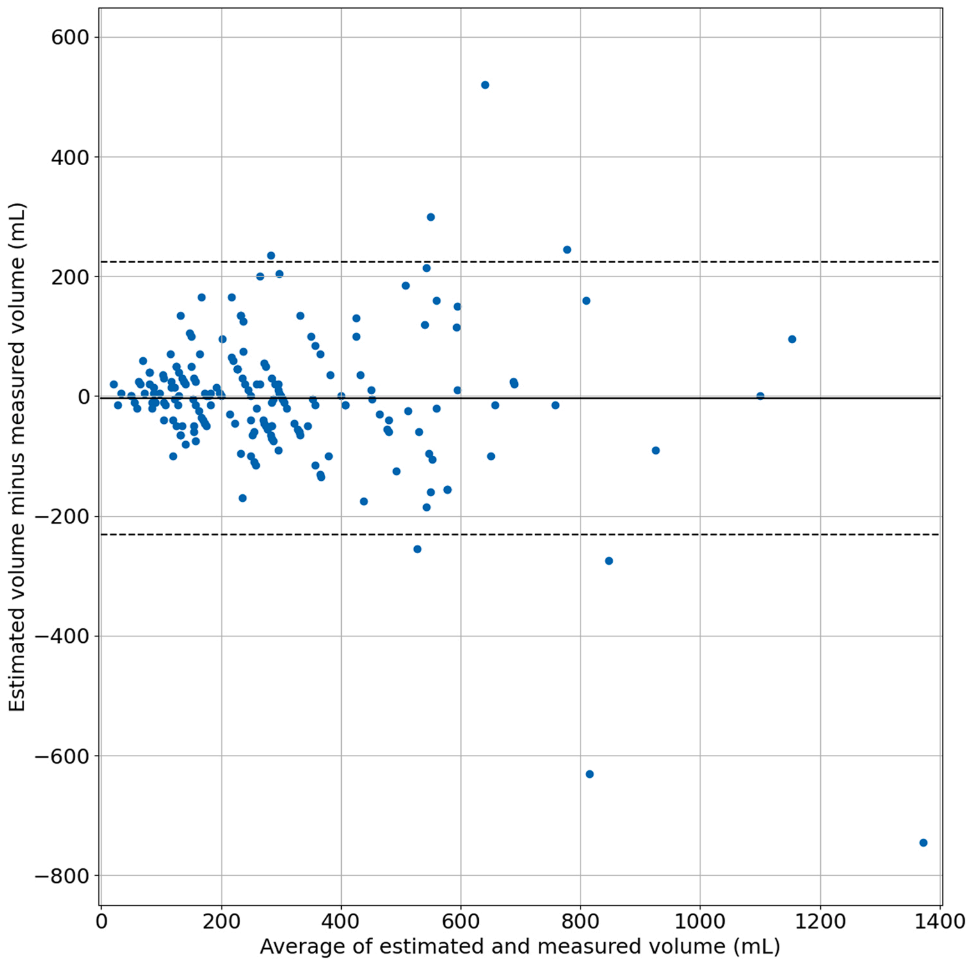

Fig. 3. Bland and Altman diagram showing the difference between the estimated and measured bleeding against the mean of the pair. The solid line indicates the mean value of the differences that reveal the small bias (−3.5 ml) and the dotted lines indicate the limits of agreement.

Discussion

Midwives working in maternity units often undertake visual estimation of blood loss during assistance in a normal birth. The accuracy of this estimation is often questioned. We found in that visual blood loss was overestimated in 45.3 % of the cases ($n = 87$) with an average of 72.9 ml and underestimated in 49.4 % of the cases ($n = 95$) with an average of 73.8 ml. Exact and correct estimations were done in 5.2 % of the cases ($n = 10$). We found a small yet significant overestimation in PPH < 300 ml (16 ml), where there was a small yet not significant underestimation (34 ml).

In another study with the aim to determine accuracy of the estimation of blood loss using simulated clinical examples, researchers found that blood in a container (bedpan or kidney dish) was more accurately estimated than blood on sanitary pads, sheets, or clothing. They also reported that participants more often correctly estimated lower volumes of blood loss than the higher volumes [17]. It might be easier to estimate the volume of blood loss in a container compared to estimating blood loss in sanitary pads, sheets or clothing, as Buckland & Homer indicate in their study [17]. There is currently no consensus in clinical practice regarding how the measurement of blood loss should be conducted. Routines on how to estimate blood loss differ between clinics and even between different professions within healthcare. During a normal birth, it is common to use bedpans, plastic bags with dipsticks, pads, coasters, sheets, and clothing to estimate blood loss.

The results of our statistical analyses of visually measuring blood loss after birth is in line with those of other studies: namely, that visual estimates tend to overestimate small volumes and underestimate large ones [8,18]. Based upon this information, it is reasonable to start weighing blood loss when it exceeds 300 ml. A Cochrane report, however, concludes there is insufficient evidence to support one method over another for blood loss estimation after vaginal birth [1].

Current data does not support any method of quantifying blood loss as superior to another: however, the American College of Obstetricians and Gynaecologists recommends in a 2019 paper that quantification of blood loss, using graduated drapes or weighing, provides a more accurate assessment of PPH estimation than does visual estimation [18].

The question remains: Is the method of weighing pads and coasters after vaginal birth more correct or safe in estimating blood loss compared to visual estimation during normal birth? Furthermore, would this routine be associated with improved outcomes related to normal births?

Unexpected PPH can occur in healthy women with normal pregnancies even if there are no certain risk factors for large blood loss [4, 19]. The potential adverse consequences of undiagnosed abnormal postpartum blood loss must of course, be taken very seriously.

Our study may have been limited by the fact that the midwives knew their estimation of blood loss would be controlled by weighing it. This research may be useful and applicable to other maternity wards.

Conclusion

Both underestimation and overestimation of blood loss was made after vaginal birth. Training to improve the skills of estimating blood

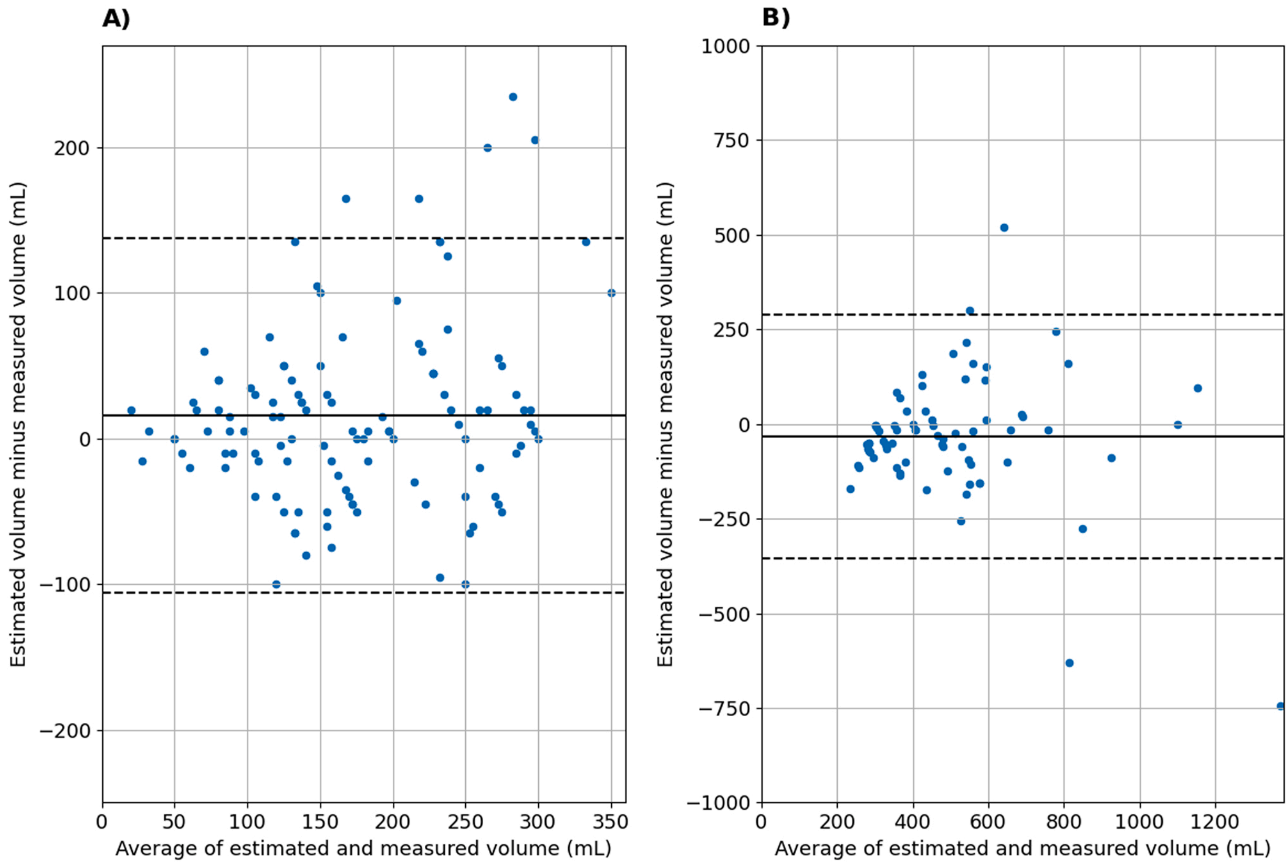

Fig. 4. Bland and Altman diagrams for small and large bleedings. **A)** Bleedings with measured volume <300 ml. **B)** Bleedings with measured volume > 300 ml.

loss at birth might lead to better accuracy. Based on the result of this study, it is reasonable to start weighing blood loss when it exceeds 300 ml.

Ethics approval and consent to participate

The head of the department at a maternity clinic approved the study design. The PPH measurement from women who give birth vaginally does not involve any discomfort to the patient.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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