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Comparing visual estimation and hematocrit change in the assessment of blood loss among women undergoing cesarean delivery in a tertiary facility in northern Uganda

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Robert Edilu, **Aaron Sanvu**, **James Ecuut**, **Alban Odong**, **Felix Bongomin**, **Ritah Nantale**, **Jackline Ayikoru**, **Baifa Arwinyo**, **Sande Ojara** and **Pebalo Francis Pebolo**

Abstract

Background: Cesarean section poses a fourfold risk for postpartum hemorrhage (PPH), necessitating accurate blood loss estimation to enable timely interventions. However, the conventional visual estimation method often leads to underestimation, resulting in undiagnosed PPH even in our setting, Uganda. Yet, the quantitative standard techniques remain underutilized.

Objective: We compared visual and calculated blood loss among women undergoing cesarean delivery at Gulu Regional Referral Hospital in northern Uganda.

Design: We employed a cross-sectional study design.

Methods: We enrolled pregnant women scheduled for cesarean section and determined both calculated and visually estimated blood loss. Data analysis involved using Pearson's moment correlation coefficient to compare the two methods and logistic regression to determine the factors associated with PPH.

Results: We included 105 participants, most were primigravida ($n = 100$, 43%), aged 15–24 years ($n = 100$, 52%), with term gestation ($n = 100$, 75%). The mean visual estimated blood loss (vEBL) was 235.3 ± 123.7 ml (interquartile range (IQR) 50–600 ml), while the calculated estimated blood loss (cEBL) was 435.0 ± 1328.2 ml (IQR −11,182.1–2226.7 ml). Visual estimation underestimated blood loss in 90% of cases ($n = 100$), and 21% ($n = 21$) had undiagnosed PPH (>1000 ml blood loss). None of the respondents had PPH (>1000 ml blood loss) following vEBL. There was a small positive correlation between both methods (vEBL and cEBL; $r = 0.1165$; $p = 0.2482$). Women aged >35 years were 1.60 times more likely to experience PPH than their counterparts aged 25–34 years (adjusted odds ratio (AOR): 1.60; 95% CI: 1.11–2.30, $p < 0.011$). Chorioamnionitis increased the risk of PPH by 2.2 times (AOR: 2.20; 95% CI: 1.20–4.05, $p < 0.012$).

Conclusion: The visual estimation technique significantly underestimated blood loss in up to 90% of cases, particularly during emergency cesarean sections. Among the 21% of cases diagnosed with PPH based on calculated blood loss, advanced maternal age and chorioamnionitis were notable contributing factors. Routine hemoglobin and hematocrit testing in obstetric care can be effectively utilized to objectively assess blood loss, aiding in the accurate diagnosis and management of PPH. Implementing these measures, even in resource-constrained settings, can significantly reduce the morbidity and mortality associated with PPH.

Trial registration: Not applicable.

Keywords: Gulu, hemoglobin, maternal mortality, postpartum hemorrhage, Uganda, underestimation

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Correspondence to:
Robert Edilu
Department of Reproductive Health, Faculty of Medicine, Gulu University, Pece-Laroo, Gulu City, Gulu, Uganda
edilogherts@gmail.com

Aaron Sanvu
James Ecuut
Alban Odong
Jackline Ayikoru
Pebalo Francis Pebolo
Department of Reproductive Health, Faculty of Medicine, Gulu University, Gulu City, Uganda

Felix Bongomin
Department of Medical Microbiology & Immunology, Faculty of Medicine, Gulu University, Gulu, Uganda

Department of Internal Medicine, Gulu Regional Referral Hospital, Gulu, Uganda

Ritah Nantale
Department of Community and Public Health, Faculty of Health Sciences Mbale, Busitema University, Mbale, Uganda

Baifa Arwinyo
Department of Obstetrics and Gynecology, Gulu Regional Referral Hospital, Gulu, Uganda

Sande Ojara
Department of Obstetrics and Gynecology, St. Mary's Hospital Lacor, Gulu, Uganda

Introduction

Maternal mortality and morbidity persist as a threat to achieving Sustainable Development Goal 3.1.[1] Globally, an estimated 287,000 women died during and after pregnancy in 2020,[2] and sub-Saharan Africa has the highest maternal mortality ratio (MMR) at 545 deaths per 100,000 live births. Though Uganda has made efforts to reduce maternal and perinatal mortality, with MMR dropping from 336 to 189 per 100,000 live births,[3] its maternal mortality and morbidity remain unacceptably high and predominantly due to obstetric hemorrhage, particularly postpartum hemorrhage (PPH).

PPH, defined as accumulative blood loss of 500 or 1000 ml following vaginal or cesarean delivery, respectively, with or without resultant hemodynamic instability after the birth of the baby up to 6 weeks postpartum has a significant impact on low- and middle-income countries, accounting for one-third of all maternal deaths.[4–7] Obstetric surgeries such as cesarean sections (CS) carry a fourfold risk for PPH,[8,9] presenting a notable drawback.[10]

The global CS rate is projected to increase to 28.5% by the year 2030.[11] In sub-Saharan African countries, where maternal and perinatal mortality rates are high, the CS rate is lower (7.3%) than in the less and more developed countries (24.2% and 27.2%, respectively).[11,12] Despite the low population CS rate in Uganda (6%), there are massive variations in the rates with facility CS rates estimated to be 36% in 2021.[13] Furthermore, unique obstacles hinder the accurate determination of the national burden and patterns of PPH. The gross underestimation of blood loss, particularly with the reliance on unreliable visual estimations, means that PPH will continue to be a significant challenge.[14]

Traditionally, blood loss estimation during cesarean section and other obstetric surgeries relies on the visual technique which involves looking at items such as blood in containers, drapes, sponges, and mops which are used to determine blood loss at the end of the procedure by multiple observers including surgeons, anesthetists, assistants, and theatre nurses with inter-observer inaccuracies.[15,16] In most clinical settings in Uganda, this estimate is done by the surgeon with less involvement of other operating team members.[14]

However, alternative methods such as hematocrit (Hct)/hemoglobin (Hb) change, gravimetric (weighing of swabs/soiled linen), volumetric (volume of blood in canisters), and colorimetric (Triton method and graduated drapes) techniques are considered superior.[17–20] For example, Briley demonstrated the efficacy of calculating blood loss by considering hematocrit change 48 h post-blood loss, multiplying pregnancy blood volume by the percentage of blood lost.[21–24] Orzolek et al. noted that this calculated blood loss technique was accurate though their study noted not much difference in mean with visual estimated blood loss (vEBL) and calculated blood loss.[25] Atukunda et al. in a randomized control trial comparing oxytocin and misoprostol in the management of PPH at Mbarara Regional Referral Hospital also noted that calculated blood loss was superior to the weighted swabs technique which had poor sensitivity but high specificity.[4]

Despite the widespread use of hematocrit and hemoglobin measurements in maternal care, even in resource-limited settings, their application in estimating blood loss in obstetric care remains underutilized. The common use of vEBL in clinical practice, particularly in low-income countries, leads to many cases of PPH being potentially missed, significantly contributing to maternal morbidity and mortality.

In our setting, there exists a paucity of literature exploring routine estimation of blood loss and its relevance to PPH diagnosis and management; therefore, we aimed to compare visual and calculated estimated blood loss (cEBL) in assessing blood loss among women undergoing cesarean delivery at a tertiary facility in northern Uganda, hence determining cases of PPH.

Methods

Design

We conducted a cross-sectional study design utilizing quantitative approaches to determine cEBL using maternal pregnancy volume and preoperative and postoperative Hct change. This was then compared with visual estimations to determine cases of PPH in a snapshot of time. This study conforms to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) cross-sectional studies statement.[26]

Setting

Gulu regional referal hospital (GRRH) is a tertiary healthcare facility with a total annual number of deliveries of approximately 4000–4500 (from ward records). It is a public hospital that serves as a teaching hospital for Gulu University, and an internship training center for medical, nursing, midwifery, and pharmacy graduates. Recently, it has been accredited as a fellowship training center for the East Central and Southern African College of Obstetrics and Gynecology. It is a referral site for more than eight districts in northern Uganda, serving a population of approximately 2 million people. Its MMR is estimated at 122/100,000 live births, justifying its low CS rate of 14%, making it the referral hospital with the lowest CS rate in Uganda.[27]

Study variables

Dependent variables. PPH (visual or calculated blood loss greater than 1000 ml).

Independent variables. Gravidity, height, weight, American College of Obstetricians and Gynecologists (ACOG) obstetric hemorrhage risk factors (previous cesarean delivery, obesity, parity, chorioamnionitis, magnesium sulfate administration, prolonged oxytocin use, platelet count, large myomas, estimated fetal weight above 4 kg and prolonged second stage), and blood loss (visual and calculated).

Participants

Selection criteria. Women undergoing CS (both emergency and elective) at GRRH and provided informed consent during the study period were included in the study.

We excluded women who had antepartum hemorrhage (APH), those who were critically ill, or received preoperative and intraoperative/postoperative blood transfusion because these conditions could alter Hct count independent of the operation's effect. Other conditions such as anemias, pre-eclampsia, or chronic diseases that potentially affect hematocrit/hemoglobin count preoperative without affecting visual estimation were not excluded.

Sample size estimation

According to Pebalo et al.,[28] the CS rate at GRRH was estimated at 14%. Also taking into account average 4500 deliveries annually, about 630 CSs per year and hence 53 per month (Hospital records). Using the Kish and Leslie (1965) formula for sample size calculation[29]:

$$n_0 = Z^2 pq / e^2$$

where n_0 = the desired sample size; Z = critical values of normal distribution at 95%, which corresponds to 1.96; p = the proportion of the target population estimated to have undergone cesarean delivery (0.14); q = compliment of p $(1-p)$ (0.86); e = estimated margin of error 5% (0.05).

Then adjusting the finite population

$$n = \frac{n_0}{1+\{n_0 - 1|N\}}$$

n = final sample size; n_0 = desired sample size (185); N = monthly CS rate (53).

Hence, the sample size was 85 participants, but adjusting for design errors and non-response, the sample size was increased by 20% to 102.

Sampling technique. Simple random sampling was employed. Every mother prescribed CS chose a random number from our lottery box, and those who drew an even number were selected. This process was repeated until the desired sample size was achieved.

Data sources

Data collection tool. Adopted from various literature reviews,[4,9,22,23,30,31] the study tool included sections to capture pregnancy and delivery factors (gravidity, parity, height and weight, indication for CS, surgeon's qualification and vtn years of experience, vEBL, ACOG Obstetrics hemorrhage risk factors, and preoperative and postoperative Hct and Hb. The tool, available only in English, was designed in Kobo Toolbox to enable Android online–offline data collection and was administered by experienced research assistants who underwent training before starting data collection.

Data collection procedure. Participants who consented were recruited, and their height, weight, and risk factors for PPH were documented as per the ACOG risk factor tool. The first blood sample

was then collected for CBC analysis to determine preoperative hematocrit (Hct1). Participants then underwent routine CS as per their obstetric indication, from which the surgeon's estimated blood loss (vEBL) was identified from the operation notes later minus their knowledge. The Nihon Kohden 5-part hematology Analyzer (model name/number: MEK-7300) was used for analysis, employing three reagents (one hemolyzing reagent (cyanide-free), one diluent, and two detergents). Daily quality controls were performed to eliminate any analytical errors. Another sample was collected 48 h postoperatively to determine the second hematocrit count (Hct2). The cEBL was then determined using the perinatology.com equations that involved the use of maternal pregnancy volume (height and weight) and hematocrit change. A comparison of blood loss by visual and calculated methods was made across all other independent variables.

PPH was defined as any visual or calculated blood loss greater than 1000 ml and calculated blood loss was considered a standard estimation technique, any vEBL by the surgeon less than the calculated was considered underestimation and if higher it meant overestimation compared to calculated. All blood samples were collected by qualified staff (research assistant) through superficial venipuncture using a 5-ml syringe in the preoperative and postoperative rooms for samples 1 and 2, respectively. These were placed in purple top vacutainer tubes containing EDTA and transported to the laboratory for analysis within 12 h. For emergency cases, informed consent was sought during the second sample collection after the debrief (second postoperative day).

Formulas employed[22]:

- Calculated pregnancy blood volume = (0.75 ((maternal height (m)) + (maternal weight (kg))
- Percent of blood volume lost = (pre-delivery Hct − post-delivery Hct)/pre-delivery Hct.
- cEBL = calculated pregnancy blood volume × percent of blood volume lost.

Bias

All the surgeons (intern doctors, medical officers, and obstetricians) were blinded from the study to reduce bias during visual blood loss estimation and their estimate was captured from their operation notes days later.

Data management and analysis. The generated data were exported as Excel from the Kobo toolbox to enable cleaning, tallying, coding, and summarizing. Pregnancy volume, hematocrit change, and cEBL were computed in Excel and later exported to Stata version 14.1 for analysis. Descriptive statistics were run to determine the interaction between variables. Pearson's product–moment correlation was employed to compare the effectiveness of surgeons at GRRH in estimating blood loss by visual estimation compared to quantitative losses. The results were presented in tables and scatter plots.

Results

Recruitment

We screened a total of 128 mothers between June and August 2023, of this, 105 were recruited and an additional 23 were eliminated. Of the 105 recruited, 5 were cleaned off due to only 1 lab result. Of those screened out, 3 had received an intraoperative blood transfusion, 2 had APH, and 18 opted out. Figure 1 shows the participant recruitment procedure.

Participant characteristics

A total of 100 women were enrolled. More than half (52.0%) were in the 15–24 age group. The median age was 24, interquartile range 21.0–29.5 years. Most, 43.0% and 49.0%, were primigravida and nulliparous, respectively. The majority, 94.0%, had an emergency Caesarean section (C/S) and 75% had term pregnancies. Details are shown in Table 1.

Comparison of vEBL and cEBL

The mean vEBL for CS was 235.3 ± 123.7 ml with a range of 50–600 ml, while the mean cEBL was 435.0 ± 1328.2 ml with a range of −11,182.1, 2226.7 ml. Visual estimation was less than calculated (standard) EBL (underestimation) in 90% (90/100) of the participants. Details are shown in Table 2.

A Pearson product–moment correlation coefficient was computed to assess the relationship

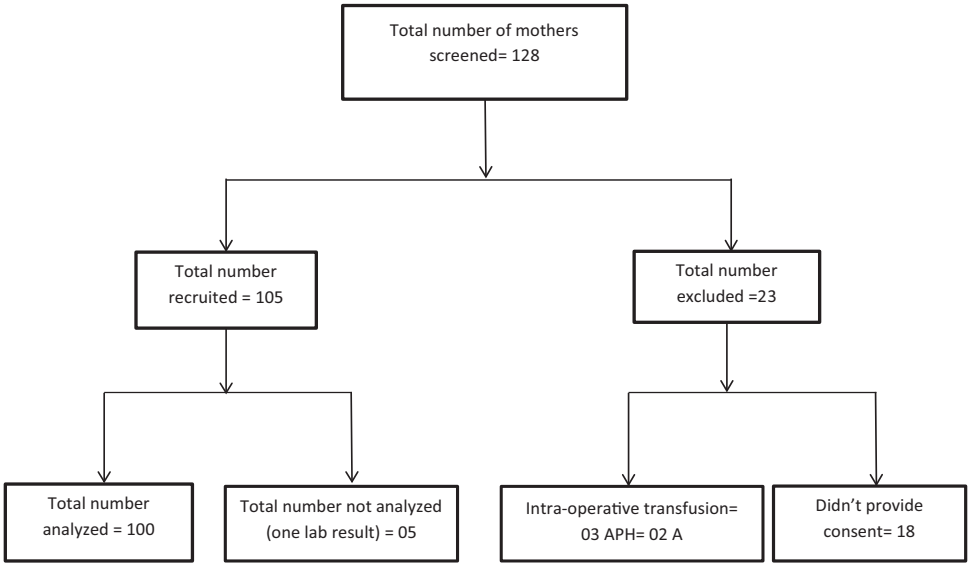

Figure 1. Consort diagram showing recruitment of participants.

between vEBL and cEBL. There was a small positive correlation between both methods ($r = 0.1165$; $p = 0.2482$) as shown in Figure 2.

PPH cases from calculated blood loss among women undergoing C/S at GRRH

A total of 21 out of 100 women (21.0%) had PPH (>1000 ml) by cEBL.

Risk factors of PPH across calculated blood loss estimation techniques among women undergoing C/S at GRRH.

Women in the age bracket above 35 years were 1.60 times more likely to have PPH compared to their counterparts between 25 and 34 years (adjusted odds ratio (AOR): 1.60; 95% CI: 1.11–2.30).

Women who had chorioamnionitis were 2.21 times more likely to have PPH as compared to those who did not have chorioamnionitis (AOR: 2.21; 95% CI: 1.20–4.05). Details are shown in Table 3.

Discussion

Our study compared visual and calculated blood loss among women undergoing cesarean delivery at a tertiary facility in northern Uganda. Most of our participants were primigravida aged 15–24 years, the majority of whom had done an emergency CS. We noted a significant underestimation of blood loss and undiagnosed PPH with only a small correlation between visual and calculated blood loss.

Despite such revealing results, the calculated blood loss utilizing the Hct change formula has potential limitations. Factors influencing hematocrit, such as dehydration, perioperative blood transfusion, and burns, could affect the accuracy of quantitative (calculated) blood loss. Elevated white blood cell and reticulocyte count might result in falsely high hematocrit values. However, we used other full blood count parameters to mitigate false elevation or decrease in Hct (Hb change). Postoperative Hct measured at least 48 h apart allowed for the redistribution of fluids and demonstrated a drop in Hct. Patients with burns and those who received blood transfusions were excluded. In addition, potential bias from the surgeon's visual estimation in the event of research was mitigated by blinding them. To address this further, combining various quantitative estimation approaches, such as weighing swabs, graduated drapes, and the triton technique, as suggested by Hancock et al., may enhance accuracy.[17,18,32] But this technique presents a feasible approach worth popularizing since a complete blood count and specifically hemoglobin estimation remains

Table 1. Characteristics of study participants.

Variable	PPH (calculated >1000 ml)		Total, *n* (%), *n* = 100
	No, *n* (%), *n* = 79	Yes, *n* (%), *n* = 21	
Age			
15–24	44 (55.7)	8 (38.1)	52 (52.0)
25–34	30 (38)	9 (42.9)	39 (39.0)
⩾35	5 (6.3)	4 (19.0)	9 (9.0)
Gravidity			
Primigravida	33 (41.8)	10 (47.6)	43 (43.0)
Multigravida (2–4)	34 (43)	7 (33.3)	41 (41.0)
Grand multigravida (>5)	12 (15.2)	4 (19)	16 (16.0)
Parity			
Nullipara	39 (49.4)	10 (47.6)	49 (49.0)
Primipara	19 (24.1)	4 (19.0)	23 (23.0)
Multipara (2–4)	17 (21.5)	5 (23.8)	22 (22.0)
Grand multipara (>5)	4 (5.1)	2 (9.5)	6 (6.0)
Gestational age at birth			
Preterm (<37 weeks)	9 (11.4)	4 (19.0)	13 (13.0)
Term (37–41)	62 (78.5)	13 (61.9)	75 (75.0)
Post-term (⩾42)	8 (10.1)	4 (19.0)	12 (12.0)
Type of cesarean delivery			
Elective C/S	6 (7.6)	0 (0.0)	6 (6.0)
Emergency C/S	73 (92.4)	21 (100)	94 (94.0)
Prior cesarean section, uterine surgery, or multiple laparotomies			
No	60 (75.9)	15 (71.4)	75 (75.0)
Yes	19 (24.1)	6 (28.6)	25 (25.0)
Multiple gestations			
No	76 (96.2)	20 (95.2)	96 (96.0)
Yes	3 (3.8)	1 (4.8)	4 (4.0)
Obesity (BMI above 40)			
No	76 (96.2)	21 (100)	97 (97.0)
Yes	3 (3.8)	0 (0.0)	3 (3.0)
Chorioamnionitis			
No	79 (100)	19 (90.5)	98 (98)
Yes	0 (0.0)	2 (9.5)	2 (2.0)

(Continued)

Table 1. (Continued)

Variable	PPH (calculated >1000 ml)		Total, *n* (%), *n* = 100
	No, *n* (%), *n* = 79	Yes, *n* (%), *n* = 21	
Magnesium sulfate administration			
No	76 (96.2)	20 (95.2)	96 (96)
Yes	3 (3.8)	1 (4.8)	4 (4.0)
Prolonged second stage			
No	74 (93.7)	19 (90.5)	93 (93)
Yes	5 (6.3)	2 (9.5)	7 (7.0)
Platelet <70,000			
No	77 (97.5)	20 (95.2)	97 (97.0)
Yes	2 (2.5)	1 (4.8)	3 (3.0)
Surgeon qualification			
Intern doctor	41 (51.9)	10 (47.6)	51 (51.0)
Medical officer	35(44.3)	10 (47.6)	45 (45.0)
Consultant obstetrician	3 (3.8)	1 (4.8)	4 (4.0)
Surgeon's years of experience			
1–5	31 (39.2)	9 (42.9)	40 (40.0)
Less than 1 year	46 (58.2)	11 (52.4)	57 (57.0)
More than 5 years	2 (2.5)	1 (4.8)	3 (3.0)
Type of anesthesia			
General	0 (0.0)	1 (4.8)	1 (1.0)
Spinal	79 (100.0)	20 (95.2)	99 (99.0)
Greater than four prior births			
No	67 (84.8)	18 (85.7)	85 (85.0)
Yes	12 (15.2)	3 (14.3)	15 (15.0)
Hct <30% and other risk factor			
No	74 (93.7)	20 (95.2)	94 (94.0)
Yes	5 (6.3)	1 (4.8)	6 (6.0)
Active bleeding			
No	79 (100.0)	20 (95.2)	99 (99.0)
Yes	0 (0.0)	1 (4.8)	1 (1.0)
Two or more medium (admission or intrapartum) risk factors			
No	72 (91.1)	19 (90.5)	91 (91.0)
Yes	7 (8.9)	2 (9.5)	9 (9.0)

BMI, body mass index; Hct, hematocrit; PPH, postpartum hemorrhage.

Table 2. Comparison of vEBL and cEBL.

Variable	Overestimation of blood loss by the surgeon, no, *n* (%), *n* = 10	Underestimation of blood loss by surgeon, yes, *n* (%), *n* = 90	Total, *n* (%), *n* = 100	*p*
Type of cesarean delivery				
Elective C/S	1 (10.0)	5 (5.6)	6 (6.0)	0.575
Emergency C/S	9 (90.0)	85 (94.6)	94 (94.0)	
Surgeon qualification				
Intern doctor	5 (50.0)	46 (30.0)	51 (51.0)	0.587
Medical officer	4 (40.0)	41 (45.6)	45 (45.0)	
Consultant obstetrician	1 (10.0)	3 (3.3)	4 (4.0)	
Surgeon's years of experience				
1–5	6 (60.0)	34 (37.8)	40 (40.0)	0.366
Less than 1 year	4 (40.0)	53 (58.9)	57 (57.0)	
More than 5 years	0 (0.0)	3 (3.3)	3 (3.0)	
Type of anesthesia				
General	0 (0.0)	1 (1.1)	1 (1.0)	0.738
Spinal	79 (100.0)	89 (98.9)	99 (99.0)	

cEBL, calculated estimated blood loss; vEBL, visual estimated blood loss.

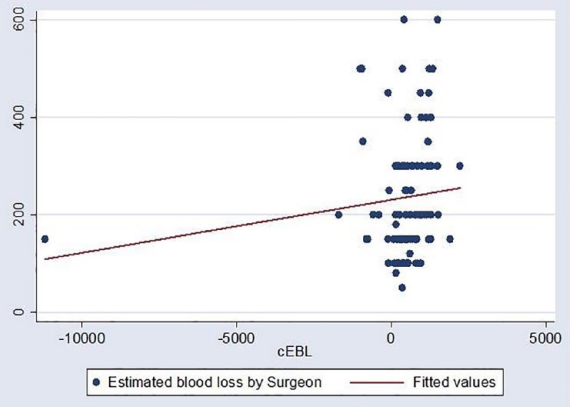

Figure 2. Relationship of vEBL and cEBL.
cEBL, calculated estimated blood loss; vEBL, visual estimated blood loss.

one of the most done investigations even in primary care providing maternal and child health services.

We observed a significant underestimation of blood loss by visual technique (in 90% of cases) compared to the calculated method, more than that in the prospective study by Sharashchandra and Shivaraj, where they reported a 50% underestimation in their setting.[23] However, they utilized both weighing of swabs and hematocrit change, and also both the surgeon and anesthetist agreed on the visual blood loss at the end of the procedure compared to ours where only the surgeon documented blood loss. In addition, in our context, emergency CS showed a higher rate of underestimation compared to the elective category, where overestimation was noted.[30] Contrary to a retrospective cohort study by Blosser et al., which indicated that age, experience, or expertise did not enhance clinicians' ability to estimate blood loss, our study found that the higher the surgeon's qualification and years of experience, the better their visual estimation, highlighting the potential influence of confounding variables.[31]

Table 3. Association between PPH and ACOG obstetric hemorrhage risk factors.

Variable	COR	95% CI	*p*	AOR	95% CI	*p*
Age						
15–24	1			1		
25–34	1.08	0.91–1.28	0.37	1.15	0.96–1.37	0.126
⩾35	1.34	1.00–1.78	0.047	1.60	1.11–2.30	0.012*
Gestational age at birth						
Preterm	1			1		
Term	0.87	0.69–1.11	0.274	0.92	0.72–1.19	0.524
Post-term	1.03	0.74–1.41	0.875	1.05	0.75–1.46	0.788
Chorioamnionitis						
No	1			1		
Yes	2.24	1.29–3.89	0.004	2.21	1.20–4.05	0.011*
Magnesium sulfate administration						
No	1			1		
Yes	1.04	0.69–1.57	0.843	1.31	0.78–2.20	0.306
Platelet <70,000						
No	1			1		
Yes	1.14	0.71–1.82	0.598	1.15	0.71–1.85	0.577
Prolonged second stage						
No	1			1		
Yes	1.08	0.79–1.49	0.613	1.16	0.84–1.60	0.374
Type of delivery						
Elective C/S	1			1		
Emergency C/S	1.25	0.89–1.75	0.193	1.22	0.85–1.75	0.284
Surgeon qualification						
Intern doctor	1			1		.
Medical officer	1.03	0.87–1.21	0.757	1.00	0.83–1.20	1.000
Consultant obstetrician	1.06	0.69–1.61	0.802	1.04	0.68–1.60	0.842
Prior cesarean section, uterine surgery, or multiple laparotomies						
No	1			1		
Yes	1.04	0.86–1.25	0.673	1.08	0.88–1.33	0.443

(Continued)

Table 3. (Continued)

Variable	COR	95% CI	*p*	AOR	95% CI	*p*
Multiple gestations						
No	1			1		.
Yes	1.04	0.69–1.57	0.843	1.14	0.74–1.74	0.553
Greater than four prior births						
No	1			1		
Yes	0.99	0.79–1.24	0.919	0.87	0.64–1.19	0.388
Obesity (BMI above 40)						
No	1			1		
Yes	0.81	0.50–1.29	0.367	0.74	0.43–1.27	0.272
Hct <30% and other risk factor						
No	1			1		
Yes	0.95	0.68–1.34	0.79	0.98	0.65–1.46	0.913
Two or more medium (admission or intrapartum) risk factors						
No	1			1		
Yes	1.01	0.76–1.34	0.926	0.82	0.54–1.23	0.334

ACOG, American College of Obstetricians and Gynecologists; AOR, adjusted odds ratio; BMI, body mass index; COR, crude odds ratio; Hct, hematocrit; PPH, postpartum hemorrhage.

Atukunda et al. documented 22.6% PPH from calculated blood loss hemoglobin drop of >10% among 1148 women enrolled in a randomized control trial comparing the effectiveness of misoprostol and oxytocin in the management of PPH, this showed a comparable result to our finding however their larger sample size and also the inclusion of vaginal deliveries compared to ours would predict high rates of PPH in our setting. It further aligns with findings from a systematic review of prognostic models for predicting PPH by Carr et al.[33] Notably, none of these participants received interventions to actively manage PPH, emphasizing the clinical dilemma of establishing a threshold for PPH management.[17,18,34–37]

Regarding the medium- or high-risk factors assessed by the Obstetric Hemorrhage Risk Factor Tool, both chorioamnionitis and advanced maternal age showed a statistical association with PPH at bivariable and multivariable analyses. These findings are consistent with retrospective cohort studies by Pubu et al.,[38] which indicated that advanced maternal age is a surrogate risk factor for PPH due to associated increased risk factors and obstetric complications. In addition, chorioamnionitis has been associated with decreased myometrial contractility during CS, leading to PPH, as observed in studies by Zackler et al. and Schwartz and Gaudet.[39,40]

Limitations of the study

This study is limited by its quantitative design; however, given the low CS rate at Gulu Regional Referral Hospital, the sample size was optimal allowing for the generalization of findings within our setting. Also, conditions that cause hematocrit change independent of operation such as APH and intraoperative or postoperative blood

transfusion, potentially affect the calculated blood loss; however, we excluded participants with such medical conditions from the study.

Conclusion

The visual estimation technique significantly underestimated blood loss in up to 90% of cases, particularly during emergency cesarean sections. Among the 21% of cases diagnosed with PPH based on calculated blood loss, advanced maternal age and chorioamnionitis were notable contributing factors. Routine hemoglobin and hematocrit testing in obstetric care can be effectively utilized to objectively assess blood loss, aiding in the accurate diagnosis and management of PPH. Implementing these measures, even in resource-constrained settings, can significantly reduce the morbidity and mortality associated with PPH.

We recommend further studies to enhance the reliability of quantitative methods, and flexible care protocols may improve measurement, diagnosis, and timely management of PPH. At the facility level, quality improvement projects can expedite better estimation of blood loss during cesarean delivery utilizing common methods like hematocrit change.

Declarations

Ethics approval and consent to participate

The study was conducted in line with the declaration of Helsinki (2008). Ethical and institutional approvals were obtained from Gulu University Research and Ethics Committee (GUREC, Protocol number: GUREC-2023-529) and Gulu Regional Referral Hospital (Correspondence-ADM/2023/05/02), respectively. All participants provided informed consent (verbal and written), and those unable to write provided a thumbprint on the consent form. Participants below 18 years provided informed consent for emancipated minors in line with GUREC guidelines. Mothers undergoing emergency C/S consented on the second postoperative day after being debriefed before the second sample for Hct determination was obtained. Research assistants were trained on the study protocol to ensure all principles of research ethics were adhered to during the course of the study. To ensure the privacy and confidentiality of participants and their information, all consent forms were kept under lock and key in a designated cupboard in the researcher's rooms. Participant identifiable information such as names were not collected.

Consent for publication

Not applicable.

Author contributions

Robert Edilu: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Supervision; Validation; Visualization; Writing – original draft; Writing – review & editing.

Aaron Sanvu: Conceptualization; Investigation; Methodology; Project administration; Supervision; Writing – original draft.

James Ecuut: Conceptualization; Data curation; Investigation; Methodology; Project administration; Supervision; Writing – original draft; Writing – review & editing.

Alban Odong: Conceptualization; Methodology; Project administration; Supervision; Writing – original draft.

Felix Bongomin: Formal analysis; Methodology; Supervision; Writing – review & editing.

Ritah Nantale: Conceptualization; Data curation; Formal analysis; Writing – original draft.

Jackline Ayikoru: Conceptualization; Data curation; Supervision; Writing – review & editing.

Baifa Arwinyo: Conceptualization; Investigation; Supervision.

Sande Ojara: Conceptualization; Writing – original draft; Writing – review & editing.

Pebalo Francis Pebolo: Conceptualization; Methodology; Project administration; Supervision; Validation; Visualization; Writing – original draft; Writing – review & editing.

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Availability of data and materials
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ORCID iDs

Robert Edilu https://orcid.org/0009-0006-2887-4596

Felix Bongomin https://orcid.org/0000-0003-4515-8517

Ritah Nantale https://orcid.org/0000-0001-8433-7054

Pebalo Francis Pebolo https://orcid.org/0000-0002-1205-1150

Supplemental material

Supplemental material for this article is available online.

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