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EVALUATION OF SHOCK INDEX AS A PREDICTOR OF ADVERSE OUTCOMES OF POSTPARTUM HEMORRHAGE IN A TERTIARY CARE TEACHING HOSPITAL: A CROSS-SECTIONAL STUDY

Obstetrics & Gynaecology

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ABSTRACT

Background: Postpartum hemorrhage (PPH) remains a leading cause of maternal morbidity and mortality worldwide, accounting for nearly one-quarter of maternal deaths. Despite progress in maternal health, its burden persists, especially in low- and middle-income countries. Early recognition and timely intervention are crucial, with the shock index (SI) emerging as a useful predictor of adverse outcomes. **Aim/Objectives:** To estimate the prevalence, clinical characteristics, interventions, and outcomes of PPH in a tertiary care teaching hospital and evaluate the role of SI and hemoglobin (Hb) change as predictors of adverse maternal outcomes. **Materials and Methods:** This retrospective cross-sectional study was conducted over one year (May 2024–May 2025) at a tertiary care teaching hospital. All 1,100 deliveries during the period were reviewed, and 100 cases of PPH (prevalence: 9.1%) were identified. Data on demographics, delivery mode, etiology, severity, interventions, and outcomes were extracted from records. Statistical analysis included descriptive measures, Chi-square, and correlation test. **Results:** The mean maternal age was 26.7 years; 73% of PPH cases followed cesarean delivery. Uterine atony was the leading cause (93%). Severity distribution was 58% mild, 33% moderate, and 9% severe. Medical management sufficed in 65%, while 20% required major surgery. Blood transfusion was administered in 24%. ICU admission occurred in a minority, with mortality recorded at 2%. SI and Hb change were strongly correlated ($r = 0.721$, $p < 0.001$) and significantly associated with transfusion needs and adverse outcomes. An SI threshold of ≥0.9 predicted complications, while ≥1.1 indicated need for aggressive intervention. **Conclusion:** PPH prevalence was high at 9.1%, with atony as the predominant cause. SI and Hb change proved reliable predictors of adverse outcomes. Strengthening standardized PPH bundles, blood bank preparedness, and integration of SI into routine care may further reduce morbidity and mortality.

KEYWORDS

(MeSH): Postpartum Hemorrhage; Shock Index; Blood Transfusion; Maternal Mortality; Obstetric Surgical Procedures

INTRODUCTION

Postpartum hemorrhage (PPH) continues to be a global threat and the leading cause of maternal mortality globally, accounting for approximately 25% of maternal deaths [1]. The World Health Organization (WHO) defines PPH as blood loss of more than 500 mL following vaginal birth or more than 1000 mL after cesarean section within 24 hours [2]. Despite great progress in maternal health through advocation of institutional deliveries and thorough antenatal follow up, the incidence of PPH has remained a constant threat, with recent reports suggesting prevalence rates variable worldwide depending on population and healthcare setting [3,4]. In low-income countries and developing countries with minimal to moderate health care infrastructure the impact is huge. In India the prevalence of postpartum hemorrhage is approximately 12 %.

Uterine atony, the failure of the uterus to contract effectively after delivery, accounts for the vast majority of cases [5]. Other causes include retained tissue, genital tract trauma, and coagulopathies [6]. Risk factors for PPH include prolonged labor, multiple gestations, cesarean delivery, placenta previa, induction of labour, and maternal comorbidities [7,8]. Undernourishment, anemia, teen age and unwanted pregnancies, improper ante-natal hospital visits, lack of sonological follow up are certain factors that adds up to the morbidity and mortality of the condition. Visual estimation is still the most widely used method for assessing postpartum blood loss, but it is often unreliable—tending to overestimate smaller amounts of bleeding and underestimate larger volumes. This inaccuracy can result in delayed intervention and increased morbidity related to postpartum hemorrhage. Moreover, while blood loss is usually assessed right after delivery, cumulative measurement over the first 24 hours is frequently overlooked, causing some cases of excessive bleeding to go unrecognized.

Recent years have witnessed significant advances in the understanding and management of PPH. Early recognition using clinical tools such as the shock index (SI) has been shown to predict adverse outcomes more reliably than systolic blood pressure or pulse rate alone [9,10]. Interventions have shifted towards structured care bundles that include active management of the third stage of labour, tranexamic acid (TXA) within three hours of bleeding onset, blood loss quantification, and stepwise escalation to mechanical or surgical interventions [11,12]. The WHO and FIGO guidelines emphasize the implementation of such bundles across all health systems to reduce morbidity and mortality [13,14].

Despite these advances, disparities persist in implementation, particularly in low- and middle-income countries. In such settings, delays in recognition, limited blood product availability, and lack of access to advanced interventions worsen maternal outcomes [15,16]. India, with its large obstetric population and heterogeneous health system, contributes significantly to the global burden of maternal mortality, making regional data essential for shaping local protocols [17].

This study investigates the prevalence, interventions, and outcomes of PPH in a tertiary care teaching hospital, aiming to provide insights that can help formulate better management strategies. The objectives of the study are to estimate the prevalence of PPH among all deliveries in the tertiary care teaching hospital, to describe the clinical characteristics and severity distribution of PPH cases.to document the frequency and type of interventions performed, including medical, surgical, and transfusion measures. assess maternal outcomes including ICU admission, complications, and mortality, explore associations between severity indices (such as SI and hemoglobin change) and outcomes.

MATERIALS AND METHODS

This was a retrospective cross-sectional study conducted in the Department of Obstetrics and Gynecology at a tertiary care teaching hospital for a period of one year between May 2024- May 2025. The hospital provides both primary and referral obstetric services, with a delivery load exceeding 1,000 annually.

A total of 1,100 deliveries conducted over the study period were included. Of these, 100 women were identified as experiencing PPH, giving a hospital prevalence of 9.1%. Inclusion criteria were all women diagnosed with PPH within 24 hours of delivery. Women with antepartum hemorrhage or incomplete records were excluded.

Data were extracted from institutional case records using a predesigned proforma. Variables included demographic characteristics (age, parity, gestational age) - Mode of delivery (vaginal, instrumental, cesarean), the record of blood loss estimated with calibrated drapes, suction containers used during caesarian section were appropriately noted. Etiology of PPH (atony, trauma, retained placenta, coagulopathy) was noted. Severity classification (mild, moderate, severe) was done based on estimated blood loss. Physiological indices such as vitals, shock index was recorded. Laboratory parameters such as baseline and follow-up hemoglobin when available were noted. Medical, mechanical and surgical interventions, transfusions were done appropriately. The post event outcomes like ICU admission, recovery, mortality, morbidity details were noted.

Statistical Analysis

Data were analyzed using Python (pandas, sciPy) 3.8 for IBM Statistical Package for the Social Sciences version 27. Descriptive statistics were computed. Continuous variables were expressed as mean ± standard deviation (SD). The paired t-test was applied to hemoglobin changes in women with paired values. Chi-square test was used to assess associations between severity and outcomes. A p-value <0.05 was considered significant.

RESULTS

The present study provides a comprehensive overview of the prevalence, clinical characteristics, interventions, and outcomes associated with postpartum hemorrhage (PPH) in a tertiary care teaching hospital. The prevalence and demographics derived results are as follows, out of 1,100 deliveries, 100 cases of PPH were identified, giving a prevalence of 9.1% as represented in Fig 1.

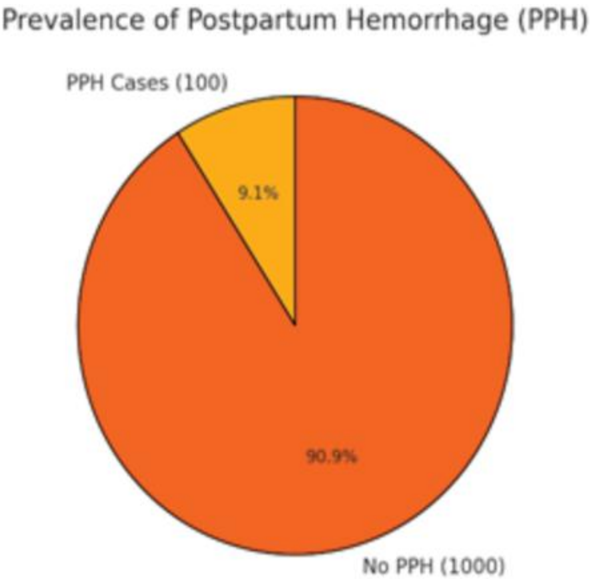

Fig 1: Prevalence of Postpartum Hemorrhage

The mean maternal age was 26.7 ± 4.82 years, and mean gestational age at delivery was 36.87 ± 3.47 weeks as presented in table 2. Multiparity was observed in 41% of cases. Amongst the PPH cases, cesarean deliveries constituted 73%, vaginal deliveries 27%. This distribution indicates a higher representation of cesarean deliveries among PPH cases.

Uterine atony accounted for 93% of cases, trauma for 6%, and mixed causes for 2%. Severity grading showed 58% mild, 33% moderate, and 9% severe PPH.

The majority of cases occurred following cesarean delivery (73%), compared to 27% after vaginal birth .This finding supports prior evidence that surgical delivery increases the risk of hemorrhage, possibly due to surgical trauma, prolonged labor preceding cesarean, or placenta-related complications. Socioeconomic distribution showed clustering in middle classes (Class II and III), but the pattern suggests that PPH can cut across all social strata.

Table 1- PPH Severity and Mode of Delivery

Variable	Category	Frequency	Percent
PPH Severity	Mild	58	58.0%
	Moderate	33	33.0%
	Severe	9	9.0%
Mode of Delivery	LSCS	73	73.0%
	Vaginal	27	27.0%

Table 2- Demographic and Baseline Data Distribution

Variable	Mean	Std. Deviation	Minimum	Maximum
Age (years)	26.74	4.82	19	43
Gestational Age (weeks)	36.87	3.47	7	40
Hospital Stay (days)	5.33	1.59	2	9
Blood Loss (mL)	746.50	598.21	150	3500
Baseline HR (bpm)	89.66	10.52	72	156
Baseline SBP (mmHg)	125.18	11.21	86	160
Shock Index (SI)	0.73	0.19	0.45	1.81

The mean gestational age was 36.9 weeks, with a wide range extending to as low as 7 weeks, suggesting inclusion of second-trimester cases with retained products or early-onset hemorrhage. The mean hospital stay was 5.3 days, but extended up to 9 days in complicated cases. Mean blood loss was 746 mL, but the wide range (150–3,500 mL) highlights variability in severity. The mean baseline heart rate was 90 bpm and systolic BP 125 mmHg, producing a mean shock index (SI) of 0.73, with some women reaching critical values up to 1.81 as depicted in Table 2.

The women with postpartum hemorrhage had some complications like previous caesarian sections with preterm birth or status post right sided salpingectomy, complete placenta previa, bicornuate uterus, cervical encerclage, intrauterine death, severe oligo and polyhydramnios, premature rupture of membrane, abruption with rupture of retroplacental clot, meconium, tobacco stained liquor, in-situ copper T, twin gestation, dense adhesions, breech presentation ,anemia and Rh negative mother.

Table 3- Type of Management for PPH

Intervention Type	n	%	Cumulative %
Medical only	65	65.0	65.0
Minor surgical	15	15.0	80.0
Major surgical	20	20.0	100.0
Blood Transfusion			
– No	76	76.0	–
– Yes	24	24.0	–

Most women (65%) were managed successfully with medical measures (uterotonics, tranexamic acid, uterine massage). Prophylactic tranexamic acid [TXA] (1 g) along with active management of the third stage of labor in reducing postpartum blood loss and the incidence of postpartum hemorrhage after vaginal delivery in 50 % of cases. TXA was administered at a fixed dose of 1 g in 10 mL (100 mg/mL) IV at 1 mL per minute (i.e., administered over 10 minutes), with a second interval dose of 1 g IV if bleeding continued post 30 minutes. However, 15% required minor surgical interventions (such as manual removal of placenta or repair of trauma), and 20% required major surgical procedures, including compression sutures, uterine artery ligation, or hysterectomy. Importantly, 24% of women received blood transfusions, reflecting the severity of blood loss in a subset of patients. This finding highlights the essential role of blood bank readiness in reducing morbidity and mortality from PPH. The interventions commonly in practice were uterotonics ± TXA. Uterine artery ligation-11%, compression sutures (B-Lynch)-6%, manual removal of placenta-2% and hysterectomy-1%. 24 % of women received transfusion support. The most common products were packed red cells and fresh frozen plasma.

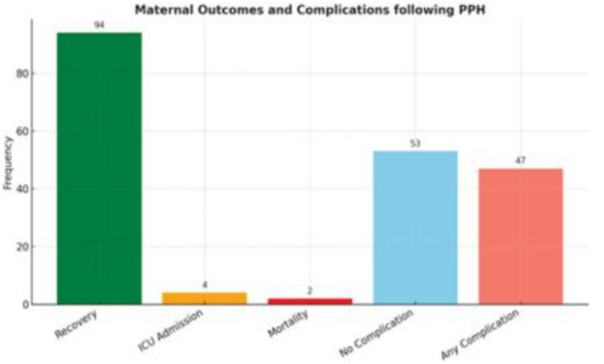

Figure 2:- Maternal Outcomes

Outcomes indicate that the majority of women recovered uneventfully. However, a subset required intensive care admission, and two maternal deaths were recorded as depicted in Figure 2. The most frequent complications seen among PPH cases were previous cesarean section (LSCS), which appears repeatedly and predisposes to scar tenderness, placenta previa, and uterine rupture risk. Placental problems such as placenta previa, abruption, and retroplacental clots are also common, often presenting with antepartum hemorrhage. Additionally, amniotic fluid abnormalities (oligohydramnios, polyhydramnios, meconium-stained liquor) are frequent, associated with fetal distress and growth restriction.

Table 4- Correlation Between Hospital Stay, Shock Index and Hemoglobin Change

Variables	Hospital Stay (days)	Shock Index (SI)	Hb Change (g/dL)
Hospital Stay (days)	1.000	0.423**	0.401**
Shock Index (SI)	0.423**	1.000	0.721**
Hb Change (g/dL)	0.401**	0.721**	1.000

The correlation matrix shows significant associations among hospital stay, SI, and hemoglobin change. Hospital stay was moderately correlated with both SI ($r = 0.423, p < 0.001$) and hemoglobin decline ($r = 0.401, p < 0.001$). This means that women with higher shock indices or greater hemoglobin drop tended to remain hospitalized longer, likely due to the need for ongoing monitoring, transfusions, or surgical recovery. SI and hemoglobin change were strongly correlated ($r = 0.721, p < 0.001$), confirming that SI is a reliable proxy for physiological derangement from blood loss.

Table 5- Severity Indices and Need for Blood Transfusion

Variable	Transfusion Group	n	Mean Rank	Mean Value	Mann–Whitney U	Z	p-value	r (effect size)
Shock Index (SI)	No	76	42.66	0.68	1082.0	–4.72	<0.001	0.47
	Yes	24	69.21	0.90				
Hb Change (g/dL)	No	75	41.11	1.51	908.5	–5.33	<0.001	0.53
	Yes	24	73.23	2.92				

This analysis compared women who did or did not receive transfusion. Those who required transfusion had significantly higher mean SI (0.90 vs 0.68, $p < 0.001$) and larger hemoglobin fall (2.9 g/dL vs 1.5 g/dL, $p < 0.001$).

Effect sizes ($r = 0.47$ and 0.53) indicate moderate to strong associations. These findings support the role of SI and hemoglobin change in predicting transfusion needs, which can guide early preparedness and timely blood requisition.

Table 6- Severity Indices and Adverse Outcome (ICU Admission/ Mortality)

Variable	Outcome Group	n	Mean Rank	Mean Value	Mann–Whitney U	Z	p-value	r (effect size)
Shock Index (SI)	Recovery	95	49.23	0.71	41.5	–3.22	0.001	0.32
	Adverse outcome	5	87.88	1.20				
Hb Change (g/dL)	Recovery	94	48.59	1.75	27.5	–3.59	<0.001	0.36
	Adverse outcome	5	92.10	3.48				

Adverse outcomes, defined as ICU admission or maternal death, were associated with markedly elevated SI (1.20 vs 0.71, $p = 0.001$) and larger hemoglobin change (3.5 g/dL vs 1.7 g/dL, $p < 0.001$). Effect sizes (0.32 and 0.36) suggest moderate predictive power. These results confirm that both SI and hemoglobin decline are strong early indicators of progression to severe morbidity and mortality. Clinically, an SI threshold of ≥0.9 may be useful for referral, while ≥1.1 could indicate the need for aggressive intervention, as supported by recent literature.

DISCUSSION

This study highlights a high prevalence of PPH (9.1%) compared to some global reports, reflecting the tertiary care referral load [2,3]. A similar study conducted in northern parts of India included 105 women with PPH for analysis and found 43.8% patients had severe PPH and required a massive blood transfusion > 4 units while 40% required intensive care. 68 patients had Shock index >0.9 while 46 patients had >1.1. The value of S.I>1.1 showed significant association with all studied adverse outcomes such as ICU admission, massive blood loss, massive blood transfusion, and need for surgical intervention (p value<0.05) [18].

In current study atony was overwhelmingly the commonest cause, in line with international evidence [5,19]. Cesarean births were disproportionately affected, echoing recent studies showing surgical deliveries carry two- to three-fold increased risk of major hemorrhage. For decades there has not been an exact demarcation to select patients with PPH for surgical intervention or otherwise. A study tried to analyze 230 patients retrospectively in two referral centers and concluded women with PPH who present with elevated lactate levels, a high shock index, and reduced body temperature may require surgical management. Prompt surgical intervention, particularly in cases of uterine atony accompanied by additional causes of hemorrhage, has the potential to improve outcomes and lower the risk of postoperative complications [20].

The universal use of transfusions underscores reliance on blood products in acute management. Literature reports significant resource challenges in many regions, where blood product shortages lead to adverse outcomes. Within this framework, quality of care (QoC) for pregnant women and newborns in health facilities depends on having skilled and motivated staff, alongside the availability of essential infrastructure and supplies. It further requires adherence to evidence-based practices for both routine and emergency management, reliable information systems that allow for proper documentation, review, and audit, and well-functioning referral pathways across different levels of care. The experiential aspect of care emphasizes three key components: effective communication so that women (and their families, when necessary) understand their condition, expectations, and rights; provision of care that upholds respect and dignity; and access to social and emotional support of their choice. [21].

In this cohort, the mortality rate of 2% is relatively low compared with historical Indian averages but aligns with outcomes reported from other tertiary care centers [22]. The mean shock index approximated 1.0, consistent with thresholds predictive of severe hemorrhage [9,10]. Recent prospective studies have validated SI as an early marker of decompensation in obstetric bleeding [23]. This emphasizes the utility of integrating SI into routine monitoring protocols. A study assessed the usefulness of the shock index (SI) as an early marker for adverse maternal outcomes and aimed to identify threshold values relevant to clinical care. SI demonstrated good performance as a screening tool for predicting complications. An SI ≥0.9 was significantly linked with adverse outcomes such as ICU admission, multi-organ dysfunction, surgical interventions, blood transfusions, and mortality. Based on these findings, the study suggests using 0.9 as a referral threshold and 1.1 as a cut-off for initiating interventions in a tertiary care setting. However, women with pregnancy-induced hypertension or eclampsia exhibited lower mean SI values compared to the rest of the cohort, indicating that SI may be less reliable in this subgroup [24].

Our findings align with recent meta-analyses showing that TXA reduces life-threatening bleeding without increasing thromboembolic events [25]. Despite WHO recommendations for its universal use, real-world adherence remains inconsistent [26]. This underscores the need for institutional protocols and simulation-based training.

The study demonstrates favorable outcomes where comprehensive bundles—including rapid transfusion protocols, uterotonics, and escalation to surgery—were available. This supports WHO and FIGO calls for structured PPH care pathways [13,14]. A multi-country study analysis of maternal and neonatal outcome suggests that even in facilities that claim readiness to deliver all key emergency obstetric interventions, variations in the occurrence of severe maternal outcomes among women with PPH continue to be observed. This underscores the importance of gaining clearer insights into how institutional capacity and the quality-of-care influence PPH-related morbidity and mortality [19].

The most common cause of PPH is uterine atony multiple other causes as observed in our study sample may contribute substantially like multiple gestation, previous LSCS amniotic fluid infection, early tissue trauma, abnormal fetal presentation, placenta previa, abruptio placenta, polyhydramnios, oligohydramnios contributing to majority equally. Prevention of such catastrophic events by uterotonics, active management of third stage of labor must be adhered to strictly. Anticipation with preventive management of antenatal anemia and minimizing blood loss during delivery, accurate assessment of symptoms and signs of PPH and prompt action may help in preventing occurrence of PPH and thereby maternal morbidity and mortality.

In women presenting with secondary postpartum hemorrhage, evaluation should include vaginal microbiology testing (high vaginal and endocervical swabs), with prompt initiation of antimicrobial therapy when endometritis is suspected. A suitable regimen consists of ampicillin (or clindamycin for those with penicillin allergy), metronidazole, and gentamicin. Once symptoms of uncomplicated endometritis resolve with intravenous antibiotics, continuing oral therapy offers no added benefit. Uterotonics may be used in cases of uterine atony. Pelvic ultrasound is recommended to rule out retained products of conception (RPOC), and surgical evacuation, if required, should be performed or closely supervised by an experienced clinician. Color Doppler imaging should also be considered in assessing the postpartum uterus, as it can aid in diagnosing uncommon but important causes of secondary PPH, such as pseudoaneurysms and arteriovenous malformations.

Strengthening adherence to standardized PPH bundles, enhancing blood bank preparedness, and promoting quantitative blood loss measurement can further reduce morbidity and mortality. Training junior clinicians in mechanical and surgical interventions may improve response time in severe cases. Taken together, the study emphasizes SI and hemoglobin change are practical, readily available markers that correlate well with transfusion needs, hospital stay, and adverse outcomes. While most women with PPH were managed successfully with medical measures, nearly one in five required major surgery and one in four required transfusion, underscoring the severity of the condition. The findings highlight the dual importance of early recognition using SI and ensuring institutional readiness with blood products and surgical expertise. The current study witnesses a prevalence of PPH viz 9.1%, in a tertiary care cohort of 1,100 deliveries with uterine atony as the leading cause. Interventions included medical therapy, surgical measures, and universal transfusion support. Despite a relatively high case load, mortality was low at 2%, reflecting effective management. Implementing standardized PPH bundles and integrating predictive tools such as shock index can optimize outcomes.

Strengths include the inclusion of all hospital cases and detailed documentation of interventions. Limitations are inherent to retrospective design, incomplete hemoglobin follow-up, and lack of long-term outcomes.

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CONCLUSION

This study reinforces the pivotal role of the shock index as a simple, reliable, and readily available tool in the early recognition of postpartum hemorrhage severity and prediction of adverse maternal outcomes. Our findings demonstrate that an SI ≥ 0.9 correlates with increased transfusion requirements and complications, while an SI ≥ 1.1 signals the need for aggressive intervention. The strong association of SI with hemoglobin change, hospital stay, ICU admission, and mortality underscores its clinical utility over conventional vital signs alone. Incorporating SI into standardized PPH management bundles can facilitate timely escalation of care, optimize resource preparedness—particularly blood bank mobilization—and ultimately reduce maternal morbidity and mortality. As a low-cost, reproducible parameter, SI holds promise for integration into both high-resource and low-resource obstetric settings to improve maternal outcomes in PPH

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