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Original Research Article

Estimation of shock index and need of blood transfusion in patients with post-partum hemorrhage: an observational study

Shyamkumar S. Sirsam, Mrunal S. Padole*, Namita N. Raut, Aparna Wahane, Gayatri M. Jawir

Department of Obstetrics and Gynecology, Government Medical College, Akola, Maharashtra, India

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***Correspondence:**
Dr. Mrunal S. Padole,
E-mail: mrunalpadole00@gmail.com

ABSTRACT

Background: Postpartum hemorrhage (PPH) is a leading cause of maternal morbidity and mortality worldwide, especially in low-resource settings. Early detection of hemodynamic instability is critical for timely intervention. The Shock Index (SI), defined as the ratio of heart rate to systolic blood pressure, may serve as a rapid bedside indicator to predict transfusion requirements in PPH.

Methods: This prospective observational study included 120 women with PPH admitted to the Department of Obstetrics and Gynaecology, Government Medical College and Hospital, Akola, Maharashtra, from March 2023 to October 2024. Serial SI measurements at 30, 60 and 120 minutes postpartum were recorded and correlated with blood transfusion requirements, clinical interventions and outcomes. Data were analysed using SPSS version 16, with $p<0.05$ considered significant.

Results: The mean SI peaked at 60 minutes (1.09±0.25). SI≥0.9 predicted transfusion need with 95% sensitivity and 60% specificity, SI≥1.1 predicted transfusion with 100% sensitivity and 93% specificity and SI≥1.3 predicted massive transfusion (>4 units) with an AUC of 0.97 (sensitivity 94%, specificity 98%). Cesarean deliveries had higher SI (1.26 vs. 0.99) and transfusion rates (88% vs. 56%) than vaginal births ($p<0.001$).

Conclusions: Shock Index is a simple, non-invasive and reliable marker for early prediction of transfusion need in PPH. Incorporating SI thresholds (≥0.9 for vigilance, ≥1.1 for intervention, ≥1.3 for critical action) into PPH protocols can improve maternal outcomes.

Keywords: Blood transfusion, Postpartum hemorrhage, Shock index

INTRODUCTION

PPH remains one of the most acute and preventable causes of maternal mortality, accounting for nearly one-quarter of maternal deaths worldwide and disproportionately affecting women in low- and middle-income countries, including India.[1,2] The rapid progression from normal childbirth to life-threatening shock underscores the need for timely recognition. While the WHO defines PPH as≥500 mL blood loss after vaginal birth or≥1000 ml following cesarean delivery, clinical deterioration often precedes these numerical thresholds.[3] Visual estimation a commonly used method may underestimate blood loss by up to 50% and early vital signs such as pulse and blood pressure often remain within normal ranges due to strong physiological compensation in pregnancy.[4,5] These limitations frequently delay critical interventions. The Shock Index (SI), calculated as heart rate divided by systolic blood pressure, offers a simple and physiologically relevant measure of early hemodynamic instability.[6] Initially applied in trauma care, SI has repeatedly demonstrated its ability to predict substantial blood loss, transfusion need and mortality.[7] Its value in

obstetrics is increasingly recognized due to its immediacy, bedside applicability and independence from laboratory testing features particularly vital in resource-constrained or high-volume maternity settings. However, pregnancy-related cardiovascular adaptations necessitate validation of SI thresholds specifically for obstetric populations.[8] Emerging evidence suggests that SI values≥0.9 may indicate early decompensation, whereas values≥1.1 often correlate with the need for prompt transfusion and advanced resuscitation.[9,10] Given that early transfusion is a major determinant of survival in PPH but is frequently delayed due to clinical uncertainty, the identification of reliable early-warning indicators becomes crucial. Against this backdrop, the present study evaluates the utility of SI in predicting transfusion requirements among women with PPH. By correlating SI patterns with transfusion needs and maternal outcomes, the study aims to refine obstetric-specific SI thresholds and strengthen timely, evidence-based decision-making in emergency obstetric care.

METHODS

This prospective observational study was conducted in the Department of Obstetrics and Gynaecology at the Government Medical College and Hospital, Akola, Maharashtra, from March 2023 to October 2024, following approval from the Institutional Ethics Committee.[11] All postpartum women who developed primary or secondary PPH, defined as blood loss ≥500 ml after vaginal delivery or≥1000 ml after cesarean section as per WHO criteria, were included. Women with hypertensive disorders, cardiac disease, sepsis, thyroid disorders or on antihypertensive treatment were excluded. A total of 120 eligible women were enrolled using universal sampling after informed consent. For each participant, demographic and obstetric details were recorded. Heart rate and systolic blood pressure were measured at 30, 60, 90 and 120 minutes postpartum and the SI was calculated as heart rate divided by systolic blood pressure. The highest SI value during observation was considered for analysis. Blood and blood product transfusion details, clinical interventions and outcomes such as ICU admission, hysterectomy and mortality were documented.

All data were entered in Microsoft Excel and analysed using SPSS version 16. Quantitative variables were expressed as mean±standard deviation and categorical variables as percentages. Correlation between SI and transfusion requirement was assessed using Pearson's correlation and receiver operating characteristic (ROC) analysis. A p value<0.05 was considered statistically significant.

RESULTS

A total of 120 postpartum women diagnosed with PPH were included in this study. The mean age was 29.4±3.0 years and the majority (40.8%) were between 28–32 years of age. Most women were primiparous or nulliparous (62.5%) and cesarean section was the predominant mode of delivery (53.3%) compared to vaginal delivery (46.7%). Primary PPH accounted for 90% of cases, while secondary PPH comprised 10%. Uterine atony was the most common cause (54.2%), followed by genital tract trauma (17.5%) and retained placental tissue (14.2%). The mean SI was highest at 60 minutes (1.09±0.25) and showed a decreasing trend by 120 minutes. The proportion of patients with SI>0.9, >1.1 and >1.3 at 60 minutes were 80%, 46% and 24%, respectively. Cesarean deliveries were associated with significantly higher mean estimated blood loss (1370 ml vs. 790 ml), higher SI (1.26 vs. 0.99) and greater transfusion requirement (88% vs. 56%) compared with vaginal births (p<0.001). Higher SI values were strongly correlated with adverse maternal outcomes. Patients with SI>1.3 had the highest rates of ICU admission (76%), hysterectomy (52%) and mortality (18%), whereas no complications occurred in patients with SI<0.9. ROC analysis demonstrated that the SI at 60 minutes was the best predictor of massive transfusion (>4 units), with an AUC=0.97, sensitivity=94% and specificity=98%. Rising SI values correlated directly with transfusion need and adverse maternal outcomes. Thresholds of SI ≥0.9, ≥1.1 and ≥1.3 effectively stratified PPH severity, transfusion requirement and critical care need.

Table 1: Distribution of study participants (n=120).

Parameter	Category	Frequency (%)
Age (in years)	24–28 / 28–32 / 32–36	37.5 / 40.8 / 21.7
Parity	0 / 1 /≥2	30.0 / 32.5 / 37.5
Mode of delivery	Vaginal / Cesarean	46.7 / 53.3
Type of PPH	Primary / Secondary	90 / 10
Major cause	Uterine atony	54.2

Table 2: Shock index distribution and blood transfusion requirement.

SI Threshold	Patients requiring transfusion (%)	Mean transfused units	Sensitivity (%)	Specificity (%)
≥ 0.9	90	3.6	95	60
≥ 1.1	100	5.3	90	93
≥ 1.3	100	8.0	75	100

Table 3: Mode of delivery and clinical outcomes.

Parameter	Vaginal (n=56)	Cesarean (n=64)	P value
Mean EBL (ml)	790	1370	<0.001
Mean SI (60 min)	0.99	1.26	<0.001
Transfusion rate (%)	56	88	<0.001

Table 4: Maternal outcomes by shock index (60 min).

SI Range	ICU admission (%)	Hysterectomy (%)	Mortality (%)
<0.9	0	0	0
0.9–1.1	14	6	0
1.1–1.3	40	20	5
>1.3	76	52	18

DISCUSSION

In this prospective observational study of 120 women with PPH, the SI was evaluated as a rapid bedside predictor of blood transfusion requirement and maternal outcomes. The findings demonstrated that SI correlated strongly with transfusion need, volume of transfused blood and adverse outcomes such as ICU admission, hysterectomy and mortality. The mean SI peaked at 60 minutes postpartum (1.09±0.25), indicating the time of maximum hemodynamic compromise. An SI ≥0.9 predicted the need for blood transfusion with 95% sensitivity, while SI ≥1.1 achieved 100% sensitivity and 93% specificity. These results are in agreement with Agarwal et al who reported similar cutoff values (SI>0.9 and>1.1) as reliable early indicators of transfusion and intensive care requirement in PPH.[12] Shen et al also observed that SI>1.0 predicted transfusion need with an area under the ROC curve (AUC) of 0.93, closely comparable to the AUC=0.97 obtained in the present study.[13] Increasing SI was associated with a stepwise rise in adverse outcomes. Women with SI>1.3 had the highest rates of ICU admission (76%), hysterectomy (52%) and mortality (18%), whereas no complications occurred among women with SI<0.9. Oglak et al similarly demonstrated that SI>1.0 significantly increased transfusion and morbidity risk.[14] Tanacan et al also reported that SI values between 0.9 and 1.3 effectively differentiated mild from severe hemorrhage, emphasizing SI's prognostic role in obstetric emergencies.[15]

In the present study cesarean deliveries were associated with significantly higher estimated blood loss (1370 ml vs. 790 ml), higher mean SI (1.26 vs. 0.99) and increased transfusion rates (88% vs. 56%) compared with vaginal deliveries (p<0.001). These findings are consistent with Dziadosz et al and Sheldon et al who found cesarean section to be a major determinant of transfusion risk and maternal morbidity in obstetric hemorrhage.[16,17] Uterine atony was the leading cause of PPH (54.2%) in this study, followed by genital tract trauma and retained placental tissue, findings that align with global data showing atony as the cause in nearly two-thirds of cases.[17] The rapid and simple calculation of SI makes it a valuable bedside tool, especially in atonic PPH where early detection of hemodynamic decompensation can guide prompt resuscitation before laboratory hemoglobin results are available. Traditional hemodynamic parameters such as blood pressure and pulse rate are often unreliable during early hemorrhage due to physiological compensation.[18] SI, being the ratio of heart rate to systolic blood pressure, integrates both parameters to reflect subtle circulatory compromise. Its non-invasive nature, simplicity and reproducibility make it particularly advantageous in low-resource settings where delay in laboratory support can hinder timely decision-making. These results are supported by the meta-analysis by El Ayadi et al and Riley et al, who found that SI is superior to individual vital signs in predicting transfusion, operative intervention and maternal morbidity.[9,19] The World Health Organization's 2023 technical brief also recognized SI as a useful early-warning indicator for PPH, recommending its integration into maternal early-warning systems to reduce preventable maternal deaths.[20] The present study has certain limitations. Being a single-center observational study, the findings may not be fully generalizable to diverse obstetric populations or different levels of healthcare facilities. SI values were recorded only during the immediate postpartum period and may not reflect dynamic changes beyond the first two hours. Laboratory parameters such as lactate levels, coagulation profile or point-of-care hemoglobin estimation which could strengthen hemodynamic assessment - were not included. Potential confounders such as analgesia, fluid administration before SI measurement or inter-observer variability in recording vital signs may also have influenced results. Additionally, the sample size, although adequate for primary analysis, may limit subgroup comparisons. Future multicentric studies with larger cohorts and integration of advanced physiological markers are required to validate and refine SI thresholds for wider clinical application.

CONCLUSION

Shock index is a simple, rapid and reliable bedside tool that effectively predicts blood transfusion requirements and adverse maternal outcomes in postpartum hemorrhage. SI

thresholds of ≥0.9, ≥1.1 and ≥1.3 demonstrate strong discriminatory ability for identifying women needing vigilance, urgent intervention and aggressive resuscitation, respectively. The strong correlation between rising SI values and increased blood loss, transfusion need, ICU admission, hysterectomy and mortality emphasizes its utility in early triage, especially in resource-limited settings where delays in laboratory support can be critical. Incorporating SI into routine PPH management protocols can enhance timely decision-making, optimize resource utilization and improve maternal outcomes.

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