Quantification of Peri-partum Blood Loss: Training Module and Clot Conversion Factor

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Abstract

Objectives To design an objective and accurate method to assess the peri-partum blood loss and to document the benefits of using this method on estimation of blood loss by healthcare professionals.

Materials and Methods This prospective study was conducted over 6 months at Cama Albless Hospital, Mumbai. To quantify the loss of liquid blood and clots, we made use of plastic drapes, measuring jars, gravimetric method and a training module along with novel clot conversion factor which was designed to validate the visual assessment of blood loss by healthcare professionals.

Results and Conclusion The visual assessment of blood loss is unreliable. Training module should be on display in labor room and periodic training sessions on visual

assessment by and for healthcare professionals are recommended, as we documented that training has definitely a beneficial impact on visual assessment. Clot conversion factor calculated in this study can prove to be a useful tool for objective assessment. Routine use of quantitative measurement rather than visual assessment of blood loss will go a long way to prevent hemorrhage-related maternal deaths.

Keywords PPH · Assessment of blood loss · Training · Clot conversion factor · Visual assessment · Quantification

Introduction

Obstetric hemorrhage is the single most important cause of maternal death. According to WHO analysis of causes of maternal deaths (2006), there is a wide regional variation in the causes of maternal deaths. Hemorrhage was the leading cause of death in Africa (point estimate 33.9 %, range 13.3–43.6; eight datasets, 4508 deaths) and in Asia (30.8 %, 5.9–48.5; 11, 16,089) [1]. The proportions of maternal deaths attributable to PPH vary considerably between developed and developing countries, suggesting that deaths from PPH are preventable [1]. Apart from few unsalvageable cases, the point of error most of the times is either delayed diagnosis due to inexperienced labor attendants, inaccurate assessment of blood loss and unavailability of the resuscitative facilities.

Visual estimation of blood loss estimation is notorious in its inaccuracy [2]. Loosing lives purely because of errors in estimations of blood loss should not happen. Peri-partum blood loss is often not estimated correctly. There are many factors for this. Blood drained during the second stage of labor is often not measured. Absorbent material like bed sheet or drape used to cover the mattress during delivery absorbs some amount of blood which is not estimated. And when clots are passed, there is no objective tool available which can help in assessment of exact whole blood loss. This is especially significant in cases of abruption/secondary PPH where blood loss has to be inferred from clots. Even if none of the above-discussed factors existed, still there is error in visual estimation. Underestimation of blood loss is detrimental as it can lead to delayed treatment for the same or at times patient may not be treated at all. This can lead to many unforeseen complications.

While, on the other hand, if blood loss is overestimated, it leads to un-indicated treatment like blood and blood product transfusion which has its own hazards.

First clinical signs appear only after percentage of blood loss has exceeded 30 %, which itself could be detrimental, especially in a country like ours where the prevalence of

anemia is 84.9 % (ICMR survey) and as high as 92.38 % in rural India [3]. Accurate measurements of the blood loss and its appropriate treatment will play an important role in reducing the maternal mortality.

In practice, we have observed that visual assessment of blood loss differs among various members of a medical team; many a times there is no agreement. No quantitative measures of the blood loss are currently available for routine practice. To address these lacunae, we conducted this prospective study to seek more objective method of assessment of postpartum blood loss.

Aims and Objectives

- To design an objective and accurate method to assess the peri-partum blood loss.
- To document the benefit of using this method on estimation of blood loss.

Materials and Methods

This study was conducted in a tertiary care hospital

- Study design: Prospective study;
- Study period: 6 months.

Methods used for accurate measurement of blood & blood clots and for development of training tool for visual assessment were as follows:

Plastic drapes were used instead of routine green sheets, and all the blood was collected and measured. After rupture of membranes, the liquor was allowed to drain in a separate measuring jar. Liquid blood was allowed to clot and serum separated was discarded. Clots were weighed, and clot conversion factor was calculated to reflect the blood loss. Clots were weighed separately, and using the clot conversion factor, exact amount of blood loss was calculated. Blood volume in soaked mops was calculated as follows.

1. *Gravimetric method* The sponges/mops/pads to be used were weighed dry first and after soaking weighed again. The difference in weight was the actual loss in ml.
2. Standardized mops used in our OT (8 × 12 in.) with four plies were soaked with known quantity of blood in steps of 25 ml, and pictures were taken to prepare posters for display to help assessment of blood loss visually (Fig. 1).

Spilled blood Known quantities of blood (expired or wasted units of blood from the blood bank) were utilized

Fig. 1 Poster displaying standard sized mops soaked in known quantity of blood. **a** 25 ml, **b** 50 ml, **c** 75 ml and **d** 100 ml

Fig. 2 Poster displaying known volume of spilled blood

Fig. 3 Size of a fist = 50 g clot

for this purpose. Known quantities in steps of 25 ml were spilled on the floor; pictures were taken to prepare posters for display to help assessment of blood loss visually (Fig. 2).

Clot size Fist size clot is approximately = 50 g (Fig. 3).

Training of personnel attending labor to incorporate information is derived from the above facts.

Four groups of uninitiated participants were asked to visually estimate blood loss without any prior training, and they were interviewed again after training.

Personnel interviewed for visual estimates

- Group 1: 20 staff nurses;
- Group 2: 8 anesthetists;
- Group 3: 20 resident doctors (junior obstetricians);
- Group 4: 6 faculty members (senior obstetricians).

Subjects

Total number of patients studied was 150, of which 100 were normal labor (Group A) and 50 were LSCS (Group B). We utilized ten units of wasted whole blood.

Protocol Followed for Normal Labor (Group A)

After the rupture of membranes, the liquor was allowed to drain in a separate container. After the delivery of baby using plastic drape already placed under the buttocks, blood was collected in measuring jar which gave the exact blood loss assessed (quantitative). This blood was then allowed to clot for 1 h. After the serum was separated, weight of the clot was measured.

Clot conversion factor calculated
= blood loss in ml/weight of clot in g

Protocol Followed for LSCS (Group B)

During LSCS, after incision on the uterus and rupture of membranes, liquor was allowed to drain in suction bottle and the bottle changed by attendant after liquor drained. All blood then sucked in a separate suction bottle. Mops soaked with blood were kept separately. Actual blood loss (ABL) was calculated by gravimetric method. Dry weights of all the standard sized mops were taken before sterilization of the drums.

Protocol Followed for Simulated Scenarios (Group C)

Wasted whole blood was obtained from the blood bank.

Simulated scenarios with known measured blood loss were created using mops and drapes and spilling the blood on surfaces.

Visual estimates of four groups of observers were noted down pre- and post-training and compared. Results were analyzed with statistical tests.

Observations and Results

A total of 100 women (random selection) who had normal vaginal delivery were included in Group A, out of which 36 were primigravida and 64 were multigravida. The average blood loss was 135 and 117 ml, respectively (Table 1).

In Group B, 50 patients who underwent LSCS were included, out of which 31 were primigravida and 17 were multigravida. Average blood loss was 315 ml and 287 ml, respectively (Table 2).

Clot conversion factor was calculated using the formula (Blood loss in ml/Weight of clot in g) on the basis of volume of blood lost (Table 3) and hemoglobin level of the patient (Table 4; Fig. 4).

Table 1 Average blood loss in group A (FTND), $N = 100$

	N	Blood loss (ml)
Primigravida	36	135
Multigravida	64	117

Table 2 Average blood loss in Group B (LSCS), $N = 50$

	N	Blood loss (ml)
Primigravida	31	315
Multigravida	17	287

Table 3 Clot conversion factor on basis of volume of blood lost, $N = 150$

Blood loss (ml)	N	Mean weight of clot (g)	Mean clot conversion factor
50–100	26	84	1.51
100–150	43	104	1.48
150–200	31	119	1.46
200–250	15	178	1.48
250–300	15	196	1.44
300–350	18	216	1.49
350–400	12	267	1.43

Table 4 Clot conversion factor on basis of hemoglobin levels, $N = 150$

Hb (g)	PCV	N	Mean weight of clot (g)	Mean clot conversion factor
<7	<22	19	89	1.51
7–9	22–28	36	116	1.48
9–11	28–34	52	118	1.43
>11	>34	43	124	1.39

Fig. 4 Clot conversion factor on basis of hemoglobin levels, $N = 100$

The blood collected was allowed to clot for 1 h. After the serum was separated, weight of the clot was measured.

$$\text{Clot Conversion Factor} = \frac{\text{Blood loss measured (ml)}}{\text{Weight of clot (g)}} \\ (\text{mean of the group taken})$$

This calculation was devised for situations like abruption placenta, adherent placenta and ruptured ectopic pregnancy, where blood loss is mainly in the form of clots and volume of blood to be consequently replaced has to be inferred from the weight of clots.

It was observed that there was no significant correlation between clot conversion factor and blood volume lost ($p > 0.05$) (Table 3).

It was observed that there is a significant inverse correlation between hemoglobin levels and clot conversion factor ($p < 0.05$), i.e., as the hemoglobin level decreases, the value of clot conversion factor increases (Table 4; Fig. 4).

Group B (LSCS)

Visual estimates of blood loss during LSCS were done. Grading of subjective visual estimates (Fig. 5) was done as follows:

Accurate: Estimated blood loss (EBL) = $\pm 20\%$ of the ABL.

Underestimate: EBL = $< 20\%$ of the ABL.

Overestimate: EBL = $> 20\%$ of the ABL.

The person (from the four groups of observers) who was present at the time of LSCS was considered to represent the group. And 50 cases were taken, so we have 50 observations from each group (Table 5; Fig. 6).

Group C (Simulated Scenarios)

In Group C, 50 simulated scenarios of blood loss in labor room and operation theater were created using our normal customary drapes, sponges, containers, kidney trays and floor spills, etc. Four groups of observers, i.e., nurses, anesthetist, junior obstetrician and senior obstetrician, entered the labor room and operation theater one by one, and their estimates of blood loss were recorded. Average of each group of observers was taken for each scenario (it was observed that the observations were similar in one professional group) and results are compared.

Out of 50 scenarios, blood loss shown was < 500 ml in 25 and more than 500 ml (PPH) in the remaining (Fig. 7).

It was found that obstetricians, senior and junior, as well as nurses underestimated the blood loss, whereas

Fig. 5 Grading of subjective visual estimates

Table 5 Visual estimates of blood loss during LSCS, $N = 50$ (pre-training)

	Overestimate	Accurate	Underestimate
Nurses	8	21	21
Anesthetist	14	27	9
Junior obstetrician	6	24	20
Senior obstetrician	2	29	19

Estimation of blood loss during LSCS (pre- training) $N = 50$

Fig. 6 Visual estimates of blood loss during LSCS, $N = 50$

anesthetists more often either overestimated or were near accurate. Alarming, the simulated scenarios of PPH were more often underestimated.

The same observers were trained with the module we designed, and the observations were repeated after training.

Post-Training Observations Group B (LSCS)

We observed significant improvement in the accurate estimations in all the groups indicating the impact of training. Interestingly, previous clinical experience did not matter much (Table 6; Fig. 8).

Discussion

Postpartum hemorrhage is an important cause of maternal mortality, especially in developing countries, and many cases are preventable [1]. Visual estimates of blood loss are inaccurate (mostly underestimated) resulting in disastrous complications [2]. Hence, it is essential to have objective tools to assess exact blood loss.

We were motivated to perform this study to analyze the visual assessment of blood loss by different professional groups of our institute. The clot conversion factor was our objective tool.

In our study, we found that there is a tendency to underestimate among the various professional groups. Age and professional experience did not influence the magnitude of estimate error, but the professional group estimates differed. It was found that obstetricians, senior and junior, as well as nurses underestimated the blood loss, whereas anesthetists more often either overestimated or were near accurate. Our capability to estimate lost blood volumes is more influenced by our professional group than by our professional experience.

Fig. 7 Visual assessment of blood loss during simulated scenarios comparison with different volumes

Table 6 Visual estimates of blood loss during LSCS, $N = 50$ (post-training)

	Overestimate	Accurate	Underestimate
Nurses	3	41	6
Anesthetist	6	39	5
Junior obstetrician	6	35	9
Senior obstetrician	2	44	4

Fig. 8 Visual estimates of blood loss during LSCS, $N = 50$

Also, the error in estimating the blood loss volume was dependent on the ABL. Visual estimates were especially inaccurate in PPH simulated scenarios, where it was grossly underestimated.

Schorn [4], in his article, Measurement of blood loss: review of the literature, January 2010, reviewed different methods used to measure blood loss during delivery. He concluded that visual estimation of blood loss is so inaccurate that its continued use in practice is questionable and it should not be used in research to evaluate treatment. A combination of direct measurement and gravimetric methods are most practical. Photometry is the most precise method, but also the most expensive and complex to use.

A variety of miscellaneous methods are presented, but none is a practical or reliable method [4].

Bose et al. [5], in their article Improving the accuracy of EBL at obstetric hemorrhage using clinical reconstructions, described an observational study to determine discrepancy between ABL and EBL. They found that significant underestimation of the ABL occurred.

Yoong et al. [6] did a prospective, single-blinded observational study to evaluate the observer accuracy and intra-observer test–retest reliability of visual estimation of blood loss by midwives and obstetricians. They concluded that visual estimations were inaccurate by healthcare professionals who have a tendency to overestimate. Experience did not appear to have a confounding effect on accuracy.

This was the only study we found in the literature where the blood volume lost was overestimated by the observers.

Al Kadri et al. [7] did a study in which 223 healthcare providers assessed 30 different simulated blood loss stations before and after educational sessions on how to visually estimate blood loss. Like our study, they found that the participants significantly underestimated postpartum blood loss. The overall results were not affected by the participant's clinical background or years of experience. They also concluded that simple educational programs can improve underestimation of blood loss.

In our study, we also found that error in estimation of blood loss was lesser when blood was collected on plastic drapes and minimum blood was allowed to be soaked on linen or spilled on the floor.

In a study conducted by Toledo et al. [8], “The accuracy of blood loss estimation after simulated vaginal delivery,” subjects were randomized to estimate simulated blood loss in calibrated or non-calibrated vaginal delivery drapes and then crossover. Visual blood loss estimation with non-calibrated drapes underestimated blood loss, with worsening accuracy at larger volumes. The calibrated drape error was acceptable at all volumes (Fig. 9).

Fig. 9 Calibrated drapes

Another study was conducted by Patel et al. [9], “Drape estimation versus visual assessment for estimating postpartum hemorrhage.” A randomized controlled study was performed with 123 women delivered at the District Hospital, Belgaum, India. The women were randomized to visual or drape estimation of blood loss. The visual estimate of blood loss was 33 % less than the drape estimate. They concluded that drape estimation of blood loss is more accurate than visual estimation and may have particular utility in the developing world.

There are a few recent studies that show training in visual estimation is necessary in order to improve accuracy in visual estimation of postpartum blood loss [10–12].

After a detailed search of literature, we did not find any studies on clot conversion factor, which has proven to be a useful tool in assessment of blood loss in critical situations.

Clot conversion factor is actually a measure of inverse of density.

However, it requires further studies for evaluation before clinically used.

Conclusion and Recommendations

We as obstetricians have a duty on our shoulders to ensure a safe delivery for both mother and the child. Prevention of PPH and its timely management goes a long way in reducing the preventable maternal morbidities and mortalities.

Experienced faculty and students demonstrate similar errors in assessment of blood loss, and both can be improved significantly with limited instructions. This educational process may assist clinicians in everyday practice to more accurately estimate blood loss and recognize patients at risk for hemorrhage-related complications as well as prevent risk of over transfusion.

Recommendations

1. Every new medical healthcare professional posted in labor room unit should undergo training for visual assessment of blood loss before joining. Training module should be designed by showing pictures of blood-soaked drapes, sponges, containers, kidney trays and floor spills, etc., as described above.
2. Educative charts regarding visual assessment of blood loss should be displayed in the labor room and operation theater.
3. Calibrated non-absorbent drapes must be used on labor table as absorbent drapes soak the blood and hamper the accurate assessment of blood loss. If these are not available, then use of a plastic drape, V-folded, draining into measuring jar is recommended.
4. Ready reckoner of clot conversion factor, for calculating ABL depending on the weight of clot and hemoglobin of the patient, should be displayed in every labor room for handy use in emergency situations (Table 4).
5. In low resource settings, where use of measuring jar is not possible, simple tool of measurement like a standard size cotton cloth/linen can be used. Standard size linen which gets completely soaked with 500 ml of blood should be made available in these settings. Birth attendant should be trained and instructed to take action when blood soakage exceeds the standard limit. Pictures of standardized linen soaked with blood (500 ml) can be displayed in such settings for reference.

Clot conversion factor is an important tool for assessment of blood loss particularly in situations like abruption placenta, ectopic pregnancy, etc., where the blood is lost as clots and it is very often underestimated.

Each hospital must take into account the resources available within its own institution and community to design a protocol that will assist them in the optimal assessment of obstetrical hemorrhage. Each institution is encouraged to review its existing policy and protocols and modify them as recommended in this study.

Compliance with Ethical Standards

Conflict of interest All the authors declared that they have no conflict of interest.

Human and Animal Rights This article does not contain any studies with human or animal subjects.

Informed Consent Informed consent was taken from the personnel participating in the training and visual estimation of discarded blood volumes.

References

1. Khan KS, Wojdyla D, Say L, et al. WHO analysis of causes of maternal death: a systematic review. *Lancet*. 2006;367(9516):1066–74.
2. Glover P. Blood loss at delivery: how accurate is your estimation? *Aust J Midwifery*. 2003;16(2):21–4.
3. Toteja GS, Singh P, Dhillon BS, et al. Prevalence of anemia among pregnant women and adolescent girls in 16 districts of India. *Food Nutr Bull*. 2006;27(4):311–5.
4. Schorn MN. Measurement of blood loss: review of the literature. *J Midwifery Womens Health*. 2010;55(1):20–7.
5. Bose P, Regan F, Paterson-Brown S, et al. Improving the accuracy of estimated blood loss at obstetric haemorrhage using clinical reconstructions. *BJOG*. 2006;113(8):919–24.
6. Yoong W, Karavolos S, Damodaram M, et al. Observer accuracy and reproducibility of visual estimation of blood loss in obstetrics: how accurate and consistent are health-care professionals? *Arch Gynecol Obstet*. 2010;281(2):207–13.
7. Al-Kadri HM, Dahlawi H, Al Airan M, et al. Effect of education and clinical assessment on the accuracy of postpartum blood loss estimation. *BMC Pregnancy Childbirth*. 2014;14:110.
8. Toledo P, McCarthy RJ, Hewlett BJ, et al. The accuracy of blood loss estimation after simulated vaginal delivery. *Anesth Analg*. 2007;105(6):1736–40.
9. Patel A, Goudar SS, Geller SE, et al. Drape estimation vs. visual assessment for estimating postpartum hemorrhage. *Int J Gynaecol Obstet*. 2006;93(3):220–4.
10. Zuckerwise LC, Pettker CM, Illuzzi J, et al. Use of a novel visual aid to improve estimation of obstetric blood loss. *Obstet Gynecol*. 2014;123(5):982–6.
11. Cheerranichanunth P, Poolnoi P. Using blood loss pictogram for visual blood loss estimation in cesarean section. *J Med Assoc Thai*. 2012;95(4):550–6.
12. Sukprasert M, Choktanasiri W, Ayudhya NI, et al. Increase accuracy of visual estimation of blood loss from education programme. *J Med Assoc Thai*. 2006;89(Suppl. 4):S54–9.