Journal Homepage: -www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI:10.21474/IJAR01/21065
DOI URL: http://dx.doi.org/10.21474/IJAR01/21065

*RESEARCH ARTICLE*

# CLINICAL UTILITY OF SHOCK INDEX IN THE EARLY DETECTION OF ADVERSE OUTCOMES IN POSTPARTUM HEMORRHAGE

**Anchala Mahilange , M.S.Darshana and Supriya Gupta**

## Manuscript Info

*Manuscript History*
Received: 02 April 2025
Final Accepted: 05 May 2025
Published: June 2025

*Key words:-*
Shock Index, Postpartum Hemorrhage, Maternal Mortality, Hemodynamic Instability, Obstetric Emergencies

## Abstract

**Background:** Postpartum hemorrhage is a major cause of maternal morbidity and mortality. Shock Index (SI), defined as heart rate (HR) divided by systolic blood pressure (SBP), is emerging as a valuable early predictor of hemodynamic instability.
**Objective:** This study evaluates the role of SI in predicting adverse maternal outcomes, including need for ICU admission, need forblood transfusion, and surgical intervention.
**Materials and Methods:** A prospective cohort study was conducted from March 2023 to March 2024 at Dr.B.R.A.M Hospital, Raipur, involving 65 patients diagnosed with PPH. SI was measured at 15-minute intervals for 1 hour post-delivery. The primary outcomes included need for ICU admission, need for blood transfusion, and surgical intervention.
**Results:** SI>1.1 was significantly associated with increased ICU admissions (40%), need for massive transfusion (68%), and surgical interventions (55%). ROC curve analysis demonstrated an area under the curve (AUC) of 0.80, indicating strong predictive value of SI.
**Conclusion:** SI is an effective tool for early detection of hemodynamic instability in PPH and should be integrated into obstetric early warning systems for better maternal outcomes.



## Introduction:-

The maternal mortality ratio (MMR) in India has declined to 97 per 100,000 live births for the period 2018–2020, down from 130 in 2014–2016, according to the SRS report.[1] However, this remains above the Sustainable Development Goal (SDG) 3.1 target of reducing global MMR to below 70 per 100,000 live births by 2030.[2]
Postpartum hemorrhage (PPH), defined as blood loss >500 mL after vaginal delivery or >1000 mL after cesarean section, remains a leading cause of maternal mortality and morbidity globally.[3,4] The World Health Organization reports that PPH affects approximately 14 million women annually, leading to around 70,000 deaths worldwide.[5]
The causes of PPH are classified into the "Four Ts": tone (uterine atony), trauma, tissue (retained placenta), and thrombin (coagulopathies), with uterine atony being the most common etiology.[6]
Prompt recognition and management of PPH are crucial. However, conventional methods of estimating blood loss, such as visual assessment, are often inaccurate, leading to diagnostic delays and suboptimal intervention.[7,8] In response, there has been increasing interest in objective tools like the Shock Index (SI), calculated as the ratio of heart rate to systolic blood pressure, to assess hemodynamic instability.[9]

**Corresponding Author:-Anchala Mahilange**

In healthy adults, normal SI ranges from 0.5 to 0.7, while in pregnant women, due to physiological changes, it ranges from 0.7 to 0.9.[10,11] Elevated SI values have been shown to correlate with greater blood loss, hemodynamic compromise, and increased risk of adverse maternal outcomes in PPH.[12,13] Unlike individual vital signs that may remain deceptively normal, SI offers a more sensitive marker of early decompensation.[9,14]
This study aims to evaluate the role of shock index in assessing adverse maternal outcomes in postpartum hemorrhage and to determine its clinical utility in comparison to traditional assessment methods. By identifying SI thresholds predictive of poor outcomes, this research seeks to support more timely and effective interventions in PPH, thereby contributing to improved maternal health outcomes.

## Objective:-

**Primary objective –**
To study the role of shock index in assessing the adverse maternal outcomes in postpartum hemorrhage.

**Secondary objective –**
To correlate shock index with visual estimation of blood loss in women with postpartum hemorrhage.

## Materials and Methodology:-

**Study Design & Setting**
A prospective cohort study was conducted in the Department of Obstetrics and Gynaecology at Dr. B.R.A.M Hospital, Raipur, from March 2023- March 2024. The study included pregnant women diagnosed with postpartum hemorrhage (PPH), and their hemodynamic parameters were continuously monitored to evaluate the predictive utility of Shock Index in determining adverse maternal outcomes.

**Inclusion criteria**
Women who delivered after 28 weeks of gestation.
Patients diagnosed with PPH based on visual blood loss ≥500mL in vaginal delivery and ≥1000 mL in LSCS.
Patients with normal baseline hemodynamic parameters before labor.

**Exclusion criteria**
Antepartum hemorrhage.
Pre-existing maternal heart disease or severe anaemia (<7gm/dL).
Pregnancy induced hypertension, preeclampsia, eclampsia
Patients with pre-existing coagulopathies.

## Methodology:-

Immediately after delivery blood loss estimation was done using blood collected in drapes, fixed size mops of 45*45cm, swabs of 10*10cm, perianal pads which when fully soaked amounted to a blood loss of approximately 350ml, 60ml and 100ml respectively. Blood loss estimation in case of caesarean section was done using fixed size mops, kidney tray and suction machine. A full kidney tray amounted to a blood loss of approximately 500ml whereas a partially filled tray amounted to a blood loss of approximately 250ml.

Baseline vitals were recorded at the time of admission. Thereafter as soon as postpartum haemorrhage was anticipated by visual estimation of blood loss study participants were subjected to BP and HR measurement every 15 minutes for 1 hour postpartum. Shock index was evaluated by dividing heart rate by systolic blood pressure. The highest SI that was recorded was selected for further analysis. Active management of third stage of labor was routinely performed.

Pre specified potential confounding factors included age, gestational age at delivery, height, weight, BMI, parity, mode of delivery, type of anaesthesia and use of oxytocin for AMTSL.
The following outcome measures were recorded: need for ICU care, need for blood and blood products transfusion, need for operative intervention, acute renal failure, surgical site infection and maternal mortality.

## Result:-

The present study aimed to assess the role of Shock Index (SI) in predicting adverse maternal outcomes in postpartum hemorrhage (PPH). The average age of participants was 24.97 years, with most being unbooked cases. The mean gestational age was 38.52 weeks, and the average BMI was 24.65. Most deliveries were vaginal (58.46%), followed by LSCS (38.46%) and VBAC (3.08%). The primary cause of PPH was uterine atony (60%).
The mean shock index was 1.26 (range 1.0–1.81).
A strong positive correlation was found between SI and blood loss (r = 0.88), with an average loss of 902.92 ± 340 mL.

**Table 1:-** Association of Shock Index and Blood Loss.

| Shock Index Range | Mean Blood Loss (mL) | Median (25th–75th percentile) | Range | p-value |
|---|---|---|---|---|
| 0.9 to <1.2 | 643.0±148.62 | 600(550–800) | 500–1050 | <0.0001 |
| 1.2 to <1.5 | 940.34±197.08 | 900(850–1000) | 600–1550 | <0.0001 |
| 1.5 to <1.7 | 1408.33±316.89 | 1300(1262.5–1450) | 1100–2000 | <0.0001 |
| ≥1.7 | 1587.5 ± 184.28 | 1600(1537.5–1650) | 1350–1800 | <0.0001 |

Significant adverse outcomes included ICU admission (52.31%), transfusion (64.62%), operative intervention (69.23%), acute renal failure (23.08%), severe anemia (50.77%), and maternal mortality (6.15%). The mean SI associated with ICU admission was 1.4 ± 0.18, ventilatory support 1.63 ± 0.16, inotropic support 1.55 ± 0.17, and mortality 1.73 ± 0.06.

**Table2:-**Association of Shock Index with Adverse Maternal Outcomes.

| Outcome | Shock Index (Mean ± SD) | Median (25th–75th percentile) | Range | p-value |
|---|---|---|---|---|
| Need for ICU Admission - No | 1.11 ± 0.09 | 1.08 (1.045–1.165) | 1–1.4 | <0.0001 |
| Need for ICU Admission - Yes | 1.4 ± 0.18 | 1.33 (1.282–1.5) | 1.19–1.81 | |
| Ventilatory Support - No | 1.21 ± 0.15 | 1.2 (1.08–1.31) | 1–1.61 | <0.0001 |
| Ventilatory Support - Yes | 1.63 ± 0.16 | 1.69 (1.48–1.73) | 1.42–1.81 | |
| Inotropic Support - No | 1.19 ± 0.14 | 1.19 (1.08–1.292) | 1–1.6 | <0.0001 |
| Inotropic Support - Yes | 1.55 ± 0.17 | 1.5 (1.42–1.72) | 1.28–1.81 | |
| Transfusion Required - No | 1.07 ± 0.06 | 1.06 (1.03–1.1) | 1–1.26 | <0.0001 |
| Transfusion Required - Yes | 1.37 ± 0.18 | 1.31 (1.22–1.468) | 1.1–1.81 | |
| Operative Intervention - No | 1.09 ± 0.09 | 1.08 (1.04–1.105) | 1–1.4 | <0.0001 |
| Operative Intervention - Yes | 1.34 ± 0.2 | 1.31 (1.21–1.46) | 1–1.81 | |
| ARF - No | 1.2 ± 0.17 | 1.18 (1.08–1.288) | 1–1.81 | <0.0001 |
| ARF - Yes | 1.46 ± 0.19 | 1.42 (1.32–1.64) | 1.2–1.76 | |
| Dialysis - No | 1.25 ± 0.19 | 1.22 (1.09–1.325) | 1–1.81 | 0.0006 |
| Dialysis - Yes | 1.74 ± 0.03 | 1.74 (1.73–1.75) | 1.72–1.76 | |
| Surgical Site | 1.25 ± 0.21 | 1.21 (1.08–1.33) | 1–1.81 | 0.167 |

| | | | | |
|---|---|---|---|---|
| Infection - No | | | | |
| Surgical Site Infection - Yes | 1.4 ± 0.17 | 1.39 (1.295–1.498) | 1.22–1.61 | |
| Severe Anemia - No | 1.11 ± 0.09 | 1.09 (1.048–1.185) | 1–1.28 | <0.0001 |
| Severe Anemia - Yes | 1.41 ± 0.18 | 1.34 (1.3–1.5) | 1.1–1.81 | |
| Maternal Mortality - Alive | 1.23 ± 0.17 | 1.21 (1.08–1.32) | 1–1.76 | <0.0001 |
| Maternal Mortality - Died | 1.73 ± 0.06 | 1.72 (1.708–1.742) | 1.67–1.81 | |

ROC analysis showed excellent predictive power: AUC values were 0.958 for ICU admission, 0.978 for transfusion, 0.896 for operative intervention, 0.864 for acute renal failure, and 0.988 for maternal mortality (all $p < 0.05$).

**Table3:-** Receiver Operator Characteristic (ROC) Curve Summary Table.

| **Outcome** | **AUC** | **Cut-off Value** | **Interpretation** |
|---|---|---|---|
| ICU Admission | 0.958 | >1.18 | Excellent discrimination. High accuracy for identifying patients needing ICU care. |
| Ventilatory Support | 0.966 | >1.4 | Outstanding discrimination. Very high sensitivity and specificity. |
| Inotropic Support | 0.944 | >1.4 | Excellent discrimination. Strong predictive value. |
| Transfusion Requirement | 0.978 | >1.18 | Outstanding discrimination. Most accurate among all outcomes evaluated. |
| Operative Intervention | 0.896 | >1.12 | Very good discrimination. Slightly lower but still reliable. |
| Acute Renal Failure (ARF) | 0.864 | >1.3 | Good discrimination. Moderate predictive capacity. |
| Need for Dialysis | 0.98 | >1.67 | Outstanding discrimination. Very high accuracy despite small sample size. |
| Surgical Site Infection | 0.752 | >1.21 | Fair discrimination. Predictive power is weaker here. |

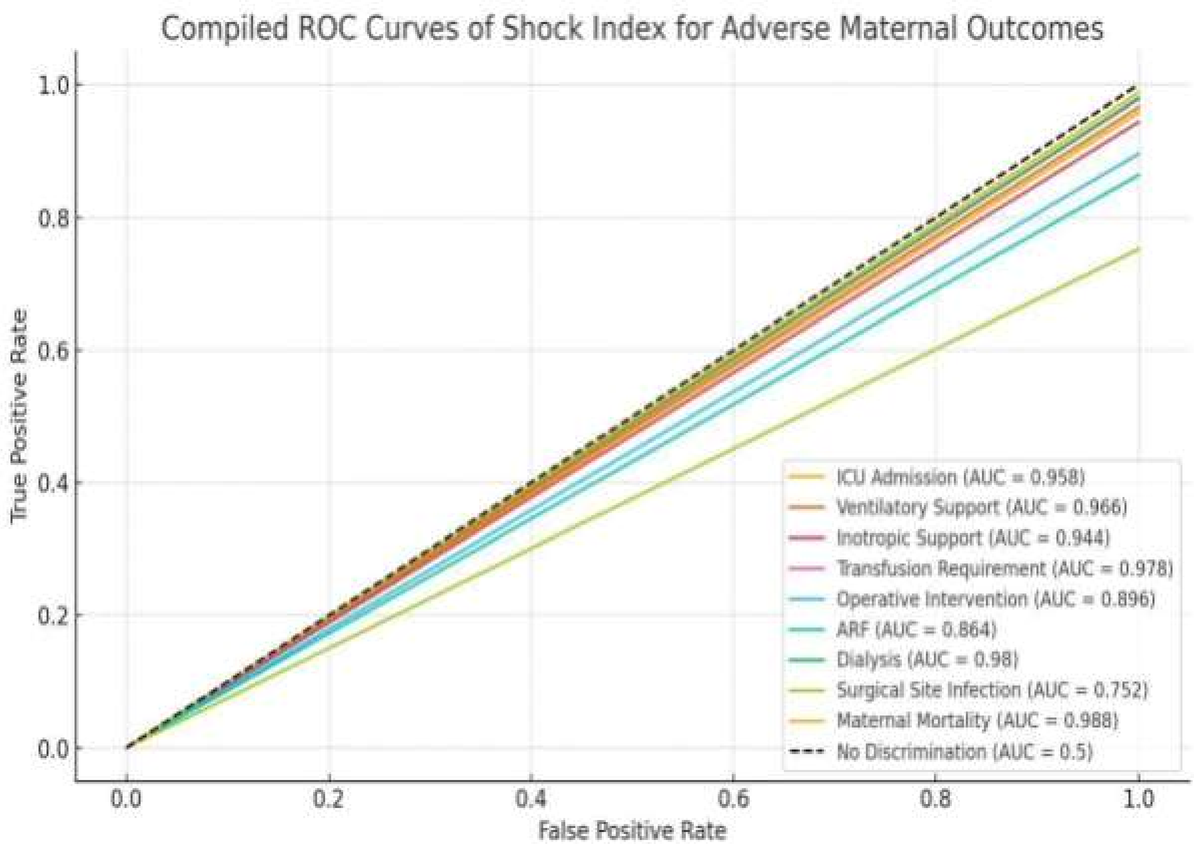


**Figure1:-** Compiled ROC curves of Shock Index for Adverse Maternal Outcomes.

SI was categorized into four ranges (0.9–<1.2, 1.2–<1.5, 1.5–<1.7, ≥1.7), with a stepwise increase in the frequency and severity of adverse outcomes across higher SI ranges. ICU admissions, transfusion needs, operative interventions, renal complications, mortality, and hospital stay duration increased with rising SI value

**Table 4:-** Association of Maternal Outcomes with Shock Index Ranges.

| **Maternal Outcome** | **0.9 to <1.2 (n=26)** | **1.2 to <1.5 (n=29)** | **1.5 to <1.7 (n=6)** | **≥1.7 (n=4)** | **p-value** |
|---|---|---|---|---|---|
| Need for ICU Admission | 1 (3.85%) | 23 (79.31%) | 6 (100%) | 4 (100%) | <0.0001 |
| Ventilatory Support | 0 (0%) | 2 (6.90%) | 2 (33.33%) | 4 (100%) | <0.0001 |
| Inotropic Support | 0 (0%) | 5 (17.24%) | 4 (66.67%) | 4 (100%) | <0.0001 |
| Operative Intervention | 8 (30.77%) | 27 (93.10%) | 6 (100%) | 4 (100%) | <0.0001 |
| ARF | 0 (0%) | 9 (31.03%) | 3 (50%) | 3 (75%) | <0.0001 |
| Dialysis | 0 (0%) | 0 (0%) | 0 (0%) | 2 (50%) | 0.003 |

| | | | | | |
|---|---|---|---|---|---|
| Surgical Site Infection | 0 (0%) | 3 (10.34%) | 1 (16.67%) | 0 (0%) | 0.223 |
| Maternal Mortality | 0 (0%) | 0 (0%) | 1 (16.67%) | 3 (75%) | <0.0001 |

**Table5:-** Correlation of Shock Index with SBP,DBP,PR and MAP.

| Variable | Correlation Coefficient | p-value |
|---|---|---|
| Systolic Blood Pressure (SBP) | -0.404 | .001 |
| Diastolic Blood Pressure (DBP) | -0.270 | 0.030 |
| Pulse Rate (PR) | 0.380 | .002 |
| Mean Arterial Pressure | -0.372 | .002 |

A weak positive correlation was observed between SI and pulse rate (r = 0.38), and negative correlations were noted with systolic BP (r = -0.404), diastolic BP (r = -0.27), and MAP (r = -0.372).

## Discussion:-

The study titled "Clinical Utility of Shock Index in the Early Detection of Adverse Outcomes in Postpartum Hemorrhage" was conducted at Pt. J.N.M Medical College Raipur (C.G) from March 2023 to March 2024.
Postpartum hemorrhage (PPH) remains a major cause of maternal mortality, especially in low-resource settings where early recognition is challenging. Shock Index (SI)—the ratio of heart rate to systolic blood pressure—is emerging as a simple, cost-effective tool for early identification of hemodynamic instability in PPH.
This study aimed to assess the role of SI in predicting adverse maternal outcomes in PPH patients, evaluating its correlation with clinical parameters such as ICU admission, need for transfusion, operative interventions, and maternal mortality.

**Descriptive statistics of Shock Index**
The shock index (SI) in our study demonstrated a mean value of 1.26, ranging from 1 to 1.81, indicating variability in patients' physiological responses to shock. El Ayadi et al. (2016) reported a comparable median SI of 1.3. The primary utility of SI lies in its ability to detect hemodynamic instability earlier than conventional vital signs, identifying significant blood loss and hypovolemia before overt hypotension develops.

**Association between Shock Index and Blood Loss**
In non-pregnant individuals, an SI of 1.0 typically corresponds to a blood loss of 750–1500 mL.[51] In obstetric settings, massive hemorrhage is defined as blood loss >2000 mL or >30% of blood volume.(16)SI values differ between pregnant and non-pregnant women due to physiological changes. Literature indicates that a 10–30% blood loss in pregnant women correlates with an SI of ~1.0, while in non-pregnant women, a similar SI reflects a 15–20% loss.(17,18)In our study, SI strongly correlated with blood loss ($r = 0.88$, $p < 0.0001$), with the highest blood loss observed in the SI ≥1.7 group (1587.5 ± 184.28 mL). These findings are consistent with studies by Dziadosz et al. (2020), Sanchez et al. (2023), and Talbot et al.(2023), all of which reported a positive association between SI and hemorrhage severity. However, contrasting studies by Huang et al. (2022) and Ushida et al. (2021) found weaker correlations, suggesting that SI alone may not always reliably quantify blood loss.

**Association of Shock Index with Adverse Maternal Outcomes**

- **Operative Intervention**

In our study, the mean SI among patients requiring operative intervention was significantly elevated at 1.34 ± 0.2, compared to 1.09 ± 0.09 in those managed medically. Among surgical procedures, the mean SI progressively increased with the severity of intervention: vaginal tear repair (1.13), uterine artery ligation (1.32), uterine compression sutures (1.44), uterine artery embolisation (1.51), and hysterectomy (1.63).

An SI cut-off of >1.12 predicted the need for operative intervention with 91.11% sensitivity, 85% specificity. Similar findings were reported by Nathan et al. (2019), where SI measured after PPH diagnosis predicted emergency hysterectomy risk. SI <0.9 indicated low risk (2% underwent hysterectomy), 0.9–1.69 moderate risk (14.7%), and ≥1.7 high risk (28.6%). El Ayadi et al. (2016) reported an SI of 1.35 (95% CI; 60% specificity) for hysterectomy, which was lower than our study's mean SI of 1.63 ±0.12. Chaudhary et al. (2020) reported a slightly higher mean SI (1.58 ±0.51) for surgical intervention.

Our findings on SI cut-off values were consistent with Agarwal et al. (2021), who reported thresholds >1 for interventions: hysterectomy >1.32 (90.91% sensitivity, 89.74% specificity), vaginal/cervical tear repair >1.32 (75%, 78.41%), internal artery ligation >1.3 (90%, 77.78%), and compression sutures >1.24 (100%, 58.76%). Studies by Sakshi Agarwal et al. (2023) and Kohn et al. (2017) also reported comparable SI values (≥1.1 and ≥1.14) with moderate sensitivity and specificity.

- **ICU Admission**

The mean SI among patients requiring ICU admission was 1.32 ± 0.15, significantly higher than 1.11 ± 0.09 in non-ICU patients. A cut-off value of >1.18 demonstrated 100% sensitivity, 80.65% specificity. These values are consistent with previous reports. El Ayadi et al. identified a threshold of 1.35, Chaudhary et al. noted 1.23, and Sakshi Agarwal et al. reported 1.32 as predictive of ICU admission. Our findings reaffirm that SI is a strong predictor of ICU-level care in PPH.

Nathan et al. (2019) demonstrated increasing ICU admission rates with rising SI: 25.5% (SI <0.9), 48.3% (SI 0.9–1.69), and 78.6% (SI ≥1.7). El Ayadi et al. (2016) reported a higher mean SI of 1.35 for ICU admission, while Chaudhary et al. (2020) found a mean SI of 1.23 ± 0.35—both comparable to our findings. Sakshi Agarwal et al. (2023) reported a cut-off SI ≥1.1 (sensitivity 97.62%, specificity 93.41%), similar to Koch et al. (2019) who found SI >1 predictive of ICU admission. Agarwal et al. (2021) and El Ayadi et al. (2016) reported higher thresholds of >1.3 and ≥1.4, with the latter showing 70.5% sensitivity and 74.8% specificity. Nathan et al. (2015) suggested an even lower threshold of SI ≥0.9.

- **Inotropic and Ventilatory Support**

Patients who required ventilatory support had a mean SI of 1.63 ± 0.16. An SI cut-off of >1.4 predicted ventilatory requirement with 100% sensitivity, 89.47% specificity
Sakshi Agarwal et al. similarly found high SI (mean 1.34) in ventilated patients, with high sensitivity and specificity. Our results further confirm that elevated SI is a reliable marker for identifying patients who may require respiratory support. Inotropic Support

The mean SI in patients needing inotropic support was 1.55 ± 0.17. A cut-off of >1.4 yielded 84.62% sensitivity, 94.23% specificity. Similar to the findings of the current study Agarwal et al. 2021 established cut-off thresholds of shock index (SI) to predict the need for ICU admission with ventilatory support and ICU admission with inotropic support. The values were >1.34 (sensitivity: 95.45%; specificity: 92.31%) and >1.446 (sensitivity: 91.67%; specificity: 93.18%) respectively.
The close alignment across studies enhances the external validity of our results.

- **Blood and Blood Products Transfusion**

The mean SI among those receiving transfusions was 1.37 ± 0.18, compared to 1.07 ± 0.06 in non-transfused patients. Among women with Hb <7 g/dL, the mean SI rose to 1.41 ± 0.18. An SI cut-off of >1.18 predicted transfusion need with 92.86% sensitivity, 95.65% specificity.

Nathan et al. (2019) reported rising transfusion requirements with increasing SI: 25.5% (SI <0.9), 37.1% (SI 0.9–1.69), and 71.4% (SI ≥1.7). In contrast, our study showed fewer transfusions in the SI range 0.9–<1.2, with a mean of 2.61 ± 2.31 units. El Ayadi et al. (2016) and Kwon H et al. (2024) found mean SIs of 1.35 and 1.22, respectively, for predicting massive transfusion—findings comparable to ours.

Chaudhary et al. (2020) reported a lower mean SI (1.15 ± 0.41), possibly due to inclusion of hypertensive and anaemic patients. Studies by Le Bas et al. (2013), Agarwal et al. (2023), and Kwon H et al. (2024) consistently identified SI >1–1.1 as predictive of massive transfusion, with high sensitivity and specificity. Koch et al. (2019) also supported SI >1 as a marker of morbidity.

Higher thresholds were reported by Guerrero-De León et al. (2018), Kohn et al. (2017), and Agarwal et al. (2021), with SI >1.32–1.4 predicting ≥4 to ≥10 units of transfusion with strong diagnostic accuracy. Despite variations, most studies affirm SI >1 as a reliable predictor of transfusion need.

- **Maternal Morbidity**

Patients who experienced significant maternal morbidity had a mean SI of 1.34 ± 0.21, significantly higher than 1.10 ± 0.09 in those without morbidity. An SI cut-off of >1.14 predicted maternal morbidity with 88% sensitivity, 88.57% specificity.

El Ayadi et al. (2016) reported an SI of 1.57 (95% CI; 80% specificity) for predicting severe end-organ damage, aligning with our findings. Chaudhary et al. (2020) also found a comparable mean SI of 1.47 ± 0.84 in patients with MODS. Similarly, Agarwal et al. (2021) identified an SI >1.3 as predictive of MODS (sensitivity 95%, specificity 88.75%), and El Ayadi et al. (2016) noted a cut-off of ≥1.4 for end-organ damage with 80.6% sensitivity and 71.4% specificity.

- **Maternal Mortality**

Among the four maternal deaths in our cohort, the mean SI was markedly elevated at 1.71 ± 0.11. While our sample size for mortality is small, the high SI reinforces previous evidence linking very high SI to fatal outcomes.

Nathan et al. (2019) reported increasing mortality with rising SI: 0% for SI <0.9, 4.3% for SI 0.9–1.69, and 7.1% for SI ≥1.7. El Ayadi et al. (2016) found a mean SI of 1.58 (95% CI; 80% specificity) for maternal mortality, aligning with our study. Chaudhary et al. (2020) and Liu et al. (2012) reported lower SI values of 1.39 ± 0.85 and 1.3 respectively. Agarwal et al. (2021) and El Ayadi et al. (2016) reported mortality cut-off SI values of >1.65 and ≥1.7, both comparable with our findings.

**Area under the curve value of Shock Index to predict adverse maternal outcome**

In our study, the Shock Index (SI) demonstrated excellent predictive performance for multiple adverse outcomes, with AUC values of 0.958 for ICU admission, 0.978 for blood product transfusion, and 0.896 for operative intervention. Additionally, AUC values for surgical site infection (0.752), acute renal failure (0.864), and maternal mortality (0.988) were statistically significant, reinforcing SI as a robust predictor in postpartum hemorrhage.

Our results are consistent with Agarwal et al. (2021), who reported AUROC values of 0.95 and 0.98 for ICU admissions requiring inotropic and ventilatory support, respectively, 0.91 for blood product transfusion and operative intervention, and 0.99 for maternal mortality. Similarly, Lee et al. (2019) and Kwon H et al. (2024) reported AUCs of 0.815 and 0.829, respectively, for predicting massive transfusion, which align closely with our findings.

M. Chaudhary et al. (2020) found lower AUC values: ICU admission (0.8), operative intervention (0.8), maternal death (0.9), and blood transfusion (0.68). The variation may stem from their inclusion of patients with pregnancy-induced hypertension and severe anaemia— conditions that can distort SI interpretation due to altered hemodynamics.

Nathan et al. (2019) also reported lower AUCs: ICU admission (0.68), hysterectomy (0.79), transfusion ≥4 units (0.65), and maternal mortality (0.86). Despite the variability, a consistent trend is evident across all studies—an elevated SI is strongly associated with adverse maternal outcomes.

**Clinical significance of Shock Index thresholds**

The normal Shock Index (SI) range in healthy pregnant women is 0.7–0.9. An SI >0.9 has been associated with adverse outcomes including ICU admission, significant blood loss, surgical intervention, and increased morbidity and mortality (21, 33). Nathan et al. (2019) found that SI <0.9 offered reassurance, while SI ≥1.7 indicated urgent need for intervention. Similarly, El-Ayadi et al. (2016) suggested SI >0.9 for referral, ≥1.4 for urgent tertiary care, and ≥1.7 for high risk of maternal complications. Our study identified a slightly lower SI threshold of ≥1.1 to predict adverse outcomes, which may be attributed to population differences, anaemia prevalence, and study design.

Comparable findings were reported by Kohn et al. (2017), where SI ≥1.14 predicted PPH with 93% specificity. Guerrero-De León et al. (2018) also found SI ≥1.0 to be predictive of severe outcomes, recommending care at tertiary centers for such patients.

We stratified SI into four categories: 0.9–<1.2, 1.2–<1.5, 1.5–<1.7, and ≥1.7. A stepwise increase in adverse outcomes was noted across these groups. For instance, transfusion was needed in 15.38% of patients with SI 0.9–<1.2, versus 96.55%, 100%, and 100% in the higher ranges, respectively. Operative intervention rose from 30.77% to 100% across these SI brackets. No acute renal failure was noted below SI 1.2, but increased substantially in higher groups—up to 75% in SI ≥1.7. Maternal mortality occurred exclusively in the ≥1.7 SI group.

Length of hospital stay also correlated with SI: the longest durations were observed in the ≥1.5 groups (mean 7.5 days), versus 2.77 days in SI <1.2. These findings mirror those of Nathan et al. (2019), who reported rising rates of transfusion, ICU admission, and hysterectomy with increasing SI. In their study, no mortality occurred in SI <0.9, while 7.1% mortality was reported for SI ≥1.7. Nathan et al. (2015) also established SI ≥0.9 as a reliable threshold for ICU admission and ≥1.7 as a critical alert trigger.

Collectively, these results reaffirm SI as a sensitive early marker of hypovolemia. Unlike conventional vital signs, which may initially remain stable due to compensatory mechanisms, SI captures the critical rise in heart rate alongside stable or declining SBP, providing a more reliable early indicator of clinical deterioration.
Overall, rising SI is a clear marker of worsening clinical status in PPH. Sustained elevation reflects ongoing hypovolemia, tissue hypoperfusion, and risk of MODS. Vital organs such as the kidneys and brain are particularly susceptible to ischemic injury in this state. Hemorrhage-induced coagulopathy further complicates management and increases the likelihood of adverse maternal outcomes.

**Correlation of Shock Index with vital signs**

Our study categorized patients based on SI ranges and found the following mean values:
SI 0.9–<1.2: SBP 98.48 mmHg, DBP 59 mmHg, PR 106 bpm, MAP 72.64 mmHg
SI 1.2–<1.5: SBP 92 mmHg, DBP 58 mmHg, PR 120 bpm, MAP 65.6 mmHg
SI 1.5–<1.7: SBP 84 mmHg, DBP 56.3 mmHg, PR 135 bpm, MAP 65 mmHg
SI ≥1.7: SBP 78 mmHg, DBP 52 mmHg, PR 138 bpm, MAP 61 mmHg

We observed that while pulse rate and diastolic blood pressure changed in accordance with SI, other parameters such as SBP and MAP remained relatively stable until SI reached ≥1.5.
These findings align with El Ayadi et al. (2019), who noted that at SI ≥1.4, PR increased to 112 bpm and SBP dropped to 80 mmHg, and at SI 1.7, PR reached 130 bpm with SBP 70 mmHg.

## Clinical Implications:-

Our findings support integrating SI into obstetric early warning systems (EWS) for PPH management. Key applications include:

**Early Recognition & Triage**

Women with SI>1.1 should receive immediate hemodynamic monitoring and blood cross matching.
SI >1.3 should prompt early ICU transfer consideration.

**Blood Transfusion Protocols**

SI>1.1 correlates strongly with the need for transfusion, suggesting SI can be used to guide blood product administration before overt hypovolemia develops.

**Surgical Preparedness**

SI>1.3 may predict surgical intervention, allowing teams to mobilize resources for emergency hysterectomy or B-Lynch suture placement.

**Strengths:**

Prospective design reduced recall bias and improved data accuracy.
Objective blood loss estimation was also incorporated along with visual estimation of blood loss.
Standardized SI measurements at multiple time points, ensuring dynamic monitoring of hemodynamic changes.

**Limitations:**

Single center study: Findings may not be generalizable to different populations.
Small sample size (n=65): A larger multicenter study would improve statistical power.

## Conclusion:-

The Shock Index is a valuable, cost-effective, and early predictor of adverse maternal outcomes in postpartum hemorrhage. By incorporating SI into standard clinical protocols, healthcare providers can improve early detection, reduce delays in intervention, and ultimately enhance maternal survival. Further multicenter studies are warranted to establish universal SI thresholds tailored to diverse populations.

## Acknowledgment:-

I would like to express my heartfelt gratitude to the Department of Obstetrics and Gynaecology, Dr. B.R.A.M Hospital, Raipur, for their support throughout the study period. I am deeply thankful to my guide, co-guide and faculty members for their continuous encouragement, guidance, and valuable suggestions during the research. I also extend my sincere appreciation to all the patients who participated in this study, without whom this work would not have been possible.

## References:-

1.Trends in maternal mortality 2000 to 2020: estimates by WHO, UNICEF, UNFPA, World Bank Group and UNDESA/Population Division. Geneva: World Health Organization; 2023 (https://iris.who.int/handle/10665/366225

2. New maternal mortality estimates: United Nations Maternal Mortality Estimation Inter-Agency Group(UN MMEIG)

3.Say L, Chou D, Gemmill A, Tuncalp Ö, Moller A-B, Daniels J et al. Global causes of maternal death: a WHO systematic analysis. Lancet Glob Health. 2014;2(6):e323–33. doi: 10.1016/ S2214-109X(14)70227-X.

4.Pacagnella RC, Souza JP, Durocher J et al. A systematic review of the relationship between blood loss and clinical signs. PLoS One 2013;8(3).e57594.DOI: 10.1371/journal.pone.00575

5.A roadmap to combat postpartum haemorrhage between 2023 and 2030. Geneva: World Health Organization; 2023(https://iris.who.int/handle/10665/373221)

6.Bienstock JL, Eke AC, Hueppchen NA. Postpartum Hemorrhage. N Engl J Med. 2021 Apr 29;384(17):1635-1645. doi: 10.1056/NEJMra1513247. PMID: 33913640; PMCID: PMC10181876.

7.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. Int J Gynaecol Obstet. 2019 Feb;144(2):221-224. doi: 10.1002/ijgo.12714. Epub 2018 Dec 10. PMID: 30447073.

8..Schorn MN. Measurement of blood loss: review of the literature. J Midwifery Womens Health 2010;55:20-7

9.Allgower M, Burri C. Shock index. Dtsch Med Wochenschr. 1967;92 (43):1947–1950. doi:10.1055/s-0028-1106070

10.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. Ann Emerg Med 1994; **24**: 685–90.

11.Rady MY, Rivers EP, Martin GB, Smithline H, Appelton T, Nowak RM. Continuous central venous oximetry and shock index in the emergency department: use in the evaluation of clinical shock. Am J Emerg Med 1992; **10**: 538–41.

12.Vandromme MJ, Griffin RL, Kerby JD, McGwin G Jr, Rue LW 3rd, Weinberg JA. Identifying risk for massive transfusion in the relatively normotensive patient: utility of the prehospital shock index. J Trauma 2011; **70**: 384–8;discussion 8–90.

13.Cannon CM, Braxton CC, Kling-Smith M, Mahnken JD, Carlton E, Moncure M. Utility of the shock index in predicting mortality in traumatically injured patients. J Trauma 2009; **67**: 1426–30.

14..Krishna H, Chava M, Jasmine N, et al. Patients with postpartum hemorrhage admitted in intensive care unit: patient condition, interventions, and outcome. J AnaesthesiolClinPharmacol 2011;27(2):192–194. DOI: 10.4103/0970-9185.81826.

15.El Ayadi AM, Nathan HL, Seed PT, Butrick EA, Hezelgrave NL, Shennan AH, Miller S. Vital Sign Prediction of Adverse Maternal Outcomes in Women with Hypovolemic Shock: The Role of Shock Index. PLoS One. 2016 Feb 22;11(2):e0148729. doi: 10.1371/journal.pone.0148729. PMID: 26901161; PMCID: PMC4762936.

16.Mavrides E, et al. Prevention and management of postpartum hemorrhage. BJOG2016;124:e106–e149. DOI: 10.1111/1471-0528.14178

17.Obstetrics Subgroup CSoO, Gynecology CiMA, Association OSCSoO, Medical GC. [Guideline of prevention and treatment about postpartum haemorrhage (2014)]. Zhonghua Fu Chan Ke Za Zhi. 2014;49(9):6

18.Liu LM, Bai XJ, Li T, Zhou XY, Yang GM, Gao W, et al. Early treatment specifications for traumatic haemorrhagic shock. Journal of Traumatic Surgery. 2012; 19 (12): (881–883, 891).)41–6.
19. Nathan HL, Seed PT, Hezelgrave NL, De Greeff A, Lawley E, Anthony J, Steyn W, Hall DR, Chappell LC, Shennan AH. Shock index thresholds to predict adverse outcomes in maternal hemorrhage and sepsis: A prospective cohort study. Acta Obstet Gynecol Scand. 2019 Sep;98(9):1178-1186. doi: 10.1111/aogs.13626. Epub 2019 May 14. PMID: 31001814; PMCID: PMC6767575.
20.Chaudhary M, Maitra N, Sheth T, Vaishnav P. Shock Index in the Prediction of Adverse Maternal Outcome. J Obstet Gynaecol India. 2020 Oct;70(5):355-359. doi: 10.1007/s13224-020-01355-z. Epub 2020 Jul 25. PMID: 33041552; PMCID: PMC7515997.
21.Agarwal V, Suri J, Agarwal P, et al. Shock Index as a Predictor of Maternal Outcome in Postpartum Hemorrhage. J South Asian FederObst Gynae 2021;13(3):131–136.
22.Agarwal, S. and Pandey, U. (2023) 'Shock index as a predictor of maternal outcome in postpartum hemorrhage: An experience from a tertiary care centre in Northern India', International Journal of Medical Reviews and Case Reports, (0), p. 1. doi:10.5455/ijmrcr.172-1669772235.
23.Jaden R. Kohn, Gary A. Dildy& Catherine S. Eppes (2017): 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, DOI: 10.1080/14767058.2017.1402882
24.Koch E, Lovett S, Nghiem T, Riggs RA, Rech MA. Shock index in the emergency department: utility and limitations. Open Access Emerg Med. 2019 Aug 14;11:179-199. doi: 10.2147/OAEM.S178358. PMID: 31616192; PMCID: PMC6698590.
25.Nathan HL, El Ayadi A, Hezelgrave N, Seed P, Butrick E, Miller S, et al. Shock index: an effective predictor of outcome in postpartum haemorrhage? BJOG. 2015;122:268-75. Medline:25546050doi:10.1111/1471-0528.13206
26.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. Int J Gynaecol Obstet. 2014 Mar;124(3):253-5. doi: 10.1016/j.ijgo.2013.08.020. Epub 2013 Dec 4. PMID: 24373705
27.Guerrero-De Leon MC, Escarcega-Ramos LR, Gonzalez-Dias OA. Utility of the shock index in obstetric hemorrhage as a predictive value for the transfusion requirement. Ginecol Obstet Mex. 2018;86(10):665–75.
28.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. Int J Gynaecol Obstet. 2019 Feb;144(2):221-224. doi: 10.1002/ijgo.12714. Epub 2018 Dec 10. PMID: 30447073.