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Original Research Article

Shock Index Is an Effective Predictor of Postpartum Transfusion Requirement in Normal Vaginal Deliveries

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Abstract: *Postpartum hemorrhage (PPH) remains a leading cause of maternal morbidity and mortality worldwide, particularly in low- and middle-income countries. Traditional vital signs such as heart rate and systolic blood pressure are often insufficient in early recognition of hemodynamic instability due to the physiological adaptations of pregnancy. The shock index (SI), calculated as heart rate divided by systolic blood pressure, has emerged as a promising tool for early detection of postpartum complications.* ***Objective:*** *To evaluate the effectiveness of the shock index in predicting the requirement for postpartum blood transfusion in women undergoing normal vaginal deliveries.* ***Methods:*** *This prospective observational study was conducted at Sir Ganga Ram Hospital, Lahore, from July to December 2024. A total of 240 women who underwent spontaneous vaginal delivery were enrolled. SI was calculated within 15 minutes postpartum, and patients were monitored for 24 hours to identify those requiring blood transfusion. Data were analyzed using SPSS version 26. Logistic regression was used to adjust for confounding variables including age, parity, pre-delivery hemoglobin, and estimated blood loss.* ***Results:*** *Of the 240 participants, 53 (22.1%) required postpartum blood transfusion. SI >0.9 was observed in 61 women (25.4%), of whom 41 (67.2%) required transfusion (p<0.001). Elevated SI was independently associated with transfusion need (aOR: 6.87, 95% CI: 3.32–14.22). Pre-delivery hemoglobin <10 g/dL and estimated blood loss >600 mL were also significant predictors.* ***Conclusion:*** *An elevated shock index (>0.9) is a strong and independent predictor of postpartum transfusion requirement following normal vaginal delivery. SI should be incorporated into routine postpartum monitoring protocols to enable early identification of women at risk and timely intervention.*

Keywords: Shock index, postpartum hemorrhage, transfusion, vaginal delivery, hemodynamic instability

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Introduction

In the third trimester of pregnancy, postpartum hemorrhage (PPH) accounts for 27.1% of all maternal deaths globally, making it one of the leading causes of maternal mortality (1, 2). Regardless of the delivery method, PPH is defined as total blood loss ≥1000 mL within 24 hours following the delivery procedure, including intrapartum loss (3). The reported incidence of PPH ranges from 1% to 10% of all deliveries (4). Severe maternal outcomes (SMO) are more prevalent in low- and middle-income countries, where approximately 17.2% of PPH cases result in maternal near-misses or maternal deaths (5). Early detection and timely intervention are therefore essential to reducing hemorrhage-related SMOs (6, 7).

Studies have shown that visual estimation of blood loss tends to overestimate minor blood loss and significantly underestimate higher volumes. However, there is limited clinical evidence that quantitative measurement of blood loss alone improves maternal outcomes (8). Clinicians commonly rely on traditional vital signs—such as heart rate (HR) and systolic blood pressure (SBP)—to evaluate hemodynamic stability, identify emergencies, and initiate escalation of maternal care (9). Due to the physiological adaptations of pregnancy and the compensatory responses during early hemorrhagic shock, these vital signs have limited prognostic accuracy in obstetric patients (10). Consequently, by the time alterations in these parameters are noted, the patient may already be in a critical state, potentially delaying necessary interventions (11). Hemodynamic changes of pregnancy can obscure early signs of hypovolemia, and individual vital signs may fail to detect impending deterioration (6).

To better reflect the clinical severity of blood loss, early warning criteria for PPH are increasingly emphasized. These criteria aim to incorporate not only the volume of blood loss but also its physiological effects, while being simple to apply and sensitive to early clinical changes (12). Compared to conventional vital signs, the shock index (SI)—calculated as the ratio of heart rate to systolic blood pressure—has emerged as a more reliable and earlier indicator of adverse outcomes in both obstetric hemorrhage and non-obstetric trauma (6). Clinical and experimental studies have demonstrated an inverse linear relationship between SI and left ventricular stroke work in cases of acute circulatory failure, such as those caused by trauma, bleeding, or sepsis. An elevated SI reflects declining ventricular function and worsening circulatory compromise (13). In non-obstetric patients, a normal SI typically ranges from 0.5 to 0.7 (10). However, most studies suggest a higher threshold of 0.9 for obstetric populations in both high- and low-resource settings, to effectively predict adverse outcomes in cases of PPH (6, 14). The current study was conducted to compare shock index values between women who required blood transfusion following normal vaginal delivery and those who did not, thereby evaluating its predictive value.

Methodology

This study titled was conducted at the Department of Obstetrics and Gynecology, Sir Ganga Ram Hospital, Lahore, a tertiary care hospital with a high volume of obstetric cases. The study was carried out after obtaining ethical approval from the College of Physicians and Surgeons Pakistan (CPSP), reference number CPSP/REU/OBG–2021-059-11309, dated June 20, 2024. The prospective observational study was conducted over a six-month period from July 1, 2024, to December 31, 2024.

The sample size was calculated using OpenEpi software version 3.01, based on the results of a prior study which reported a 20% postpartum transfusion rate among women with an elevated shock index (>0.9)

compared to 5% among those with a normal shock index. Using a 95% confidence level and 80% power with a 1:1 ratio between exposed and non-exposed groups, the minimum sample size required was 220 participants. To accommodate potential dropouts and missing data, the final sample size was rounded up to 240 participants.

A non-probability consecutive sampling technique was employed to recruit patients who met the eligibility criteria. All women aged between 18 and 40 years who presented for spontaneous vaginal delivery at Sir Ganga Ram Hospital during the study period were considered for inclusion. Only those who delivered singleton pregnancies at term (≥37 weeks of gestation) with cephalic presentation and without prior medical or obstetric complications were included. Patients with known bleeding disorders, preeclampsia or eclampsia, placenta previa, abruptio placentae, previous cesarean delivery, instrumental vaginal delivery, or those requiring surgical intervention for postpartum hemorrhage (PPH) were excluded. Additionally, patients who refused consent or who had incomplete clinical records were also excluded from the study.

Upon delivery, immediate postpartum vital signs including heart rate and systolic blood pressure were measured using a calibrated automated monitor. The shock index was calculated by dividing the heart rate (beats per minute) by the systolic blood pressure (mmHg). Measurements were taken within 15 minutes following delivery of the placenta, while the patient was lying in a supine position. The primary exposure variable was the calculated shock index, which was dichotomized into two groups: normal (≤0.9) and elevated (>0.9), based on previously established clinical thresholds.

The primary outcome measure was the requirement for postpartum blood transfusion within 24 hours after delivery. Transfusion decisions were made by the attending obstetric team based on institutional guidelines, which consider hemoglobin levels below 8 g/dL, ongoing visible blood loss exceeding 500 mL, or hemodynamic instability not responding to fluid resuscitation.

Secondary variables recorded included maternal age, gestational age, parity, pre-delivery hemoglobin levels, estimated blood loss (EBL), and hemoglobin level 6 hours post-delivery. EBL was assessed visually and corroborated by weighing soaked pads and drapes using standardized methods. Hemoglobin levels were measured using an automated hematology analyzer.

Data were entered and analyzed using IBM SPSS Statistics version 26. Descriptive statistics were computed for all variables. Continuous variables such as age, gestational age, hemoglobin levels, EBL, and shock index were expressed as means ± standard deviation (SD) or medians with interquartile ranges, depending on distribution. Categorical variables such as transfusion requirement and shock index category were summarized as frequencies and percentages. The association between elevated shock index and postpartum transfusion requirement was assessed using the Chi-square test or Fisher's exact test where applicable. Independent t-tests or Mann-Whitney U tests were used to compare continuous variables between groups. Multivariable logistic regression analysis was performed to adjust for potential confounders such as age, parity, baseline hemoglobin, and EBL, and to determine the independent predictive value of elevated shock index. Odds ratios (ORs) with 95% confidence intervals (CIs) were reported. A p-value of less than 0.05 was considered statistically significant.

The study adhered to ethical principles outlined in the Declaration of Helsinki. Written informed consent was obtained from all participants prior to data collection. All collected data were anonymized and securely stored to ensure patient confidentiality.

Results

A total of 240 women who delivered via normal spontaneous vaginal delivery were enrolled in the study. All participants met the inclusion criteria and were followed for transfusion requirement within the first 24 hours postpartum. The mean maternal age was 27.6 ± 4.2 years, and the average gestational age was 38.7 ± 1.1 weeks. Of the total participants, 53 (22.1%) required postpartum blood transfusion. An elevated shock index (>0.9) was found in 61 participants (25.4%).

Table 1 shows the baseline maternal and obstetric characteristics of the study participants. No significant difference was noted in maternal age, gestational age, or parity between those who required transfusion and those who did not.

Table 1: Baseline Maternal and Obstetric Characteristics

Parameter	Total (n=240)	Transfusion Required (n=53)	No Transfusion (n=187)	*p*-value
Maternal Age (years)	27.6 ± 4.2	27.9 ± 4.5	27.5 ± 4.1	0.512
Gestational Age (weeks)	38.7 ± 1.1	38.6 ± 1.2	38.8 ± 1.0	0.197
Parity (Median, IQR)	2 (1–3)	2 (1–3)	2 (1–3)	0.778
Pre-delivery Hb (g/dL)	10.9 ± 1.1	10.1 ± 1.0	11.1 ± 1.0	<0.001
Baseline SBP (mmHg)	116 ± 9	112 ± 8	118 ± 9	<0.001
Baseline HR (bpm)	89 ± 11	96 ± 12	87 ± 10	<0.001
Shock Index (SI)	0.77 ± 0.12	0.94 ± 0.14	0.72 ± 0.10	<0.001

Independent t-test or Mann-Whitney U test applied where appropriate. Significant p-values are <0.05. Table 2 demonstrates the association between shock index and the requirement for blood transfusion. A statistically significant association was observed, with 41 out of 61 patients (67.2%) with elevated shock index requiring transfusion compared to only 12 out of 179 patients (6.7%) with a normal shock index ($p < 0.001$). Chi-square test applied. Significant association between elevated SI and transfusion requirement. Participants who required transfusion experienced significantly higher estimated blood loss (EBL) and greater hemoglobin drop at 6 hours post-delivery. (Table 3)

Table 2: Relationship Between Shock Index and Transfusion Requirement

Shock Index Group	Total (n=240)	Transfusion Required (n=53)	% Requiring Transfusion	*p*-value
SI ≤ 0.9	179	12	6.7%	<0.001
SI > 0.9	61	41	67.2%	

.**Table 3: Estimated Blood Loss and Hemoglobin Levels**

Parameter	Transfusion Group (n=53)	Non-Transfusion Group (n=187)	*p*-value
Estimated Blood Loss (mL)	810 ± 155	460 ± 112	<0.001
Post-delivery Hb (g/dL, 6 hrs)	7.9 ± 1.0	10.3 ± 1.1	<0.001
Hb Drop (g/dL)	2.2 ± 0.8	0.9 ± 0.6	<0.001

Independent t-test applied. All differences statistically significant.

To adjust for potential confounders such as age, parity, pre-delivery hemoglobin, and EBL, multivariable logistic regression analysis was performed. Elevated shock index remained an independent predictor of transfusion requirement with an adjusted odds ratio (aOR) of 6.87 (95% CI: 3.32–14.22, p < 0.001). (Table 4)

Table 4: Adjusted Odds Ratios for Predictors of Postpartum Transfusion

Predictor Variable	Adjusted Odds Ratio (aOR)	95% Confidence Interval	*p*-value
Shock Index > 0.9	6.87	3.32 – 14.22	<0.001
Pre-delivery Hb <10 g/dL	2.95	1.38 – 6.30	0.005
EBL > 600 mL	4.41	2.02 – 9.60	<0.001
Parity ≥3	1.42	0.66 – 3.08	0.368
Maternal Age >30 years	1.11	0.53 – 2.34	0.772

Significant predictors in bold. Logistic regression adjusted for all listed variables.

Discussion

This prospective observational study aimed to determine the predictive utility of the shock index (SI) in assessing the need for postpartum blood transfusion following normal vaginal delivery. Our findings demonstrate that an elevated SI (>0.9) is significantly associated with an increased requirement for blood transfusion within the first 24 hours postpartum. These results align with existing literature and further reinforce the role of SI as a valuable, non-invasive bedside tool in early detection of hemodynamic instability in postpartum patients.

In our study, 22.1% of women required postpartum transfusion, and 67.2% of those with SI >0.9 received blood transfusion compared to only 6.7% with SI ≤0.9. This significant association supports previous studies, including Le Bas et al., who observed that patients with SI ≥1.1 at 10 minutes had an 89% transfusion rate, reinforcing that elevated SI values in the immediate postpartum period correlate with higher transfusion requirements (15). Borovac-Pinheiro et al. also reported that patients who received blood transfusions had significantly higher SI values at multiple time points post-delivery, particularly at 30 minutes, 1 hour, and 2 hours after birth (12). These results are consistent with our finding that an SI >0.9 at early postpartum measurement is a strong predictor of transfusion need.

Our findings also indicate that traditional parameters such as maternal age, parity, and gestational age did not significantly differ between the transfused and non-transfused groups. This suggests that physiological parameters alone may not reliably predict PPH severity or transfusion requirement, further highlighting the importance of integrating SI into clinical assessment, as supported by previous literature (6, 8). Moreover, multivariable regression in our study demonstrated that SI >0.9 remained an independent predictor of transfusion after adjusting for confounders including EBL, baseline hemoglobin, and parity, with an adjusted odds ratio of 6.87 (95% CI: 3.32–14.22, p<0.001). This is in agreement with earlier findings which emphasized that elevated SI retains its predictive value even after accounting for potential influencing variables (12, 16).

Pre-delivery hemoglobin levels were also found to be significantly lower in patients requiring transfusion (10.1 ± 1.0 g/dL vs. 11.1 ± 1.0 g/dL, p<0.001). This is clinically intuitive and corroborates the physiological basis for increased transfusion need in anemic patients, as lower baseline hemoglobin reduces physiological reserve against acute blood loss. This observation is consistent with the literature, where lower hemoglobin has been identified as a risk factor for increased transfusion rates, and where anemic patients exhibit compensatory tachycardia that further inflates SI values (17, 18).

Estimated blood loss (EBL) was significantly higher in the transfusion group (810 ± 155 mL) compared to the non-transfusion group (460 ± 112 mL), further reinforcing that SI corresponds well with actual blood loss. However, visual estimation of blood loss, as used in our study, has been shown to underestimate true loss by 30–50% (17). Despite this limitation, the strong correlation between elevated SI and transfusion requirement in our study supports the findings of Nathan et al., who emphasized that SI may outperform both EBL and early hemoglobin drop in predicting postpartum hemorrhage severity (18). Hemoglobin drop at 6 hours post-delivery was also significantly greater in the transfusion group (2.2 ± 0.8 g/dL vs. 0.9 ± 0.6 g/dL), consistent with ongoing hemorrhage and hemodilution from fluid resuscitation, further validating the need for transfusion.

The pathophysiological basis for SI as a superior indicator in postpartum patients lies in the unique cardiovascular adaptations of pregnancy. Due to plasma volume expansion and compensatory mechanisms, up to 30% of blood volume may be lost before clinical signs of shock manifest (17, 18). Consequently, standard vital signs may remain deceptively stable, while SI, as a composite marker, provides a more sensitive and early signal of hemodynamic compromise. Previous studies have consistently demonstrated that an SI ≥0.9 is a reliable threshold in obstetric patients for anticipating serious outcomes including transfusion and surgery (6, 8, 12).

Importantly, the role of therapeutic interventions such as uterotonics (oxytocin/ergometrine) and intravenous fluids must be considered. These were administered uniformly across our cohort, minimizing their confounding effect on SBP and HR, as previously noted by Nathan et al. (18). Furthermore, although perineal pain could transiently elevate heart rate and SI, none of the patients in our study reported severe pain requiring analgesics, and pain-induced SI elevation is likely to be minimal and short-lived.

Our exclusion of patients with hypertensive disorders of pregnancy, emergency cesarean section, and surgical interventions following delivery was purposeful to avoid distortion of the natural cardiovascular response to blood loss. Previous literature, including the work of Kohn et al., has shown altered SI kinetics in hypertensive patients, warranting separate consideration in such cases (18).

The strength of our study lies in its prospective design, standardization of measurement protocols, and use of automated monitoring to reduce human error. While our study relied on single-time-point SI measurement, we acknowledge that serial SI monitoring may further improve predictive accuracy, as demonstrated by Borovac-Pinheiro et al. (12). Additionally, while non-calibrated drapes for EBL estimation limit the precision of blood loss quantification, our robust correlation between SI and transfusion need suggests that SI is a practical adjunct in low-resource or high-volume settings where precise measurement tools are unavailable.

Conclusion

The study supports the incorporation of SI as a simple, early, and reliable marker to predict the need for blood transfusion following normal vaginal delivery. SI >0.9 identifies women at high risk for hemorrhagic complications and facilitates timely escalation of care. Given its cost-effectiveness and ease of use, SI should be integrated into postpartum monitoring protocols, especially in resource-limited settings.

Declarations

Data Availability statement
All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate
Approved by the department concerned. (IRBEC-REU/OBG–2021-059-11309)

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Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

SM (Post Graduate Residant)
Manuscript drafting, Study Design,
AA (Medical SHO)
Review of Literature, Data entry, Data analysis, and drafting articles.
HSK (Designation Woman medical officer)
Conception of Study, Development of Research Methodology Design,

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

References

1. Sebghati M, Chandraharan E. An update on the risk factors for and management of obstetric haemorrhage. Women's Health. 2017;13(2):34-40.
2. Oğlak SC, Obut M. Does keeping the Bakri balloon in place for longer than 12 hours provide favourable clinical outcomes in the treatment of uterine atony? Ege Tıp Dergisi. 2020;59(3):209-14.
3. Shields LE, Goffman D, Caughey AB. ACOG practice bulletin: Clinical management guidelines for obstetrician-gynecologists. Obstetrics and gynecology. 2017;130(4):e168-e86.
4. Borovac-Pinheiro A, Pacagnella R, Cecatti J, Miller S, El Ayadi A, Souza J, et al. Postpartum hemorrhage: new insights for definition and diagnosis. American journal of obstetrics and gynecology. 2018;219(2):162-8.
5. Sheldon W, Blum J, Vogel J, Souza J, Gülmezoglu A, Winikoff B, et al. Postpartum haemorrhage management, risks, and maternal outcomes: findings from the World Health Organization Multicountry Survey on Maternal and Newborn Health. BJOG: An International Journal of Obstetrics & Gynaecology. 2014;121:5-13.
6. El Ayadi AM, Nathan HL, Seed PT, Butrick EA, Hezelgrave NL, Shennan AH, et al. Vital sign prediction of adverse maternal outcomes in women with hypovolemic shock: the role of shock index. PloS one. 2016;11(2):e0148729.
7. Wasim T, Bushra N, Riaz S, Iqbal HI. Fetomaternal outcome in patients with placenta previa. Pakistan Journal of Medical Sciences. 2020;36(5):952.
8. Obstetricians ACo, Gynecologists. Quantitative blood loss in obstetric hemorrhage. Obstetrics & Gynecology. 2019;134(6):1368-9.
9. El-Menyar A, Goyal P, Tilley E, Latifi R. The clinical utility of shock index to predict the need for blood transfusion and outcomes in trauma. Journal of Surgical Research. 2018;227:52-9.
10. Kohn JR, Dildy GA, Eppes CS. Shock index and delta-shock index are superior to existing maternal early warning criteria to identify postpartum hemorrhage and need for intervention. The Journal of Maternal-Fetal & Neonatal Medicine. 2019;32(8):1238-44.
11. Taylor D, Fleischer A, Meirowitz N, Rosen L. Shock index and vital-sign reference ranges during the immediate postpartum period. International Journal of Gynecology & Obstetrics. 2017;137(2):192-5.
12. Borovac-Pinheiro A, Pacagnella RC, Puzzi-Fernandes C, Cecatti JG. Case–control study of shock index among women who did and did not receive blood transfusions due to postpartum hemorrhage. International Journal of Gynecology & Obstetrics. 2018;140(1):93-7.
13. Rady MY, Smithline HA, Blake H, Nowak R, Rivers E. A comparison of the shock index and conventional vital signs to identify acute, critical illness in the emergency department. Annals of emergency medicine. 1994;24(4):685-90.
14. Nathan HL, Seed PT, Hezelgrave NL, De Greeff A, Lawley E, Anthony J, et al. Shock index thresholds to predict adverse outcomes in maternal hemorrhage and sepsis: a prospective cohort study. Acta obstetricia et gynecologica Scandinavica. 2019;98(9):1178-86.
15. Le Bas A, Chandraharan E, Addei A, Arulkumaran S. Use of the "obstetric shock index" as an adjunct in identifying significant blood loss in patients with massive postpartum hemorrhage. International Journal of Gynecology & Obstetrics. 2014;124(3):253-5.
16. Lee SY, Kim HY, Cho GJ, Hong SC, Oh MJ, Kim HJ. Use of the shock index to predict maternal outcomes in women referred for postpartum hemorrhage. International Journal of Gynecology & Obstetrics. 2019;144(2):221-4.
17. Lilley G, Burkett-St-Laurent D, Precious E, Bruynseels D, Kaye A, Sanders J, et al. Measurement of blood loss during postpartum haemorrhage. International journal of obstetric anesthesia. 2015;24(1):8-14.
18. Nathan H, El Ayadi A, Hezelgrave N, Seed P, Butrick E, Miller S, et al. Shock index: an effective predictor of outcome in postpartum haemorrhage? BJOG: An International Journal of Obstetrics & Gynaecology. 2015;122(2):268-75.