

Immediate Postpartum Obstetric Hemorrhage: Visual Blood Loss Assessment and Correlation with Laboratory Findings

Cesar Alejandro Chávez-Jiménez¹, Francisco Javier Castro-Apodaca^{2–4}, Gloria María Peña-García⁵, Dalia Magaña-Ordorica³, Melina Rabelo-Aguilar¹, Rosa Ávila-Valdez⁴, Roberto Joel Tirado-Reyes⁶, José Héctor Carreón-Tiscareño¹, Adrián Canizalez-Román⁷, Joel Murillo-Llanes⁷, Anibal Zaldivar-Colado⁸, Nancy Godoy-Rodríguez³, Talia Gierut⁴, Debra Gierut⁴

Abstract

Objective: To determine the frequency of significant postpartum blood loss underdiagnosed by visual estimation by comparing clinical assessment with an objective laboratory criterion.

Materials and methods: A retrospective observational analytical study included women aged 16–35 years with singleton pregnancies who underwent vaginal or cesarean delivery at a hospital in Mazatlán, Mexico, between July 2023 and July 2024. Visual blood loss estimation was compared with a postpartum hemoglobin decrease ≥ 2 g/dl accompanied by a hematocrit reduction. Agreement between paired assessments was evaluated using McNemar's exact test and Cohen's kappa coefficient.

Results: Ninety-six women were included. Mean quantified blood loss was 791.15 ± 736.46 ml. Visual

estimation identified clinically significant bleeding in 33/96 women (34.4%), whereas the laboratory criterion identified 69/95 women (72.6%). Fifty were classified as negative by visual estimation but positive by laboratory assessment. McNemar's exact test demonstrated significant discordance between methods ($p = 3.02 \times 10^{-6}$). Visual estimation showed 27.5% sensitivity, 50.0% specificity, 59.4% positive predictive value, 20.6% negative predictive value, 33.7% accuracy, and poor agreement ($\kappa = -0.156$).

Conclusions: Visual estimation substantially underestimated postpartum blood loss and demonstrated poor agreement with laboratory findings. Standardized objective blood-loss assessment may improve early recognition and management of postpartum hemorrhage.

Keywords: Postpartum hemorrhage, blood loss, hemoglobin, hematocrit, visual estimation, maternal morbidity.

¹ Department of Gynecology and Obstetrics, "Dr. Martiniano Carvajal" General Hospital, Mazatlán, Sinaloa, Mexico

² Faculty of Nutritional Sciences and Gastronomy, Autonomous University of Sinaloa, Culiacán, Sinaloa, Mexico

³ Department of Urogynecology and Pelvic Reconstructive Surgery, "Fray Antonio Alcalde" Old Civil Hospital of Guadalajara, Guadalajara, Jalisco, Mexico

⁴ Department of Gynecology and Pelvic Floor Surgery, Flying Doctors of Mercy Clinic, El Fuerte, Sinaloa, Mexico

⁵ Faculty of Nursing, Autonomous University of Sinaloa, Mazatlán, Sinaloa, Mexico

⁶ Faculty of Nursing, Autonomous University of Sinaloa, Culiacán, Sinaloa, Mexico

⁷ Faculty of Medicine, Autonomous University of Sinaloa, Culiacán, Sinaloa, Mexico

⁸ Faculty of Computer Science, Autonomous University of Sinaloa, Mazatlán, Sinaloa, Mexico

Address for correspondence:

Francisco Javier Castro Apodaca, MD, BScNutr, MSc
Faculty of Nutrition and Gastronomy Sciences, Autonomous University of Sinaloa

Av. Cedros and Sauces Street, Los Fresnos, C.P. 80010, Culiacán, Sinaloa, Mexico

Email: Francisco.castroapodaca@uas.edu.mx

ORCID: 0000-0002-1857-1595

Introduction

Postpartum hemorrhage (PPH) remains the leading preventable cause of maternal morbidity and mortality worldwide, accounting for approximately 27% of all maternal deaths despite substantial advances in obstetric care. (1,2) Delayed recognition of excessive blood loss is associated with an increased risk of hemorrhagic shock, massive transfusion, emergency hysterectomy, intensive care unit admission, and maternal death. (1,3) Consequently, the World Health Organization (WHO) has identified early diagnosis and prompt management of PPH as global priorities to reduce preventable maternal mortality. (1)

Visual estimation of blood loss remains the most widely used method for diagnosing PPH because it is simple, inexpensive, and immediately available. However, considerable evidence has shown that visual estimation is highly subjective and frequently inaccurate, particularly when blood loss exceeds 500–1,000 ml. (4–6) This method tends to overestimate small blood losses while underestimating clinically significant hemorrhage, potentially delaying activation of institutional hemorrhage protocols and timely therapeutic interventions. (4,5)

To improve diagnostic accuracy, international organizations including the WHO, the International Federation of Gynecology and Obstetrics (FIGO), the American College of Obstetricians and Gynecologists (ACOG), and the Royal College of Obstetricians and Gynaecologists (RCOG) recommend objective quantification of postpartum blood loss using gravimetric, volumetric, or calibrated collection methods whenever feasible. (1,5,7,8) Although the impact of these approaches on maternal mortality remains under investigation, objective blood loss measurement has consistently demonstrated greater sensitivity for identifying clinically significant hemorrhage and facilitating earlier treatment. (5,7)

In many low- and middle-income countries, however, visual estimation continues to be the standard method because quantitative measurement tools are not routinely available. (2,3) Consequently, a substantial proportion of women may remain undiagnosed until laboratory abnormalities or clinical signs of hypovolemia become evident. Reductions in hemoglobin and hematocrit after delivery provide indirect evidence of significant blood loss and may complement clinical assessment, particularly when quantitative blood loss measurement is unavailable. (9,10)

Evidence comparing visual blood loss estimation with postpartum hematological changes remains limited in Latin America, where maternal mortality from obstetric hemorrhage continues to exceed that

observed in high-income countries. (2,3) Identifying the extent of underdiagnosis associated with visual estimation may support the implementation of standardized hemorrhage assessment protocols and improve early recognition of PPH.

Therefore, the present study aimed to determine the frequency of underdiagnosis of immediate postpartum hemorrhage associated with visual blood loss estimation by comparing the clinical assessment performed by the anesthesiology team with objective laboratory evidence of significant blood loss, defined according to the American College of Obstetricians and Gynecologists (ACOG) recommendations. We hypothesized that visual estimation alone underestimates clinically significant postpartum hemorrhage compared with laboratory assessment.

Materials and methods

Study design and setting

A retrospective observational analytical study was conducted using electronic medical records from women admitted to the Department of Gynecology and Obstetrics at "Dr. Martiniano Carvajal" General Hospital, Mazatlán, Sinaloa, Mexico, between July 2023 and July 2024.

Study population

Women aged 16–35 years with singleton pregnancies between 28 and 42 weeks of gestation who underwent vaginal delivery or cesarean section during the study period were eligible for inclusion.

Inclusion criteria

Patients were included if they had:

- Age between 16 and 35 years;
- Singleton pregnancy between 28 and 42 weeks of gestation;
- Vaginal or cesarean delivery at the study institution;
- Complete clinical records;
- Hemoglobin and hematocrit measurements obtained both before delivery and approximately 8 hours postpartum.

Exclusion criteria

Patients were excluded if they had:

- Pre-existing hematologic disorders;
- Chronic medical conditions potentially affecting hemoglobin or hematocrit values;
- Delivery performed at another institution;
- Incomplete clinical or laboratory records.

Clinical assessment of blood loss

Immediately after delivery, estimated blood loss was visually assessed by the attending anesthesiology team according to routine institutional practice. Visual estimation was based on the amount of blood collected in suction canisters and surgical drapes, together with the degree of saturation of gauzes and surgical sponges. The estimated blood loss recorded in the medical chart represented the clinical assessment used by the treating team.

Laboratory assessment

As part of the institutional obstetric protocol, a complete blood count was routinely obtained upon admission before delivery and repeated approximately eight hours after the obstetric event.

For the purposes of this study, a postpartum decrease in hemoglobin of ≥ 2 g/dL, accompanied by a corresponding reduction in hematocrit, was used as an objective indicator of clinically significant postpartum blood loss to complement routine clinical assessment. This laboratory criterion was not intended to establish the diagnosis of postpartum hemorrhage by itself but rather to identify women who may have experienced clinically significant blood loss not recognized by visual estimation.

Variables

The primary outcome was the frequency of clinically significant postpartum blood loss identified by laboratory assessment compared with routine visual estimation.

The following variables were collected from the medical records: Maternal age, number of prenatal visits, obstetric history, maternal height and body mass index, prepartum hemoglobin and hematocrit, postpartum hemoglobin and hematocrit, estimated blood loss, mode of delivery, contraceptive method selected before hospital discharge.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics version 29.0 (IBM Corp., Armonk, NY, USA). Continuous variables were evaluated for normality using the Kolmogorov-Smirnov test. Normally distributed variables are presented as mean $\pm$ standard deviation (SD), whereas non-normally distributed variables are expressed as median and interquartile range (IQR). Categorical variables are summarized as frequencies and percentages. Associations between categorical variables were evaluated using Pearson's chi-square test. Because visual estimation and laboratory assessment represented paired binary observations obtained from the same

patients, agreement between the two approaches was evaluated using McNemar's test. An exact two-sided McNemar test was used to assess differences in the proportions of patients classified as having clinically significant postpartum blood loss by each method. A two-sided p-value < 0.05 was considered statistically significant.

Ethical considerations

This study involved secondary analysis of existing electronic medical records and posed no additional risk to participants. Patient confidentiality was maintained throughout the study, and all data were anonymized before analysis. The study was reviewed and approved by the Research and Ethics Committee of "Dr. Martiniano Carvajal" General Hospital, Mazatlán, Mexico (Approval No. CEI-2024-24).

Results

A total of 96 women were included in the analysis. The mean maternal age was 23.46 ± 5.86 years, and the mean number of prenatal visits was 4.98 ± 2.92 . The mean hemoglobin concentration at admission was 11.69 ± 1.48 g/dl and decreased to 8.92 ± 2.02 g/dl after delivery, corresponding to a mean decrease of 2.77 ± 2.05 g/dl. The mean hematocrit decreased from $35.30 \pm 3.84\%$ at admission to $27.05 \pm 6.04\%$ postpartum. Mean quantified blood loss was 791.15 ± 736.46 ml. The main clinical and hematological characteristics of the study population are summarized in **Table 1**.

Visual estimation identified clinically significant postpartum bleeding in 33 of 96 women (34.4%). Quantified blood loss of ≥ 750 ml was documented in 39 women (40.6%). When the laboratory criterion was defined as a postpartum decrease in hemoglobin of ≥ 2 g/dl accompanied by a corresponding decrease in hematocrit, 69 of 95 women with complete paired hematological measurements (72.6%) met this criterion. The frequency of clinically significant blood loss according to each assessment method is presented in **Table 2**.

Because visual estimation and laboratory assessment were performed in the same women, a paired analysis was conducted. Among the 95 women with complete hematological data, 50 were classified as negative by visual estimation but positive according to the laboratory criterion, whereas 13 were classified as positive by visual estimation but negative according to the laboratory criterion. Nineteen women were positive by both methods, while 13 were negative by both methods (**Table 3**).

McNemar's exact test demonstrated a statistically significant difference between the paired assessment

methods ($p=3.02 \times 10^{-6}$) indicating significant discordance between visual estimation and the laboratory-based criterion. Using the laboratory criterion as the reference standard, visual estimation had a sensitivity of 27.5%, specificity of 50.0%, positive predictive value of 59.4%, and negative predictive value of 20.6%. Overall diagnostic accuracy was 33.7%, while Cohen's kappa coefficient was -0.156 , indicating poor agreement between the two assessment methods (Table 4).

Regarding quantified blood loss, 55 women (57.3%) had blood loss ≥ 500 ml, 39 (40.6%) had blood loss ≥ 750 ml, 29 (30.2%) had blood loss $\geq 1,000$ ml, and 11 (11.5%) had blood loss ≥ 1500 ml. Because these categories are cumulative, they represent progressively higher thresholds of quantified blood loss and should not be interpreted as mutually exclusive categories (Table 5).

Discussion

PPH remains a major cause of preventable maternal morbidity and mortality, and timely recognition is essential for initiating appropriate treatment. In the present study, we found substantial discordance between routine visual estimation of blood loss and the laboratory criterion used to identify clinically significant postpartum blood loss. (5,11) Among 95 women with complete hematological data, 72.6% met the laboratory criterion, whereas visual estimation identified only 34.4% of the total study population. Notably, 50 women were classified as negative by visual estimation but positive according to the laboratory criterion, suggesting substantial under-recognition of clinically significant blood loss.

These findings are consistent with previous evidence demonstrating the limitations of visual estimation. Visual assessment is subjective and becomes progressively less accurate as blood loss increases, with a tendency toward underestimation at higher volumes. (5,12) A prospective study comparing visual estimation with gravimetric measurement reported approximately 30% underestimation of postpartum blood loss by healthcare providers. (13) Similarly, studies using objective collection systems have demonstrated poor agreement between visual and quantitative assessments and a considerable proportion of cases of postpartum hemorrhage being missed by visual estimation. (14)

The diagnostic performance observed in our study further supports these concerns. Using the laboratory criterion as the reference, visual estimation demonstrated a sensitivity of only 27.5%, an accuracy of 33.7%, and a Cohen's kappa coefficient of -0.156 , indicating poor agreement. The statistically significant result of McNemar's exact test ($p=3.02 \times$

10^{-6}) confirms that the two approaches did not classify patients similarly. These findings are clinically relevant because failure to recognize significant blood loss may delay escalation of care, laboratory reassessment, uterotonic therapy, blood product preparation, or activation of institutional hemorrhage protocols.

The mean quantified blood loss in our cohort was 791.15 ± 736.46 ml. Furthermore, 57.3% of women had quantified blood loss ≥ 500 ml, 40.6% ≥ 750 ml, and 30.2% ≥ 1000 ml. These findings reinforce the importance of objective assessment, particularly because visual estimation becomes increasingly unreliable at higher blood-loss volumes. The American College of Obstetricians and Gynecologists has reported that quantitative methods are more accurate than visual estimation and that visual estimation tends to underestimate blood loss when volumes are high. (1) The World Health Organization similarly recommends routine objective measurement of postpartum blood loss to improve detection and prompt treatment of PPH. (15)

An important consideration is that the laboratory criterion used in this study a postpartum hemoglobin decrease ≥ 2 g/dl accompanied by a corresponding hematocrit reduction was intended as an objective indicator of clinically significant blood loss rather than as a standalone diagnostic definition of PPH. (16,17) Hemoglobin concentration after delivery may be influenced by intravenous fluid administration, timing of sampling, and physiological hemodilution. Therefore, the laboratory criterion should be interpreted as complementary evidence of blood loss rather than as an absolute reference standard. This distinction is particularly important when interpreting the sensitivity and specificity of visual estimation. (18)

The relatively low baseline hemoglobin observed in our population may also have clinical relevance. The mean hemoglobin concentration decreased from 11.69 ± 1.48 g/dl before delivery to 8.92 ± 2.02 g/dl postpartum, with a mean reduction of 2.77 ± 2.05 g/dl. (19) Although this study was not designed to evaluate anemia as a risk factor for postpartum hemorrhage or adverse outcomes, limited hematologic reserve may increase the clinical consequences of blood loss. Therefore, early recognition of bleeding is particularly important in populations in which maternal anemia may be prevalent. (20)

Our findings support the transition from subjective estimation toward standardized objective blood-loss assessment. Current international recommendations favor quantitative approaches, including calibrated collection drapes and gravimetric methods, because these approaches provide a more accurate

assessment of blood loss than visual estimation. (2,5,21) Importantly, however, greater measurement accuracy does not necessarily translate automatically into improved maternal outcomes. Evidence regarding whether quantitative blood-loss measurement alone reduces severe morbidity remains limited, emphasizing that measurement should be incorporated into broader postpartum hemorrhage recognition and treatment protocols rather than considered an isolated intervention. (2,3,22)

Conclusion

Visual estimation demonstrated poor sensitivity, low diagnostic accuracy, and poor agreement with the laboratory criterion for clinically significant postpartum blood loss. The substantial number of women with negative visual assessments but positive laboratory findings suggests that visual estimation alone may contribute to under recognition of clinically important blood loss. These findings support the incorporation of standardized objective

blood-loss assessment into postpartum hemorrhage recognition protocols, particularly in settings where timely identification of bleeding is essential. Prospective multicenter studies using standardized quantitative blood-loss measurement and clinically validated outcomes are warranted to determine whether improved recognition translates into better maternal outcomes.

To our knowledge, this is among the first studies from Mexico to demonstrate the magnitude of postpartum hemorrhage underdiagnosis associated with visual blood loss estimation using objective laboratory criteria. Adoption of standardized postpartum hemorrhage assessment protocols may facilitate earlier diagnosis, prompt therapeutic intervention, and ultimately reduce preventable maternal morbidity and severe obstetric complications.

Conflicts of interest

None of the authors have any proprietary interests or conflicts of interest related to this submission.

Table 1. Clinical and hematological characteristics of the population

Variable	Result
Women included, n	96
Maternal age (years), mean±SD	23.46±5.86
Number of antenatal visits, mean±SD	4.98±2.92
Hemoglobin on admission (g/dl), mean±SD	11.69±1.48
Postpartum hemoglobin (g/dl), mean±SD	8.92±2.02
Decreased hemoglobin (g/dl), mean±SD	2.77±2.05
Hematocrit on admission (%),mean±SD	35.30±3.84
Postpartum hematocrit (%),mean±SD	27.05±6.04
Decrease in hematocrit (%), mean±SD	8.25±5.97
Quantified blood loss (ml), mean±SD	791.15±736.46

Legend: SD=standard deviation.

Table 2. Bleeding frequency according to the different evaluation methods

Evaluation method	Positive, n (%)	Negative, n (%)	Total, n
Visual estimation	33 (34.4)	63 (65.6)	96
Quantified blood loss ≥ 750 ml	39 (40.6)	57 (59.4)	96
Decrease in Hb ≥ 2 g/dl + decrease in Hct	69 (72.6)	26 (27.4)	95

Legend: Hb=hemoglobin; Hct=hematocrit.

Table 3. Agreement between visual estimation and hematological criteria

Visual estimation	Negative hematological criteria	Positive hematological criteria	Total
Negative, n	13	50	63
Positive, n	13	19	32
Total, n	26	69	95

Table 4. Performance of visual estimation against hematological criteria

Parameter	Result
Sensitivity	27.5%
Specificity	50.0%
Positive predictive value	59.4%
Negative predictive value	20.6%
Accuracy	33.7%
κ index	-0.156
McNemar exacta	p<0.001

Table 5. Distribution of quantified blood loss

Quantified blood loss	n (%)
<500 ml	41 (42.7)
≥500 ml	55 (57.3)
≥750 ml	39 (40.6)
≥1000 ml	29 (30.2)
≥1500 ml	11 (11.5)

References

1. World Health Organization. WHO recommendations on the assessment of postpartum blood loss and use of a treatment bundle for postpartum haemorrhage [Internet]. Geneva: WHO; 2023 Dec 21.
2. Coomarasamy A, Sindhu KN, Gallos I, Periyathambi N, Price MJ, Yunas I, et al. Postpartum haemorrhage: epidemiology, consequences, and missed opportunities. *Lancet* 2026;408:62–73.
3. Bienstock JL, Eke AC, Hueppchen NA. Postpartum hemorrhage. *N Engl J Med* 2021;384:1635–45.
4. Association of Women's Health, Obstetric and Neonatal Nurses. Quantification of blood loss: AWHONN Practice Brief No. 13. *Nurs Womens Health* 2021;25:e5–7.
5. Quantitative Blood Loss in Obstetric Hemorrhage: ACOG COMMITTEE OPINION, Number 794. *Obstet Gynecol* 2019;134:e150–6.
6. Afrykańska G, Kłopecka M, Maciocha H, Wszyńska J, Włodarczyk Z, Paruszewski S, et al. Accuracy of blood loss estimation and identification of factors contributing to early postpartum hemorrhage following vaginal delivery. *J Clin Med* 2026;15:3000.
7. Begum F, Nieto-Calvache AJ, Schlembach D, Hofmyer J, Palacios-Jaraquemada J, Bhardwaj A, et al. FIGO recommendations on objective measurement of blood loss after birth for early detection of postpartum hemorrhage. *Int J Gynaecol Obstet* 2025;171:933–50.
8. Haque N, Roberts R, Kumar B. Quantification of blood loss in obstetric haemorrhage: implications on intervention and transfusion. *Obstet Gynaecol* 2023;25:165–74.
9. Girault A, Deneux-Tharaux C, Sentilhes L, Maillard F, Goffinet F. Undiagnosed abnormal postpartum blood loss: incidence and risk factors. *PLoS One* 2018;13:e0190845.
10. Barasinski C, Pranal M, Léger S, Debost-Légrand A, Vendittelli F. Change in hemoglobin was not a reliable diagnostic screening test for postpartum hemorrhage: a French prospective multicenter cohort study (HERA Study). *Healthcare (Basel)* 2023;11:1111.
11. Yunas I, Price MJ, Vigneswaran K, Tobias A, Devall AJ, Coomarasamy A. Effects of combinations of diagnostic and treatment strategies for postpartum haemorrhage: a network meta-analysis. *Cochrane Database Syst Rev* 2025;6:CD016259.
12. Schorn MN. Measurement of blood loss: review of the literature. *J Midwifery Womens Health* 2010;55:20–7.
13. Gallos I, Devall A, Martin J, Middleton L, Beeson L, Galadanci H, et al. Randomized Trial of Early Detection and Treatment of Postpartum Hemorrhage. *N Engl J Med* 2023;389:11–21.
14. Patel A, Goudar SS, Geller SE, Kodkany BS, Edlavitch SA, Wagh K, et al. Drape estimation vs. visual assessment for estimating postpartum hemorrhage. *Int J Gynaecol Obstet* 2006;93:220–4.
15. Consolidated guidelines for the prevention, diagnosis and treatment of postpartum haemorrhage [Internet]. World Health Organization; 2025 Oct 5 [cited 2026 Aug 11]. Available from: <https://www.who.int/publications/i/item/9789240115637>
16. Yefet E, Yossef A, Suleiman A, Hatokay A, Nachum Z. Hemoglobin drop following postpartum hemorrhage. *Sci Rep* 2020;10:21546.
17. Anger H, Durocher J, Dabash R, Winikoff B. How well do postpartum blood loss and common definitions of postpartum hemorrhage correlate with postpartum anemia and fall in hemoglobin? *PLoS One* 2019;14:e0221216.
18. Wang T, Li H, Liu Y, Min X. Quantitative blood loss measurement methods for early detection of primary postpartum haemorrhage following vaginal birth: A scoping review. *J Clin Nurs* 2024;33:3869–85.
19. Gallos ID, Sindhu KN, Yunas I, Sobhy S, Mavrides E, Sheikh L, et al. Prevention of postpartum haemorrhage: from evidence to implementation at scale. *Lancet* 2026;408:74–82.
20. Ubom AE, Begum F, Ramasauskaitė D, Nieto-Calvache AJ, Oguttu M, Nunes I, et al. FIGO good practice recommendations on anemia in pregnancy, to reduce the incidence and impact of postpartum hemorrhage (PPH). *Int J Gynaecol Obstet* 2025;171:993–1007.
21. Yunas I, Gallos ID, Devall AJ, Podsek M, Allotey J, Takwoingi Y, et al. Tests for diagnosis of postpartum haemorrhage at vaginal birth. *Cochrane Database Syst Rev* 2025;1:CD016134.
22. Semrau K, Litman E, Molina RL, Marx Delaney M, Choi L, Robertson L, et al. Implementation strategies for WHO guidelines to prevent, detect, and treat postpartum hemorrhage. *Cochrane Database Syst Rev* 2025;2:CD016223.