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Midwives' Perceptions of Visual Underpad Estimation of Postpartum Blood Loss and Analysis of the Need for an Objective Measurement Tool to Support Hemorrhage Diagnosis: A Qualitative Study

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ABSTRACT

Introduction: Accurate measurement of postpartum blood loss is crucial for establishing a diagnosis of postpartum hemorrhage. Current methods for measuring blood volume still rely primarily on visual estimation of the blood present on and absorbed by the underpad (a pad placed under the buttocks to absorb and retain fluid during labor). This approach is highly subjective and may lead to inter-provider variability and diagnostic bias. This study aimed to explore midwives' experiences and perceptions of visual blood loss estimation and to identify their needs and requirements for an objective, real-time blood loss measurement tool to support postpartum hemorrhage diagnosis. The study served as a needs assessment to inform the future design of an underpad equipped with a measurement scale.

Methods: This qualitative study explored midwives' experiences in managing postpartum bleeding and their perceived needs for more objective blood loss assessment across different healthcare settings, including independent midwife practices, inpatient primary health centers, and a referral hospital. Data were collected between September and October 2025 through in-depth interviews and a focus group discussion (FGD), supplemented by field notes. A qualitative thematic analysis was conducted to examine the need for an objective bleeding measurement tool to support diagnostic decision-making.

Results: Four themes emerged from the data analysis: (1) Clinical Practice and Experience in Managing Postpartum Hemorrhage; (2) Hemorrhage Estimation Methods and Perceived Accuracy; (3) Decision-Making Process in Hemorrhage Management; and (4) Expectations and Needs for Innovation in Hemorrhage Estimation. Participants reported persistent uncertainty in visual estimation and identified requirements for a new tool, including a rapid volume readout, differentiation of blood from other fluids, consistency across underpad products, and ease of use.

Conclusion: This qualitative study found that midwives across multiple levels of health facilities perceive clear limitations in the visual estimation of postpartum blood loss. Although adaptive strategies such as team verification and physician consultation are commonly used, participants reported persistent uncertainty in their estimates. These findings indicate a perceived need for an objective, real-time, and user-friendly measurement tool; such a tool will require subsequent development and validation before any improvement in postpartum hemorrhage diagnosis or clinical outcomes can be claimed.

Keywords: Postpartum Hemorrhage; Underpad; Visual Estimation; Midwives' Perceptions; Needs Assessment; Qualitative Research

INTRODUCTION

Postpartum hemorrhage (PPH) is the blood loss of 500 mL or more within 24 hours after delivery (1). PPH remains a major cause of maternal morbidity and is associated with up to a fivefold increase in the risk of death (2). An estimated 14 million women experience PPH each year, approximately 70,000 of whom die (equivalent to 1 death every 6 minutes) (3). PPH accounts for approximately 25% of maternal deaths globally (4), while in developing countries it contributes to 25%–43% of maternal deaths (5). Data from the Indonesian Ministry of Health show that maternal deaths declined from 7,389 in 2021 to 3,737 in 2025, despite a temporary increase from 3,572 in 2022 to 4,482 in 2023. In 2025, obstetric hemorrhage accounted for 889 deaths (23.8%), nearly equal to hypertensive disorders of pregnancy (890; 23.8%), making it one of the leading causes of maternal mortality in Indonesia (6).

Postpartum hemorrhage affects not only mortality but also maternal morbidity, including hemorrhagic anemia (2), Sheehan's syndrome (7–9), and, in some cases, hysterectomy during reproductive age (10–12). These outcomes can have long-term physical, psychological, and social consequences for both the mother and the family (13,14). The interventions required to manage hemorrhage are associated with longer hospital stays (15), and costs up to four times higher than those for women without PPH (16). Important contributors to maternal mortality include delays in decision-making, referral, and diagnosis (17,18). Difficulty in diagnosing hemorrhage remains a substantial problem. Delays in symptom recognition and accurate diagnosis can delay hemorrhage management (19,20). Although individual risk factors for PPH have been identified, no studies have accurately predicted the incidence of PPH (21,22).

Reducing the burden of PPH remains a challenge, and accurate measurement of blood loss is essential for the diagnosis, prevention, management, and improvement of clinical outcomes, especially in severe PPH (23–25). A recurring challenge is delayed diagnosis because accurate, real-time measurement of postpartum blood loss is not routinely available.

In Indonesia, postpartum blood loss is commonly estimated visually from blood present on and absorbed by an underpad (a pad that absorbs and holds fluid during labor). This approach provides a rapid bedside estimate that can support timely clinical assessment. However, even with training, visual estimates can vary among healthcare workers and may be influenced by several factors, including clinical experience, workload, age of the worker, and brand of the underpad. This variability can produce estimates that differ from actual blood loss, potentially delaying decision-making, diagnosis, and treatment (26). Objective, accurate, real-time blood loss measurement methods could support more timely diagnosis and hemorrhage management.

Previous studies of postpartum blood loss assessment have described several methods for evaluating PPH, particularly after vaginal delivery. The first method is spectrophotometry (27), which can quantify blood more precisely by distinguishing it from other fluids, such as amniotic fluid. Although this method can provide accurate estimates of blood loss, it is complex, costly, and inefficient, limiting its use across levels of care (27).

The second method is direct measurement using a disposable funnel-shaped plastic bag to collect blood, which is then attached to a plastic sheet and placed on the mother's buttocks (28). Blood collected in the bag is poured into a graduated cylinder and measured. This method relies on the accuracy of blood volume measurements when collected and measured directly. A limitation is that measurement is not real-time because the collected blood must be measured separately, which can delay assessment. Furthermore, the measured blood may be mixed with other fluids, such as amniotic fluid (28).

The third method is gravimetry, in which the underpad is weighed before and after exposure to blood and the difference is calculated (26,29–31). However, this method has several limitations; it cannot be used in real time, increases the workload of healthcare workers, and is not suitable for use in referral hospitals. The fourth method, which is currently widely used, especially in Indonesia, is visual estimation (30,32–35). This method relies on real-time visualization of the blood volume in the underpad, allowing for a rapid estimate of the blood volume, prompt diagnosis, and prompt treatment. Its main limitation is subjectivity: it relies on visual judgment and is prone to estimation error and interobserver variation (24,30,31,34). Compared with direct measurement, visual estimation missed two-thirds of bleeding cases (28).

In addition to these methods, Indonesian midwives monitor vital signs, including decreased blood pressure and increased heart rate, as indicators of significant blood loss (36,37). The limitations of visual estimation are already well documented in the quantitative literature (24,28,30–35). However, less is known about how midwives working at different levels of care experience these limitations in daily practice, how they compensate for them, and what they require from an objective, real-time blood loss measurement tool for it to be usable across settings. To our knowledge, limited evidence is available, particularly in Indonesia, on these cross-setting user requirements and implementation needs from the perspective of midwives working in independent midwife practices, primary health centers, and referral hospitals. This study therefore seeks to add to existing evidence by moving beyond the question of whether visual estimation is inaccurate, to describe how its perceived limitations shape clinical decision-making and which features an objective measurement tool should have. The aim of this study was to explore midwives' experiences and perceptions of visual blood loss estimation and to identify their needs and requirements for an objective, real-time blood loss measurement tool through a focus group discussion and in-depth interviews with participants from health services ranging from independent midwife practices and primary health centers to a referral hospital. The findings are intended to inform the concept design of an underpad equipped with a measuring scale, which will subsequently require development and validation.

METHODS

A qualitative approach was employed to gain an in-depth understanding of midwives' experiences of visual blood loss estimation and their perceived needs for an objective, real-time blood loss measurement tool. This design is suited to exploring experiences, perceived limitations, and desired tool characteristics; it does not assess the accuracy or validity of a measurement method, which will require separate validation studies.

Study Design

This study adopted a generic qualitative design to explore midwives' needs regarding development of a tool to support hemorrhage diagnosis. A qualitative approach was considered appropriate for capturing participants' experiences, perceptions, and preferences in depth (38). The selection of a generic qualitative design was deliberate, as the aim of this study was to explore diverse perspectives and practical needs, rather than to develop a substantive theory (as in grounded theory) or to capture lived existential meaning (as in phenomenology) (39). This flexible approach enabled the integration of diverse perspectives, perceptions of hemorrhage assessment, and needs analysis for the development of a hemorrhage assessment tool, yielding rich, contextualized insights to inform intervention design. By prioritizing thematic breadth over theory development or phenomenological depth, the chosen design ensured methodological appropriateness, conceptual coherence, and practical utility in addressing midwives' needs related to hemorrhage diagnosis. Data were analyzed thematically to identify recurring patterns and emerging insights, using the Braun and Clarke approach (40).

Research Team and Reflexivity

Data were collected by four researchers: FNR, IMP, FEC, and LR. All four are midwifery lecturers with experience in conducting qualitative research. The in-depth interviews were conducted by FNR, with LR taking field notes. The FGD was facilitated by IMP, with LR acting as note-taker and FEC managing audio recording and documentation. FNR transcribed the audio recordings verbatim in Indonesian, using TurboScribe for the initial draft, and IMP cross-checked the transcripts against the recordings. The participating practice sites had an institutional collaboration with the researchers' university; however, the researchers had no prior personal relationship with any of the individual midwives. The team acknowledged that their positions as midwifery lecturers at a partner institution and their involvement in developing an underpad-based blood loss measurement tool could influence participants' responses (for example, by encouraging socially desirable answers) as well as the questions asked and the interpretation of the data. To limit this influence, the researchers kept reflective notes after each interview and FGD and discussed their interpretations in regular meetings involving all authors.

Participants and Sampling

This study was conducted in three types of maternity care settings: independent midwife practices, inpatient primary health centers, and a referral hospital. Purposive sampling was used, in which participants were intentionally selected based on predetermined inclusion criteria to ensure that the information obtained was rich and relevant. Midwife participants worked in independent midwife practices, inpatient primary health centers, and the referral hospital. In addition, one obstetrician-gynecologist (F.1; 13 years of clinical experience) from a referral hospital was intentionally invited to the FGD as an expert, to provide specialist clinical input on blood loss estimation, the diagnosis of postpartum hemorrhage, and the proposed measurement tool, and to allow source triangulation. Midwife participants were eligible if they had at least 2 years of experience assisting with deliveries and were willing and able to participate in an in-depth interview. Midwives who did not work in the delivery room or were unwilling to be interviewed were excluded. These criteria applied to midwife participants; the obstetrician-gynecologist was selected as an expert on the basis of specialist expertise in the diagnosis and management of postpartum hemorrhage. One FGD participant (F.2) had one year of work experience and therefore did not meet the two-year criterion; she was included to fulfill the planned representation from independent midwife practice in the FGD, so that this setting was adequately represented. This deviation is acknowledged as a limitation. Sample adequacy was determined by achievement of the research objectives, data saturation, sample heterogeneity, and available resources. Data were obtained from 8 in-depth interview participants and 10 FGD participants in a single FGD session (18 participation instances). Three hospital midwives (I.6/F.4, I.7/F.3, and I.8/F.5) took part in an in-depth interview and subsequently in the FGD; the dataset therefore comprised 15 unique participants. This overlap is consistent with the complementary purposes of the two methods: the in-depth interviews explored individual experiences in depth, whereas the FGD explored shared views and allowed participants to respond to, confirm, or challenge the perspectives of midwives from other settings and of the expert. Participation in both allowed these midwives to elaborate on issues raised in their interviews in a group context, which supported method triangulation. To avoid overstating the prevalence of views, contributions from the same individual were linked through their participant codes during analysis, so that a view expressed by one person in both an interview and the FGD was counted as a single source and was not treated as independent confirmation.

Setting

The study was conducted at Independent Midwife Practices in Sleman Regency, Sleman Inpatient Primary Health Centers and PKU Muhammadiyah Gamping Hospital. All three study sites are located in Sleman Regency, Special Region of Yogyakarta, Indonesia. PKU Muhammadiyah Gamping Hospital serves as one of the referral hospitals for obstetric cases in the region.

Data Collection Instruments

Two main instruments were used in this study: a semi-structured interview guide and a focus group discussion (FGD) guide. Both instruments were developed based on a review of existing literature on the need for and analysis of bleeding assessment accuracy and refined through expert consultation with maternal health specialists and qualitative researchers. To enhance rigor (41), the guides underwent pilot testing with two midwives who were not included in the final sample. The pilot test assessed the clarity and relevance of the questions, as well as the feasibility of the data collection procedures. Feedback from the pilot test was used to revise the wording of the questions, adjust the order of the topics, and ensure that the guide encouraged open and detailed responses. The final guides consisted of open-ended questions designed to explore participants' needs, knowledge, experiences, perceived barriers, and preferences regarding blood loss measurement tools. Analytical questions were included to elicit richer descriptions and allow participants to clarify or expand their views. The guides covered the following domains: (1) experience in managing postpartum hemorrhage; (2) methods used to estimate blood loss and their perceived accuracy; (3) clinical decision-making, consultation, and documentation; (4) barriers to estimating blood loss; and (5) expectations and needs regarding a blood loss measurement tool. Questions about innovation were first asked in an open-ended way, inviting participants to describe what kind of tool would help them measure blood loss. After these spontaneous responses, the interviewer used follow-up probes to explore specific features of a potential tool, such as a volume scale on the underpad. Because some ideas were discussed in response to these probes rather than raised spontaneously, the innovation ideas reported in the Results are interpreted as participants' reactions and suggestions, not as fully independent proposals.

Data Collection

Data collection was conducted using in-depth interviews and a focus group discussion (FGD). The interviews were conducted by the research team in participants' respective workplaces at locations agreed with the participants, using a semi-structured protocol that allowed them to elaborate on issues important to them. A total of 8 in-depth interviews were conducted individually with 2 midwives working in independent midwife practices, 2 midwives from primary health centers (PHCs), and 4 midwives at referral hospitals. The in-depth interviews lasted 20–35 minutes. One focus group discussion (FGD) was held with 2 midwives from the Independent Midwife Practices, 2 midwives from the primary health centers (PHCs), 5 midwives from the hospitals, and 1 obstetrician-gynecologist who participated as an expert. The FGD was conducted in a meeting room outside the participants' workplaces. The FGD lasted approximately 90 minutes and was facilitated by IMP, with LR acting as note-taker and FEC managing audio recording and documentation. All interviews and discussions were conducted in Indonesian, audio-recorded with the participants' consent, and supplemented with field notes to capture contextual observations.

Saturation was assessed jointly across the interviews and the FGD by the first and second authors, using a saturation table that recorded the new codes generated by each successive transcript. Transcription and coding were carried out concurrently with data collection, and the FGD was conducted after the in-depth interviews had been completed. Saturation was considered reached when the last two transcripts generated no new codes relevant to the research questions. Saturation was judged across all settings combined rather than within each setting, which is acknowledged as a limitation given the small number of participants per setting.

Data were collected in September and October 2025. The FGD was facilitated by the second author (IMP) in a single session and involved a total of 10 participants: nine midwives and one obstetrician-gynecologist who participated as an expert. Because an obstetrician-gynecologist participated as an expert alongside midwives, the facilitators set ground rules emphasizing that all views were equally valued, invited midwives to respond first, directly invited quieter participants to speak, and explicitly asked for differing opinions, in order to reduce the influence of professional hierarchy on group dynamics.

Field notes were taken during the interviews and the FGD to record nonverbal cues and contextual information, and were used to support the interpretation of the transcripts. No separate structured observation of clinical practice was conducted.

Data Analysis

Data were analyzed using thematic analysis following Braun and Clarke's six-step framework (40). This approach was chosen for its flexibility in identifying, analyzing, and reporting patterns across qualitative data. The process included: (a) familiarization with the data through repeated readings of transcripts; (b) inductive initial coding of meaningful text segments; (c) searching for themes by organizing codes into potential categories; (d) reviewing and refining themes within the data set; (e) defining and naming themes to capture their essence; and (f) drafting a final report with supporting quotations. Keywords and phrases in the transcripts that related to the research questions were coded, and relevant data were collated under each code. Regular discussions involving all authors were conducted to test ideas and interpretations and identify potential biases and alternative interpretations. An initial list of codes encompassing the identified themes and subthemes was also shared and discussed with the research team to ensure that the final categories and explanations were appropriate and reflected what had been discussed during the interviews. The trustworthiness of the study was supported through a variety of strategies (41), explained in Table 1.

Coding was performed in OpenCode version 4.03 by four coders (all authors, each experienced in qualitative research). Disagreements and alternative interpretations were discussed until consensus was reached. The coding framework evolved from an initial set of inductive codes to 44 codes grouped into 11 subthemes and four themes; changes were documented in the audit trail. Interview and FGD data were coded using the same framework and then compared to identify convergent and divergent views between individual and group accounts and across facility types. Each quotation in the Results is attributed

to the single participant who spoke it. Where a similar statement was also made by another participant, this is indicated as "see also". Quotations were translated into English by the Language Development Center of Universitas Aisyiyah Yogyakarta.

Table 1. Rigor Aspects and Applied Strategies

Rigor Aspect	Applied Strategies
Credibility	Credibility was achieved through triangulation of data sources (midwives from independent midwife practices, primary health centers, and hospitals, together with expert input from one obstetrician-gynecologist) and of methods (individual interviews and an FGD), and through regular debriefing sessions with qualitative research experts. Debriefing challenged the initial coding; for example, statements about blood mixing with amniotic fluid or urine and about differences in underpad absorbency were initially coded only as sources of "doubt in estimating bleeding volume" (Theme 2). During debriefing, the experts questioned whether these statements described only uncertainty or also conditions that a new tool would have to address. After re-reading the transcripts, the team coded them separately as "external factors (urine, amniotic fluid) and variations in underpad products that influence estimates" under Theme 4.
Dependability	Dependability was supported by maintaining a clear audit trail, including coding frameworks, memos, and analytical decisions, allowing the research process to be traced.
Confirmability	Confirmability was enhanced through reflexivity, with researchers keeping reflective notes to acknowledge and minimize potential bias.
Transferability	Transferability was strengthened by providing in-depth descriptions of the research context, participant characteristics, and setting, allowing readers to assess the applicability of the findings to similar contexts.

Ethical Considerations

Ethical approval was granted by the Health Research Ethics Committee of PKU Muhammadiyah Gamping Hospital (No. 210/KEP-PKU/VII/2025), which acted as the ethics review body and one of the research sites; the research sites are described under Setting. Prior to data collection, the facilitator explained the purpose and procedures of the study and confirmed voluntary participation, and all participants provided informed consent including permission for audio recording. Participant data were anonymized, and all documentation was archived for research purposes only. Participants documented consent by signing an informed consent form.

RESULTS

The participants included midwives from independent midwife practices, primary health centers, and a hospital, as well as one obstetrician-gynecologist who participated as an expert. Participants also varied in age, education level, and clinical experience, as shown in Table 2.

Table 2. Characteristics of Participants

Participant	Workplace	Age (years)	Education	Experience (years)
FGD				
F.1	Hospital	52	Obstetrician-gynecologist	13
F.2	Independent Midwife Practice	24	Professional Midwife (Bachelor + profession program)	1
F.3	Hospital	45	Diploma in Midwifery	24
F.4	Hospital	43	Diploma in Midwifery	12
F.5	Hospital	31	Applied Bachelor in Midwifery	6
F.6	Hospital	33	Applied Bachelor in Midwifery	6
F.7	Hospital	35	Applied Bachelor in Midwifery	8
F.8	Independent Midwife Practice	35	Applied Bachelor in Midwifery	8
F.9	Primary Health Center	40	Applied Bachelor in Midwifery	20
F.10	Primary Health Center	36	Applied Bachelor in Midwifery	8
In-depth Interview				
I.1	Independent Midwife Practice	40	Professional Midwife (Bachelor + profession program)	19
I.2	Independent Midwife Practice	29	Applied Bachelor in Midwifery	7
I.3	Primary Health Center	30	Diploma in Midwifery	7
I.4	Hospital	49	Diploma in Midwifery	28
I.5	Primary Health Center	55	Master's degree in Midwifery	23
I.6	Hospital	43	Diploma in Midwifery	12
I.7	Hospital	45	Diploma in Midwifery	24
I.8	Hospital	31	Applied Bachelor in Midwifery	6

Note: I.6 and F.4, I.7 and F.3, and I.8 and F.5 are the same individuals, who participated in both an in-depth interview and the FGD (18 participation instances; 15 unique participants). F.1 participated as an expert.

The thematic analysis identified four main themes related to blood loss measurement and diagnostic decision-making: (a) Clinical Practice and Experience in Managing Postpartum Hemorrhage; (b) Hemorrhage Estimation Methods and Perceived Accuracy; (c) Decision-Making Process in Hemorrhage Management; and (d) Expectations and Needs for Innovation in Hemorrhage Estimation. These themes highlight clinical experiences of hemorrhage, challenges in hemorrhage management, and expectations and needs for improved blood loss measurement, as described in Figure 1.



Figure 1. Themes Identified in the Study

Theme 1: Clinical Practice and Experience in Managing Postpartum Hemorrhage

This theme reveals that midwives have varied experiences in managing postpartum hemorrhage, ranging from less complex cases to cases requiring referral. Midwives reported experience managing hemorrhage caused by several etiologies, ranging from uterine atony and retained placenta to lacerations of the birth canal. Participants reported that many cases could be managed on-site, whereas some required referral. *"If it was a case of a over-volume bleeding, God willing, we could have handled it early. …I referred patients if the bleeding seemed like there was still some placenta remaining"* (In-depth Interview, I.1, Midwife in Independent Practice). "I have, at that time *I had a case of uterine atony, the bleeding was around 2 underpads."* (In-depth Interview, I.3, Midwife in a PHC). Participants described collaboration with physicians, especially obstetricians, as important in managing severe cases. They also described differences in treatment capacity among health facilities (Independent Midwife Practices, Primary Health Centers, and Hospitals), reflecting disparities in resources and access to specialist services.

Collaboration with physicians, either directly or through remote consultation, was important in managing serious cases. *"Collaboration with an obstetrician and gynecologist depends on the condition. If bleeding exceeds 500 cc, the procedure includes fluid resuscitation"* (In-depth Interview, I.6, Midwife in a Hospital). Participants described consulting physicians directly or, when no physician was on standby, by telephone or by sending photographs of the underpad: "…if for example there is no one on standby, we do it by phone" (In-depth Interview, I.3, Midwife in a PHC). These accounts indicate that midwives rely on physician consultation, particularly when they are uncertain about the estimated volume. However, participants did not describe specific instances in which consultation itself caused a clinically meaningful delay, and delays in care were not observed directly in this study. The possible implications of this reliance are therefore considered in the Discussion.

Theme 2: Hemorrhage Estimation Methods and Perceived Accuracy

Underpads were used as the primary tool for visually estimating blood loss volume. Participants who discussed this method commonly described it as uncertain and subjective and expressed limited confidence in their estimates; this was a recurring view among participants from all three types of facilities rather than a view explicitly voiced by every participant. They relied on rough, nonstandardized estimates, such as "a half underpad = 500 cc," although participants acknowledged that these

estimates were inaccurate. *"Usually, you just look at the underpad, and estimate how many cc of blood there is in the underpad*" (In-depth Interview, I.3, Midwife in a PHC). "Still using underpad. *So even in DPJP, they wondered how much it was in the underpad."* (I.8, Midwife in a Hospital). Doubts arose especially when blood was mixed with amniotic fluid or urine and when different underpad brands had different absorbencies, which participants perceived as increasing the subjectivity of their estimates. *"…not yet (visual method accuracy) because it is based on estimation"* (In-depth Interview, I.2, Midwife in Independent Practice). "It's not accurate. *Later on, determining the volume of fluid that enters will be approximate."* (In-depth Interview, I.8, Midwife in a Hospital). "Yes, I often hesitate because Yes, I often hesitate because there are blood clots". (In-depth Interview, I.8, Midwife in a Hospital). These participant-reported perceptions are consistent with previous quantitative studies showing that visual estimation tends to be inaccurate and often underestimates blood loss (28,32); however, the present study did not measure estimation accuracy directly.

Theme 3: Decision-Making Process in Hemorrhage Management

Participants relied on team discussions and consultations with physicians to verify bleeding estimates and determine treatment. *"Of course, we saw it together with my partner. Actually, when we give birth, we have at least 4 hands, right?"* (In-depth Interview, I.1, Midwife in Independent Practice). "We work as a team, right? If there is bleeding, we immediately call our friends" (In-depth Interview, I.6, Midwife in a Hospital). Participants used various forms of documentation such as partographs, SOAP notes, and fluid-balance records, although the recorded volumes are still based on estimates. "*The documentation with SOAP (Subjective, Objective, Assessment, Plan) notes and partograph on the second sheet has a table, for monitoring the fourth stage of labor*." (In-depth Interview, I.3, Midwife in a PHC). Participants viewed team collaboration as helpful in reducing errors, but also noted that the recorded volumes remained estimates, which may affect the quality of documentation. Our interpretation is that uncertainty persisted despite team verification because all team members relied on the same visual method; team verification appeared to support shared judgment rather than resolve the underlying uncertainty of the estimate.

Theme 4: Expectations and Needs for Innovation in Hemorrhage Estimation

Participants from all three types of facilities expressed a need for a more objective, rapid, and easy-to-use measurement tool. They attributed this need to several external factors that influence visual estimation, such as blood mixing with urine and amniotic fluid, as well as the variety of underpad brands that also affect blood volume estimates. Many participants expressed doubts about their estimates, especially when blood is mixed with amniotic fluid or urine. *"We often wonder how much blood has come out, whether it has started bleeding or not."* (In-depth Interview, I.3, Midwife in a PHC). Different brands of underpads have different absorbency and thickness, adding to the variability of estimates. *"Sensi (an underpad brand) has maximum absorption. There are brands that, for example, if they get amniotic fluid, they float in the water, they can't be absorbed"* (In-depth Interview, I.1, Midwife in Independent Practice). Participants also stated that most facilities lacked a standardized protocol for objective blood-volume measurement. *"There is no other measuring instrument"* (In-depth Interview, I.1, Midwife in Independent Practice). "Not yet. So far, we seek confirmation from the attending physician so that we share the same perception based on the photo*."* (In-depth Interview, I.8, Midwife in a Hospital). When asked about a new tool, participants stated that it should be more objective, rapid, and easy to use. *"Yes, it's necessary, but I'm also thinking about what the equipment will be like."* (In-depth Interview, I.1, Midwife in Independent Practice). *"It's necessary, so that later we can give the fluid according to the volume that is released*." (In-depth Interview, I.8, Midwife in a Hospital). Midwives provided suggestions including scaled underpads, separate collection tools such as funnels or containers, and digital technology. *"There should be a reservoir, shaped like a funnel. The blood goes in there; the blood goes out the back*)*."* (In-depth Interview, I.1, Midwife in Independent Practice). "Underpad is given a scale *to measure blood volume, but we can also differentiate with this, amniotic fluid."* (In-depth Interview, I.5, Midwife in a PHC). *"…How many cc is the underpad in this circle, how many cc is the larger circle outside*)*"* (FGD, F.9, Midwife in a PHC; see also I.3, Midwife in a PHC)

Synthesizing these accounts, the data were translated into explicit, traceable user requirements for a new tool: (1) a rapid, real-time quantitative volume readout at the point of care; (2) differentiation of blood from amniotic fluid and urine; (3) consistent performance across underpad products with different absorbency; (4) ease of use that does not interrupt hemorrhage management; (5) a warning when a volume threshold is reached; (6) a readout that can be shared with physicians and recorded in existing documentation; and (7) complementary standardized training and protocols.

In addition to the availability of more accurate measuring tools, midwives also expressed a desire for ongoing training in visual estimation methods. Several midwives had implemented internal training initiatives to improve visual estimation skills. *"We use water with turmeric added, so the color is more visible. How much it is 100 cc, 200 cc, and 500 cc"* (In-depth Interview, I.1, Midwife in Independent Practice)

Overall, the findings describe midwives' experiences of hemorrhage management across healthcare settings, barriers to visual blood loss estimation, and requirements and ideas for improved measurement tools. Table 3 summarizes the themes.

Table 3. Themes, Subthemes, and Quotations from Interviews and the FGD

Theme	Subtheme	Interview and FGD Quotations
Clinical Practice and Experience in Managing Postpartum Hemorrhage	Direct Experience with Multiple Etiologies	*"If it was a case over-volume bleeding, God willing, we could have handled it early. …I referred the patients because the bleeding seemed like there was still some placenta remaining."* (In-depth Interview, I.1, Midwife in Independent Practice) *"I have, at that time I had a case of uterine atony, the bleeding was around 2 underpads."* (In-depth Interview, I.3, Midwife in a PHC)

Theme	Subtheme	Interview and FGD Quotations
		"Yes, I have, when I encountered cases of bleeding such as abortion and childbirth with retained placenta.... Collaboration with an obstetrician and gynecologist (Obstetrician-gynecologist) depends on the condition." (In-depth Interview, I.6, Midwife in a Hospital).
	Collaboration with other health workers	*"So far, what has been done is that if we are in doubt, we consult with the general practitioner on duty, if for example there is no one on standby, we do it by phone."* (In-depth Interview, I.3, Midwife in a PHC) *"Collaboration with an obstetrician and gynecologist (Obstetrician-gynecologist) depends on the condition. If bleeding exceeds 500 cc, the procedure includes fluid resuscitation*." (In-depth Interview, I.6, Midwife in a Hospital)
Hemorrhage Estimation Methods and Perceived Accuracy	Underpad as the Main "Measuring Tool"	*"…The calculation is usually from the underpad, a quarter of it starts to fill with blood, maybe that's the estimate, if we look at it, it's usually 250 cc. If it's still flowing and the contrast is also poor, it could be due to bleeding."* (In-depth Interview, I.2, Midwife in Independent Practice) *"Usually, we just look at the underpad, and estimate how many cc of blood there is in the underpad, ma'am."* (In-depth Interview, I.3, Midwife in a PHC) *"…*we use underpad here*."* (In-depth Interview, I.4, Midwife in a Hospital) *"We still using underpad, so the Attending Physician asked how much per underpad"* (In-depth Interview, I.8, Midwife in a Hospital) *"…That's the feeling... I use underpads, I haven't tried others yet"* (FGD, F.10, Midwife in a PHC; see also I.2, Midwife in Independent Practice)
	Doubt in estimating bleeding volume and High Subjectivity	*"…yes not yet (visual method accuracy) because it is based on estimates yes."* (In-depth Interview, I.2, Midwife in Independent Practice) *"It's not accurate. Later on, determining the volume of fluid that enters will be approximate."* (In-depth Interview, I.8, Midwife in a Hospital) *"Yes, I often hesitate because Yes, I often hesitate because there are blood clots."* (In-depth Interview, I.8, Midwife in a Hospital) *"Actually, it's not enough. If you look at the amount, it automatically means there's a valid measurement. Whether it's poured into a measuring cup or seen. As far as I know, there are people who count or weigh... But in my opinion, the service is an effort to stop the bleeding first, then we count the amount."* (In-depth Interview, I.1, Midwife in Independent Practice) *"Yes, sometimes I get confused because the colors are different, the consistency is different, so it makes me hesitate to determine the amount of bleeding*." (In-depth Interview, I.3, Midwife in a PHC)
Decision-Making Process in Hemorrhage Management	Verification Strategy Through Team and Consultation	*"Of course, we check it together with my partner. Actually, when we help giving birth, we have at least four hands, right"* (In-depth Interview, I.1, Midwife in Independent Practice) *"We work as a team. If there's bleeding, we immediately call our colleagues."* (In-depth Interview, I.6, Midwife in a Hospital) *"Now, at primary health centers and Independent Practices, we're not allowed to assist the deliveries alone. Partnering with one shift can involve 2-3 midwives."* (In-depth Interview, I.5, Midwife in a PHC) *"…then we make sure, because we have at least two midwives assisting with deliveries."*(FGD, F.9, Midwife in a PHC) "*We definitely ensure a second opinion... Because it relates to fluid requirements and the doctor's report"* (FGD, F.5, Midwife in a Hospital)
	Documentation as Part of Accountability	*"So, the bleeding is recorded in the medical record, the form, the partograph, and the birth book"* (In-depth Interview, I.1, Midwife in Independent Practice) *"It's documented with soap and a partograph in the second sheet has a table for monitoring the fourth stage of labor,"* (In-depth Interview, I.3, Midwife in a PHC) *"We use a partograph, a fluid balance observation sheet. For example, for a patient diagnosed with severe preeclampsia (patient diagnosed with severe preeclampsia), we also have a fluid balance chart, so we can see not only bleeding but also urine output. There's a monitoring sheet for that. For patients with regular Sectio Caesarea (SC) postpartums, we use the fourth stage sheet. Then, after the fourth stage, we monitor per shift. Each shift, we'll have another note in the Early Warning Score (EWS) obgyn in the Integrated Patient Progress Notes, and the graph will appear immediately"* (In-depth Interview, I.8, Midwife in a Hospital)
	Handling Priorities	*"But in my opinion, the service aims to stop the bleeding first, then we calculate the amount."* (In-depth Interview, I.1, Midwife in Independent Practice) *"We look at the patient's clinical condition, such as anemia, VBAC, blood pressure, and previous bleeding history. Vital signs such as blood pressure are sometimes not always a definitive guideline because some patients have normal blood pressure but still experience bleeding"* (In-depth Interview, I.6, Midwife in a Hospital). *"Besides estimating bleeding, to determine the cause, we also need to look at the hemoglobin level. Clinically, too. They may experience hypotension, tachycardia, and so on"* (In-depth Interview, I.7, Midwife in a Hospital) *"…have to examine the clinical features, for example, their pulse, blood pressure…"* (FGD, F.3, Midwife in a Hospital; see also I.4, Midwife in a Hospital) *"…the cc count is an estimate, but if you really want to assess the condition, check the clinical features"* (FGD, F.1, obstetrician-gynecologist, expert)
Expectations and Needs for Innovation in Hemorrhage Estimation	External factors (urine, amniotic fluid) and variations in underpad products that influence estimates	*"Sensi (an underpad brand) is more effective for absorption. There are brands that, for example, if it touches the amniotic fluid, the water floats, and it can't be absorbed"* (In-depth Interview, I.1, Midwife in Independent Practice) "*Because, for example, here, if the amniotic fluid is mixed with the amniotic fluid during labor, it's like, for example, changing the underpad immediately so it's*

Theme	Subtheme	Interview and FGD Quotations
		visible... oh, this much, it means there's already bleeding, why is it quite heavy? We've already found out what's causing the bleeding. "I just use my gut feeling." (In-depth Interview, I.2, Midwife in Independent Practice) *"We often wonder how much blood is coming out, whether it's bleeding or not"* (In-depth Interview, I.3, Midwife in a PHC) *"I'm not sure if it's actually bleeding, because sometimes it's mixed with urine."*(In-depth Interview, I.6, Midwife in a Hospital) *"I use my guesstimate...if it's accurate, during labor, if it's mixed with amniotic if it's mixed with amniotic fluid or blood clots, then subtract 500, at most, then subtract 500, at most. If it's mixed with urine, etc., but if it's full blood, 1 underpad, it's probably 1,000, but it's still an estimation" (*FGD, F.8, Midwife in Independent Practice; see also I.3, Midwife in a PHC)
	Lack of Standardization of Tools and Training	*"There's no other measuring tool."* (In-depth Interview, I.1, Midwife in Independent Practice) *"Not yet. So far, we seek confirmation from the attending physician so that we share the same perception based on the photo."* (In-depth Interview, I.8, Midwife in a Hospital) *"We use water with turmeric added, so the color is more visible. How much it is for 100 cc, 200 cc, and 500 cc…"* (In-depth Interview, I.1, Midwife in Independent Practice) "*...to confirm, we sometimes send a photo to the doctor during consultation, so the doctor can also see it from the photo." (In-depth Interview, I.6, Midwife in a Hospital)*
	The need for objective and real-time measuring instruments	"*Actually, it's not enough. If we look at the amount, there's automatically a valid measurement. Whether it's poured into a measuring cup or seen. As far as I know, there's someone who counts or weighs it*" (In-depth Interview, I.1, Midwife in Independent Practice) *"Yes, it's necessary, but I'm also thinking about what the equipment is like"* (In-depth Interview, I.1, Midwife in Independent Practice) *"It's necessary, so that we can administer the fluid according to the volume released…"* (In-depth Interview, I.8, Midwife in a Hospital)
	Innovation Ideas from Midwives	*"...There should be a reservoir, shaped like a funnel. The blood goes in there, and the blood goes out the back."* (In-depth Interview, I.1, Midwife in Independent Practice) *"The underpad is given a scale to measure blood volume, but it can also differentiate with this, amniotic fluid."* (In-depth Interview, I.5, Midwife in a PHC) *"…I hope there's a circle on the underpad with a number of ccs marked. This circle could be 250, this circle 300. It could be like that, but sometimes it shifts to the other side)"* (In-depth Interview, I.6, Midwife in a Hospital) *"I expected that there's a measuring tool underneath the delivery pad. I mean, the blood will flow. I want the blood to enter the pad, and then there's a cc reading. Oh, it's flowing, and then there's writing like 100 cc, 100 cc, 100 cc... Or else there's writing on the underpad, for example, if the patient's blood is how many cm from here to here, that's 200 cc. For example, up to 10 cm in front, that's 1000 cc."* (FGD, F.3, Midwife in a Hospital) *"…how many cc is the underpad in this circle, and how many cc is the larger circle outside it..."* (FGD, F.9, Midwife in a PHC; see also I.3, Midwife in a PHC) *"…for example, how many cc can change color, or there's a warning like that, ma'am"* (FGD, F.2, Midwife in Independent Practice; see also I.4, Midwife in a Hospital)

Each quotation is attributed to the single participant who spoke it; "see also" indicates another participant who expressed the same idea. Participant codes and facility types correspond to Table 2.

DISCUSSION

This study describes midwives' diverse experiences in managing postpartum hemorrhage (PPH) caused by etiologies such as uterine atony, retained placenta, and lacerations. Participants reported managing less complex cases on-site and referring more severe cases to an obstetrician-gynecologist (Obstetrician-gynecologist). Midwives' competence in initial PPH management is important for reducing morbidity risk. Previous research has identified three primary roles for midwives in PPH management: prevention through risk-factor identification and labor management (42); diagnosis through early detection based on clinical signs such as tachycardia, tachypnea, and hypotension, together with physical and psychological assessment (42) and estimated blood loss (43–46); and management through team coordination, emergency intervention, etiologic investigation, stimulation of uterine contractions, repair of perineal lacerations, and referral (47–49).

In this study, midwives described relying on physician consultation directly, by telephone, or by sending photographs of the underpad, particularly when uncertain about the volume of blood loss. Although delays attributable to consultation were not observed directly, previous studies suggest that such reliance, particularly where access to physicians is limited, may delay interventions critical to maternal safety. Previous studies have shown that weak interprofessional collaboration, miscommunication, lack of resources, and irregular referral systems are factors associated with an increased risk of hemorrhagic complications (24,42,50–53). High-quality communication and team coordination are important for managing obstetric emergencies (54–57). Without structured collaborative mechanisms, responses to PPH are often delayed, especially in resource-constrained primary facilities (42,51,58–60).

Strengthening the capacity of midwives as first-line providers is essential. Interprofessional simulation training has been shown to improve clinical skills and decision-making in PPH situations (61). Because participants already used informal remote consultation (telephone calls and photographs of underpads) when physicians were not on site, more structured collaboration models, such as telemedicine-supported consultation and clear referral protocols, may be worth developing and evaluating. Such approaches could improve service efficiency and help ensure that every mother receives safe, equitable, and timely care, regardless of location and health facility limitations.

Blood loss estimation in this study relied on visual assessment of underpads, using simple estimates such as "half an underpad is equivalent to ±500 cc." However, this method is considered highly subjective and prone to error because blood is often mixed with amniotic fluid or urine and the absorbency varies between underpad brands, which creates uncertainty in the assessment and can lead to underestimation or overestimation of volume. Visual estimation tends to overestimate actual blood loss when blood volume is low and underestimate blood loss when blood volume is high. Sweat, amniotic fluid, and diuresis are confounding factors in visual estimation because they can overestimate blood loss (62,63). One study (32) reported that a blood volume of almost 700 mL was overestimated by most healthcare providers. Another study (46) found that, compared with gravimetric measurements, only 5.2% of blood loss estimates were accurate with visual estimation. The rates of overestimation and underestimation reached 45.3% and 49.4%, respectively (46).

A study in China reported low visual-estimation accuracy overall (30.52%), with 25.3% of participants correctly identifying PPH at 500 mL and 18.0% correctly identifying severe PPH at 1,000 mL, respectively (44). A systematic review also reported low sensitivity of visual estimation, compared with gravimetric measurements as the standard, with a sensitivity and specificity of 48% and 97%, respectively. Compared with volumetric measurements, visual estimation had a sensitivity of 22% and a specificity of 99% (64). The low sensitivity of visual estimation may result in missed PPH cases. Previous studies have reported that as many as 52%–65.4% of PPH cases are missed due to visual estimation (28,64). Missed cases may delay treatment and increase the risk of morbidity and mortality. Inaccurate assessment of blood loss during labor and postpartum can contribute to delayed response to hemorrhage (26).

Clinical decision-making involved team verification by at least two to four midwives, together with physician consultation. Documentation is supported by the use of a partograph, SOAP notes, and fluid balance monitoring. Good clinical documentation and communication are important for reducing missed diagnoses and ensuring continuity of care (65,66). In acute situations, stopping bleeding is the top priority before more precise measurements are taken. Clinical signs such as hypotension and tachycardia were also used to complement visual assessment, consistent with WHO recommendations (67). Although teamwork provides crucial support in emergency situations, participants' accounts suggest that uncertainty in hemorrhage estimation persisted despite team verification, as all team members relied on the same subjective visual method. Previous studies have shown that visual estimation, whether conducted individually or in a team, tends to produce inaccurate estimates (28,32,68). These inaccuracies can also affect documentation quality, which can compromise clinical audits and service evaluation (69,70). Thus, from the participants' perspective, team collaboration alone did not resolve the uncertainty, and the lack of an objective measuring tool was perceived as an important, though not exclusive, gap.

Some midwives have implemented in-house training using turmeric-colored fluid as a simulation to improve the accuracy of bleeding estimates. However, they also expressed a desire for ongoing training on postpartum hemorrhage, particularly on measuring blood loss. Previous research has shown that ongoing simulation training can improve knowledge and skills related to the prevention and management of PPH (71). Midwives also emphasized the need for more objective measurement tools capable of providing real-time results, because standardized measurement methods and consistent training were limited. Participants proposed several innovations, including the development of scaled underpads, specialized collection funnels, and color-change-based digital indicators (Theme 4). Delayed detection and inadequate resuscitation can contribute to morbidity and mortality from postpartum hemorrhage, underscoring the clinical importance of improved blood loss measurement methods (72).

Interpretation of Key Findings

This study suggests that, while midwives described experience with initial PPH management, they also relied on physician consultation, which previous studies suggest may contribute to delayed intervention in resource-limited areas (24,42). A central challenge perceived by participants was the subjectivity of visual blood loss estimation, which, in their accounts, remained uncertain even when verified by a team; this perception is consistent with quantitative evidence on the limited accuracy of visual estimation (28,32,68). The absence of an objective measurement tool therefore emerged as one important gap in PPH care from the participants' perspective, alongside other system factors identified in this and previous studies, including access to physicians, referral pathways, interprofessional communication, documentation practices, and training (42,50–53,58–60). Addressing these factors together through the development and validation of real-time measurement aids, standardized protocols, and ongoing training may help support timely and safe maternal care (61,71,72).

Comparison with Previous Studies

The participants' experiences are consistent with previous quantitative studies showing that visual estimation is unreliable, frequently underestimates severe blood loss, and misses 52%–65.4% of PPH cases (28,46,64). Studies in China and elsewhere have reported substantially lower sensitivity of visual assessment compared with gravimetric or volumetric methods (44,64). The present study did not directly compare visual estimation with these reference standards; rather, the uncertainty described by midwives is consistent with these concerns. Furthermore, the findings are consistent with existing evidence that weak interprofessional communication and irregular referral systems are major systemic risks (50–53,58–60). In line with prior

literature, participants' use of in-house simulation with colored fluid and their wish for ongoing training are consistent with evidence that simulation-based training can improve clinical decision-making and emergency response (61,71).

Limitations and Cautions

This study has several limitations that need to be considered. First, the sample size is relatively small, and although it was conducted in different service settings (independent midwife practice, primary health center, and hospital), the study was conducted within the same cultural context and geographic region, thus limiting the transferability of the findings to other populations. Second, purposive sampling may have favored participants who were more experienced or more interested in the topic, so the findings may not represent the views of all midwives. Third, responses may have been influenced by social desirability and interviewer effects, because participants discussed their own clinical practice with midwifery lecturers from a university that collaborates with their practice sites and that is developing a measurement device; in addition, the FGD included an obstetrician-gynecologist as an expert, whose presence as a senior clinician may have influenced midwives' openness. Fourth, participants came from heterogeneous facility types with different resources, and the number of participants per setting was small, which limits comparisons between settings. Fifth, reflexivity was addressed through reflective notes, but the researchers' involvement in developing a measurement tool may still have influenced data collection and interpretation (see Research Team and Reflexivity). Finally, as a qualitative study, it did not directly measure or validate the accuracy of visual blood loss estimation; statements about accuracy reflect participants' perceptions. In addition, the dataset combined individual interviews and a single FGD, and three hospital midwives contributed to both, so group and individual accounts are not fully independent and hospital perspectives may carry more weight in the dataset. Because only one FGD session was held, the range of group interactions captured was limited. Saturation was judged across the whole dataset rather than within each setting, and the small number of participants per setting means that setting-specific themes may not be saturated. One FGD participant did not meet the two-year experience criterion. In addition, some innovation ideas were discussed in response to follow-up probes, which may have steered participants' suggestions toward the research team's concept of a scaled underpad. Because no criterion-standard measurement (e.g., gravimetric or volumetric) was undertaken, this study cannot draw causal or diagnostic-accuracy conclusions; its findings should be read as perceptions and needs that require confirmation through measurement and validation studies. The conclusions have been framed with these constraints in mind.

Recommendations for Future Research

Before future validation, the present findings can already be translated into a concise set of evidence-linked design and implementation requirements (Theme 4). Two requirements appeared across all three settings: a rapid quantitative volume readout and differentiation of blood from amniotic fluid and urine; these should be treated as core features of any new tool. Requirements raised mainly in specific settings should guide adaptation to context: consistent performance across underpad brands and ease of use without interrupting hemorrhage control were raised explicitly in independent midwife practice, whereas a readout that can be shared with physicians and linked to fluid-balance documentation was emphasized in hospitals and PHCs, where estimates inform physician decisions and fluid resuscitation. Threshold warnings and complementary standardized training were raised in more than one setting. From a public health and healthcare-delivery perspective, these requirements indicate that a new tool should be simple, affordable, compatible with existing underpads and documentation (partographs, fluid balance charts, and early warning scores), and usable within routine workflows at every level of care.

Future research should develop and test the validity of a simple and affordable hemorrhage measurement tool based on midwives' ideas and the requirements summarized in Theme 4, examine the effectiveness of visual estimation training with colored fluid simulations in improving clinical accuracy, and explore optimal interprofessional collaboration models for hemorrhage management in resource-limited settings. By highlighting the gap between current practice and clinical needs, this study encourages collective action from researchers, medical device developers, policymakers, and service providers to improve the quality of postpartum hemorrhage management and ultimately reduce maternal mortality.

CONCLUSION

This qualitative study found that midwives at various levels of health facilities perceive clear limitations in the visual method they use to estimate postpartum blood loss. Despite adaptive strategies such as team verification and physician consultation, participants reported persistent uncertainty in their estimates. As a needs-assessment finding, midwives expressed a need for an objective, real-time, and easy-to-use measurement tool that provides a rapid volume readout, differentiates blood from other fluids, performs consistently across underpad products, and fits into existing workflows. Such a tool will require subsequent development and validation before claims about improved diagnosis or clinical outcomes can be made.

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