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ORIGINAL RESEARCH

From Scene to Emergency Department: Is Delta Shock Index a Reliable Predictor in Trauma Care? A Meta-Analysis

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ABSTRACT

Background: Trauma is a leading global cause of morbidity and mortality, with hemorrhage being a highly preventable cause of death. Delta SI (dSI), reflecting time-dependent hemodynamic changes, shows promise, though conflicting data necessitate comprehensive evaluation of its predictive superiority. This study, therefore, aims to assess the diagnostic accuracy of dSI in predicting clinical outcomes among trauma patients.

Methods: This systematic review and meta-analysis included eight studies (Jan 2015–Jul 2025) on adult trauma patients evaluating dSI (Emergency Department SI – prehospital SI) for mortality, blood transfusion needs, or Intensive Care Unit (ICU) admission. Searches were conducted across ScienceDirect, PubMed, Scopus, and Taylor & Francis. The risk of bias was assessed using the QUADAS-2.

Results: Eight studies (931,954 patients) were included. DSI consistently showed low sensitivity but high specificity. For blood transfusion, sensitivity was 0.411 (0.313–0.517) and specificity was 0.873 (0.802–0.921). For mortality, sensitivity was 0.350 (0.259–0.454) and specificity was 0.821 (0.763–0.867). ICU admission had a sensitivity of 0.21 (0.144–0.298) and a specificity of 0.887 (0.843–0.919). Subgroup analysis of massive transfusion and in-hospital mortality analyses also showed similar trends.

Conclusion: Our findings highlight that while DSI demonstrates consistently high specificity across key clinical outcomes—including mortality, transfusion needs, and ICU admission—it suffers from limited sensitivity. However, its optimal utility lies in its integration with comprehensive clinical assessment rather than standalone use.

Keywords: Delta Shock Index; ICU admission; Mortality; Outcomes; Transfusion.

INTRODUCTION

Trauma is a major global health issue, contributing significantly to morbidity, mortality, and long-term disability. According to the World Health Organization (WHO), trauma affects an estimated 20 to 50 million people annually and was the third leading cause of death globally in 2019, accounting for nearly 10% of all deaths.[1,2] The prognosis of trauma patients presenting to emergency departments is influenced by the severity of injury and the timeliness of care provided.[3]

Hemorrhage remains a primary cause of early mortality in trauma patients, particularly when it progresses to hemorrhagic shock accompanied by the lethal triad of coagulopathy, acidosis, and hypothermia. Hemorrhagic shock accounts for roughly 30–40% of trauma-related deaths[4]. Despite its severity, bleeding is one of the most preventable causes of death if promptly recognized and treated.[3,5] Therefore, early restoration of hemostasis is needed to improve patients' outcomes[3].

Early identification of patients at risk facilitates rapid blood product mobilization, enhances survival, and minimizes unnecessary transfusions[6]. To support early risk stratification, various scoring systems have been developed using physiological parameters, particularly vital signs recorded either prehospital or upon emergency department (ED) arrival. This is necessary, as it would facilitate the implementation of aggressive interventions, such as emergent surgery, angiography with embolization, and early activation of massive transfusion protocol (MTP).

While vital signs alone are often inadequate, SI variants have shown utility in predicting hemodynamic deterioration and poor outcomes in trauma patients The shock index (SI), defined as the ratio of heart rate to systolic blood pressure, has been widely used in different forms: prehospital SI, ED SI, and delta SI (the difference between field and ED SI)[7,8].

Among these, the delta shock index (dSI) has emerged as a promising predictor of outcomes, capturing dynamic hemodynamic changes between the field and the ED. Although some studies favor ED SI for its predictive accuracy[7,9] others support dSI as a simple, rapid, and effective tool for predicting mortality,

Intensive Care Unit (ICU) admission, and resource needs—highlighting its advantage in capturing time-dependent changes in vital signs and reflecting dynamic physiological deterioration [3,10–14].

A recent meta-analysis found that SI alone has limited value in predicting massive transfusion or mortality, though it may help identify low-risk[6]. Unlike SI, dSI reflects dynamic changes over time rather than a single point and, despite conflicting findings, has shown potential as a more reliable early predictor.

This systematic review aims to evaluate the diagnostic accuracy of delta shock index (dSI) in predicting key clinical outcomes—mortality, need for blood transfusion, and ICU admission in adult trauma patients, with the goal of clarifying its utility in guiding early clinical decision-making to improve patient outcomes.

METHODS

Protocol and guidance for conducting and reporting

This protocol was developed in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) guidelines. The methodology for conducting and reporting the systematic review followed the PRISMA-DTA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses of Diagnostic Test Accuracy studies) guidelines. The protocol has been registered in the International Prospective Register of Systematic Reviews (PROSPERO) under the ID 1090482.

Eligibility Criteria

We included studies involving adult trauma patients. The primary focus was on evaluating the Delta Shock Index (dSI), defined as the difference between the Shock Index (SI) measured in the emergency department (ED) and the prehospital setting. Studies were eligible if they reported dSI and its association with clinical outcomes.

We included randomized controlled trials, as well as prospective and retrospective observational studies. Studies that provided data from both the prehospital and hospital settings were eligible for inclusion. Exclusion criteria were limited to pediatric populations and study with unextractable outcome data. Conference abstracts, case reports, and

non-human studies were excluded. There were no language restrictions.

Search strategy

We conducted a systematic search of the ScienceDirect, PubMed, Scopus, and Taylor & Francis databases for relevant studies published between January 2015 and July 2025. The reference lists of all eligible articles and relevant reviews were also screened to identify additional studies.

Study selection and data extraction

Three reviewers independently conducted title and abstract screening, full-text assessment, and data extraction using a standardized template. Any disagreements were resolved through consensus. Owing to variations in outcome definitions and measurement methods, the data were analyzed using a narrative synthesis approach.

Risk of bias assessment

Following the Cochrane DTA handbook, the risk of bias and applicability concerns in diagnostic accuracy studies were assessed using the QUADAS-2 tool. This included evaluation of four key domains: patient selection, index test, reference standard, and flow and timing. Each domain was rated as having low, unclear, or high risk of bias, and the study's overall risk was determined based on the highest level of bias identified in any domain.

Statistical analysis

All statistical analyses will be carried out using R software version 4.2. Following a qualitative assessment of the included articles, data on sensitivity, specificity, and area under the curve (AUC) will be extracted. To assess variability among studies, a heterogeneity test will be conducted.

If significant heterogeneity is detected ($I^2 > 50\%$), a random-effects model will be applied; otherwise, a fixed-effect model will be used. Pooled estimates for sensitivity, specificity, and AUC will be calculated along with their corresponding 95% confidence intervals (CIs) and presented in a forest plot.

RESULTS

Study Selection and Identification

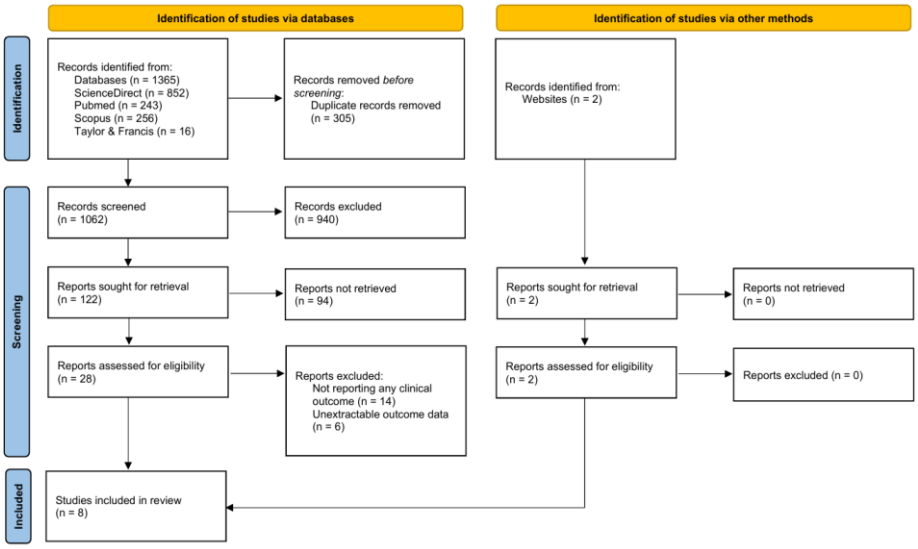

Figure 1. PRISMA 2020 flow diagram.

A total of 1,365 records were identified through database searches: ScienceDirect (n = 852), PubMed (n = 243), Scopus (n = 256), and Taylor & Francis (n = 16). Two additional records were identified through website searches. After removing 305 duplicates, 1,062 records remained for title and abstract screening. Of these, 940 records were excluded based on title and abstract review.

We assessed 122 full-text articles for eligibility. Of these, 94 articles were excluded because they evaluated different scoring tools (e.g., Shock Index, Age Shock Index, Reverse Shock Index, RSIG, TRISS) rather than the index of interest. Among the remaining 28 articles, 14 were excluded for not reporting the primary outcome (massive transfusion) or any of the secondary outcomes (mortality or ICU admission). Of the remaining 14 full-text articles, 6 were excluded due to unextractable outcome data. The 2 additional records identified through website searches were assessed and included as they met the eligibility criteria. In total, 8 studies were included in the final review. Included studies were published between 2015 and 2025, and reported on at least one of the outcomes of interest.

Eight retrospective studies were included, encompassing a total of 931,954 trauma patients from the United States, Asia, and Europe. The majority of studies involved adult trauma populations aged ≥18 years, with a pooled male proportion of 61.5%. Sample sizes ranged from 113 to 750,407 participants. Reported mean or median ages varied between 33 and 53 years.

Risk of Bias Assessment

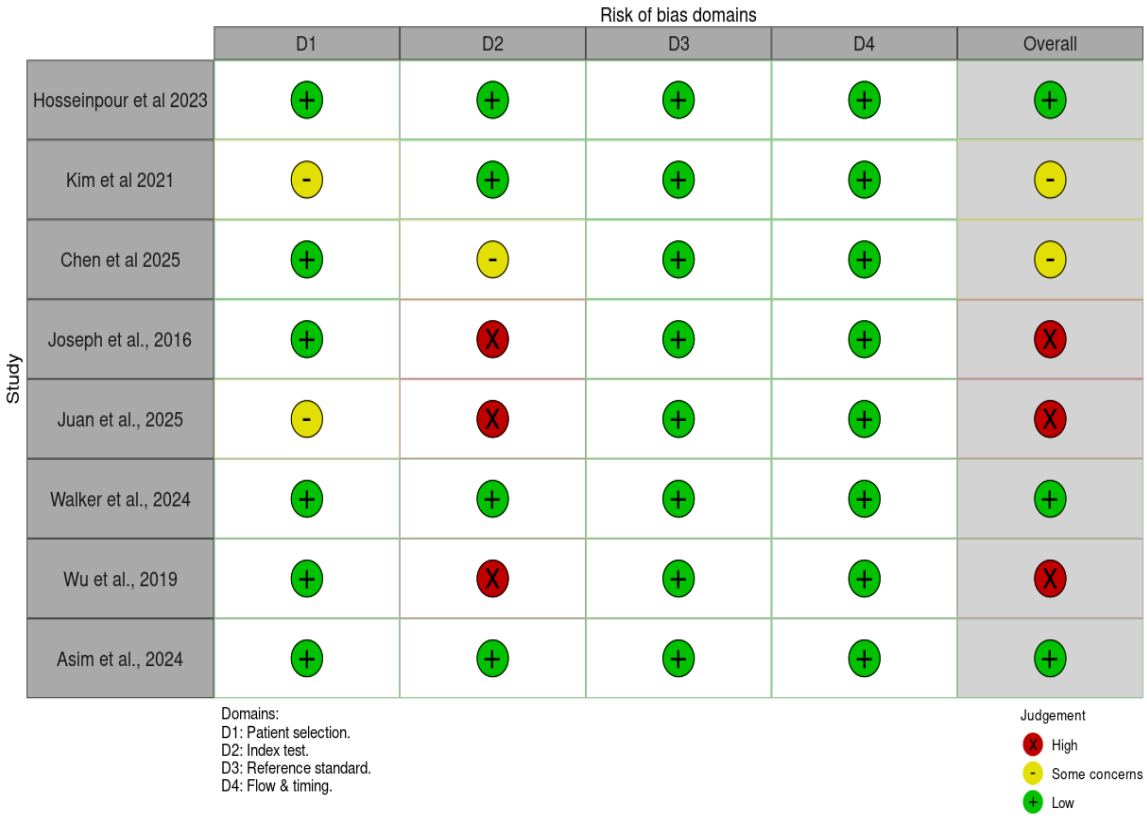

Figure 2. Risk of bias using the QUADAS-2 tool

The risk of bias assessment was shown in Fig. 2 using the QUADAS-2 tool. Most studies had low risk of bias across domains. However, high risk of bias were shown in 50% of the index test domain.

Study Characteristics and Population

Table 1. Characteristic of Included Studies

Study	Design	Country	Population	N (%male)	Age Mean ± SD / Med (IQR)
Hosseinpour et al., 2023 [7]	Retrospective, cohort analysis	US	Adult trauma patients aged ≥18 years.	750,407 (59.4%)	53 ± 21 years
Kim et al., 2021 [9]	Retrospective, cross-sectional	South Korea, Malaysia, Taiwan	Adult trauma patients aged 18-85 years.	21,534 (61.5%)	47 (29-64)
Chen et al., 2025 [12]	Retrospective, cohort analysis	Taipei	Adult trauma patients aged ≥ 18 years.	13,132 (53.4%)	NR
Joseph et al., 2016 [10]	Retrospective, cohort analysis	US	All trauma patients aged 18-85 years old and Injury Severity Score (ISS) >15 with complete data.	95,088 (72.6%)	46.2 ± 19.2 years
Juan et al., 2025 [15]	Retrospective, cohort analysis	Spain	Multiple trauma patients	113 (82.3%)	53 ± 20.36 years
Walker et al., 2024 [14]	Retrospective, cohort analysis	US	Adult trauma patients aged ≥ 18 years.	30,511 (67.8%)	dSI > 0.1: 47 [30-66] dSI ≤ 0.1: 52 [32-69]
Wu et al., 2019 [13]	Retrospective, cross-sectional	Taiwan	All trauma patients aged ≥ 20 years.	7,957 (53.8%)	MT (Yes): 53.9 ±19.5 MT (No): 52.7 ±19.1
Asim et al., 2024 [3]	Retrospective, cohort analysis	Qatar	All trauma patients.	13,212 (91%)	33 ± 15 years

dSI: Delta Shock Index; MT: Massive Transfusion; NR: Not Reported

A total of 8 studies were included, with several reporting on multiple outcomes. The predictive performance of dSI was assessed across three major clinical outcomes: mortality (n = 9 entries), blood transfusion requirements (n = 6 entries), and ICU admission (n = 3 entries). Most studies used a dSI cutoff of > 0.1, with one reporting performance at a higher threshold (≥ 0.2) as shown in Table 1.

We considered a total of 6 studies for blood transfusion. DSI showed an overall sensitivity of 0.411 [0.313-0.0.517] and an overall specificity of 0.873 [0.802-0.921] to predict blood transfusion. The AUC was 0.671. A subgroup analysis to predict MT was done, , showing an overall sensitivity of 0.413 [0.266-0.578] and an overall specificity of 0.894 [0.806-0.945] to predict MT with an AUC of 0.76.

Table 2. Pooled review

Study	Outcomes	Sensitivity	Specificity	AUC/AUROC (95% CI)	Cutoff
Mortality					
Hosseinpour et al., 2023	24-h mortality	28.4%	83.4%	0.6	0.1
Hosseinpour et al., 2023	In-hospital mortality	28%	83.5%	0.56	0.1
Kim et al., 2021	In-hospital mortality	29.2%	86.1%	NR	0.1
Chen et al., 2025	In-hospital mortality	19.33%	91.46%	0.594	0.1
Joseph et al., 2016	Mortality	47.4%	67.7%	0.556 (0.550-0.563)	0.1
Juan et al., 2025	24-h mortality	NR	NR	0.75 (0.64-0.86)	NR
Juan et al., 2025	In-hospital mortality	NR	NR	0.76 (0.63-0.89)	NR
Walker et al., 2024	28-d mortality	36.9%	78.5%	NR	0.1
Asim et al., 2024	In-hospital mortality	62.1%	77.1%	0.711 (0.676-0.746)	0.1
Blood transfusion					
Hosseinpour et al., 2023	24-h PRBC requirement	37.9%	83.9%	0.55	0.1
Kim et al., 2021	Massive transfusion	46.6%	86%	NR	0.1
Walker et al., 2024	4-h blood product requirement	42.4%	79.9%	NR	0.1
Wu et al., 2019	Massive transfusion	32.9%	90.8%	NR	0.1
Wu et al., 2019	Massive transfusion	23.2%	96.1%	NR	0.2
Asim et al., 2024	Massive transfusion	63.4%	77.3%	0.725 (0.692-0.758)	0.1
ICU admission					
Hosseinpour et al., 2023	-	28.5%	85.7%	NR	0.1
Kim et al., 2021	-	23.8%	86.6%	NR	0.1
Chen et al., 2025	-	13.28 %	92.60 %	NR	0.1

NR: Not reported; PRBC: Packed Red Blood Cell

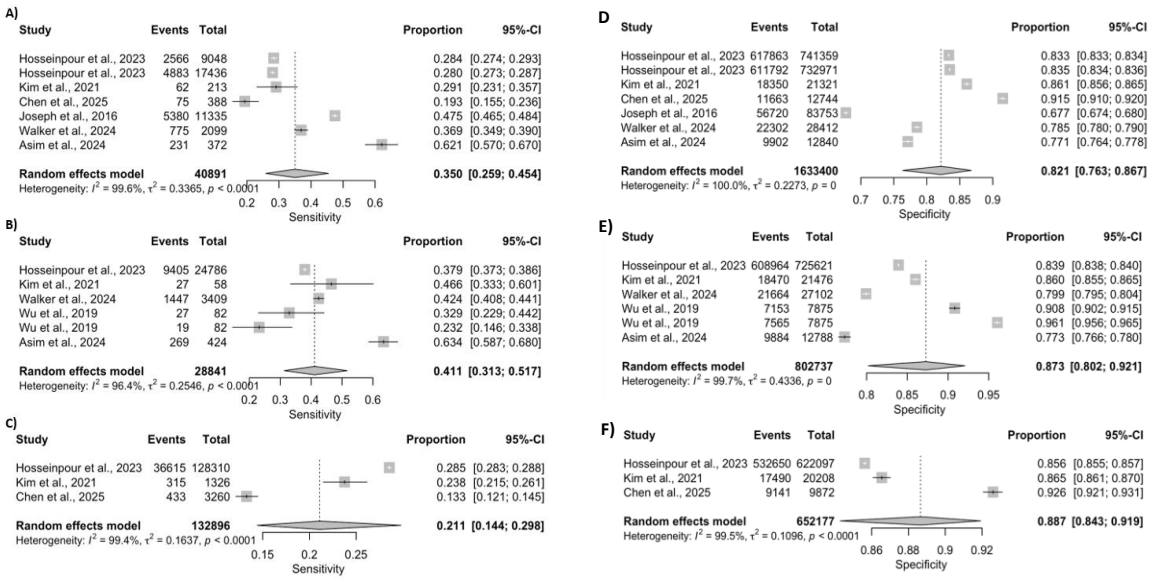

Figure 3. Pooled sensitivity and specificity. Forest plot for dSI showing the individual study sensitivity of (A) mortality, (B) blood transfusion need, and (C) ICU admission and specificity of (D) mortality, (E) blood transfusion need, and (F) ICU admission.

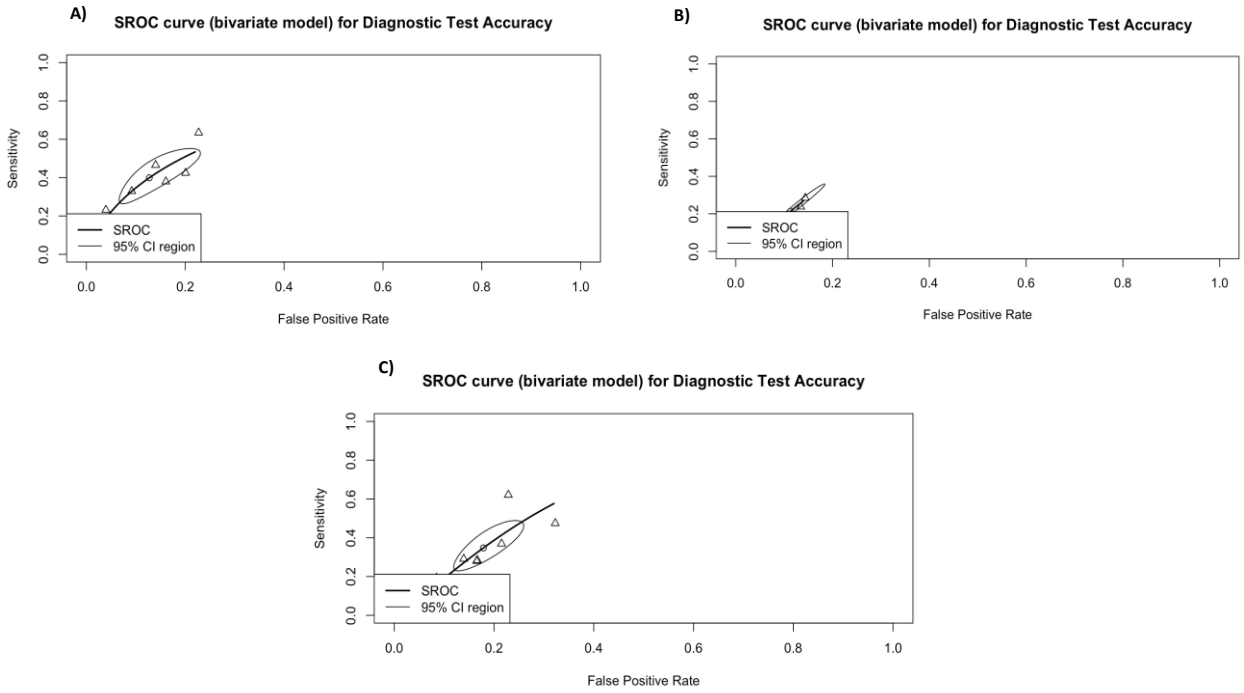

Figure 4. SROC curve for dSI in predicting (A) mortality, (B) ICU admission, and (C) blood transfusion need among trauma patients.

For mortality, 7 studies were considered. DSI showed an overall sensitivity of 0.350 [0.259-0.0.454] and an overall specificity of 0.821 [0.763-0.867] to predict mortality with an AUC of 0.673. However, to reduce the potential source of heterogeneity due to different time points for mortality definition, we performed an analysis for in-hospital mortality considering 4 studies. DSI showed an overall sensitivity of 0.333 [0.198-0.503] and an overall specificity of 0.853 [0.794-0.897] to predict in-hospital mortality. The AUC was 0.751. For ICU admission, we considered 3 studies showing an overall sensitivity of 0.21 [0.144-0.298] and an overall specificity of 0.887 [0.843-0.919] to predict ICU admission an AUC of 0.679. The pooled performance was illustrated in Fig. 3 and Fig. 4.

DISCUSSION

Major bleeding, defined by significant blood loss criteria, causes 30-40% of trauma-related deaths, yet it's largely preventable with prompt recognition and treatment[4,5,16].

The Shock Index (SI), a simple calculation of heart rate divided by systolic blood pressure, is a well-known predictor in trauma. Normal adult SI ranges from 0.5-0.7, with higher values (e.g., above 0.7) indicating increasing severity of hypovolemic shock and predicting mortality more intuitively than heart rate or blood pressure alone [3]. Recently, the delta shock index (dSI) (dSI = ED SI – Scene SI) has been studied and shown to have a better predictive power for outcomes in adult patients, which can be explained by the fact that the dSI considers time-dependent variations in vital signs and SI. An increasing SI over time, driven by a rising heart rate or falling systolic blood pressure, indicates worsening hemodynamic status and a higher risk of poor outcomes[3].

Consequently, a high (positive) dSI indicates worsening hemodynamic status, suggesting that initial resuscitation efforts may be insufficient and the patient is at higher risk of poor outcomes. Several studies have recommended a dSI cutoff value of >0.1, with values above this threshold independently associated with an increased risk of mortality in trauma patients[3,9,10]. Our meta-analysis assessed dSI's diagnostic accuracy for mortality, ICU admission, and blood transfusion needs, specifically minimizing heterogeneity by focusing on in-hospital

mortality and including a subgroup analysis for massive transfusion. Across all outcomes, dSI consistently demonstrated limited sensitivity but high specificity in predicting clinical deterioration. For mortality, dSI showed low sensitivity (0.350 [95% CI: 0.259–0.454]) and high specificity (0.821 [95% CI: 0.763–0.867]), with an AUC of 0.673, suggesting its greater utility in ruling in rather than ruling out patients at risk of death.

This aligns with primary studies demonstrating dSI's independent association with increased mortality in critically ill and trauma patients [3,8]. In order to reduce the potential source of heterogeneity due to different timepoints for mortality definition, we performed an analysis for in-hospital, but dSI still showed the same result in predicting in-hospital mortality. Similarly, for blood transfusion needs, dSI exhibited low sensitivity (0.411 [95% CI: 0.313-0.517]) and high specificity (0.873 [95% CI: 0.802-0.921]), indicating its effectiveness in identifying those likely to require blood products, though a low dSI may not reliably exclude the need**.** Creating the same pattern, with a subgroup analysis in predicting massive transfusion only, it shows a low sensitivity yet high specificity. This aligns with Asim et al. (2024), who found increased transfusion volume and massive transfusion activation in patients with elevated dSI. Schellenberg et al. (2017) further supported dSI's value in trauma settings, linking dSI >0.1 to higher transfusion needs[3,17].

For ICU admission, dSI again showed low sensitivity (0.210 [95% CI: 0.144–0.298]) but high specificity (0.887 [95% CI: 0.843–0.919]), supporting that a rising dSI reflects significant hemodynamic deterioration warranting intensive care and highlighting its value in acute triage. This is consistent with studies linking high dSI to increased ICU admissions, intubation, and longer ICU stays, even showing superiority over more time-consuming severity scores like TRISS or ISS[3,17].

DSI has emerged as a valuable prognostic tool in both trauma and critical care settings, owing to its ability to reflect time-dependent hemodynamic deterioration. Unlike static values such as heart rate (HR) or systolic blood pressure (SBP), dSI—defined as the difference in

shock index between two time points—captures dynamic physiological changes.

A positive dSI, indicating an increase in SI over time, typically reflects worsening cardiovascular status despite initial resuscitation efforts, and therefore warrants clinical concern[6]. Across all assessed outcomes; mortality, blood transfusion needs, and ICU admission, our meta-analysis consistently revealed that the dSI demonstrated low sensitivity but relatively high specificity.

This consistent pattern suggests that while a significantly elevated DSI is a strong indicator of impending severe outcomes, its absence does not reliably rule them out. The consistently low sensitivity observed across these outcomes is likely attributable to the body's robust compensatory physiological mechanisms, which can sustain seemingly stable vital signs despite significant occult bleeding or ongoing hypoperfusion.

The progression of relative blood volume deficit depends on both the severity and duration of hemorrhage. As compensatory mechanisms maintain vital signs within normal limits, early significant blood loss may be masked, delaying a noticeable rise in DSI until decompensatory shock occurs[18]. Given that dSI reflects dynamic hemodynamic changes, this delay may account for 'false negatives'—cases where patients deteriorate despite initially unremarkable DSI values. Building upon the observed consistent pattern of low sensitivity and high specificity, the multifactorial nature of the outcomes under investigation provides critical context for these diagnostic characteristics. Each of these endpoints is influenced by a complex interplay of factors far beyond isolated hemodynamic instability or its dynamic change, which dSI primarily reflects[6].

For instance, mortality in trauma or critically ill patients can result from severe traumatic brain injury, profound metabolic derangements, or pre-existing comorbidities that may not overtly manifest as significant dSI changes in their early or even terminal stages.

The utility of dSI is notably challenged in older populations, those with cardiovascular disease, and patients with TBI. In these groups, reduced physiological compensation and medications like beta-blockers or calcium channel blockers can significantly affect HR and SBP measurements, thus

obscuring shock signs and delaying compensation[8,19]. Chen et al., 2025 similarly found dSI to be a less accurate predictor among patients with cardiovascular disease and TBI. However, the limited number of cases in the extreme dSI subgroups (dSI < -0.5 and dSI > 0.5) within their cohort prevents definitive conclusions on these specific sub-populations[12].

The decision to transfuse is a nuanced clinical judgment, integrating factors like estimated blood loss, injury mechanism, evolving laboratory values (e.g., hemoglobin, lactate), and the overall clinical context of ongoing bleeding and hypoperfusion [20].

Consequently, while dSI serves as an early indicator of hemodynamic compromise, its low sensitivity suggests it may miss patients whose deterioration isn't primarily driven by a changing heart rate/blood pressure ratio, or those whose decompensation is subtle or prolonged before becoming critically apparent. Conversely, the consistently high specificity highlights that when DSI does register a substantial positive change, it powerfully correlates with a true adverse event.

This indicates that a marked elevation in DSI is a highly reliable 'red flag,' effectively identifying patients who are experiencing critical physiological deterioration requiring immediate intervention. A study comparing dSI and other shock indices found dSI had much higher AUROC values for predicting major injury (0.621 for dSI vs. 0.559/0.568 for static SI), prolonged ICU stays (0.568 vs. 0.514/0.512), and in-hospital mortality (0.594 vs. 0.499/0.518)[12].

Although one study by Hosseinpour et al. (2023) ED SI has been reported to outperform prehospital SI in predicting short-term outcomes, this study did not account for prehospital resuscitation and intervention. Failure to account for prehospital interventions such as fluid administration or bleeding control can mask the true severity of shock, especially in cases of obstructive or neurological shock where SI may remain within normal limits despite clinical deterioration[7].

This limitation may contribute to the low sensitivity of delta SI observed in our study. Supporting this, Yamada et al. (2023) analyzed 89,495 major trauma patients and found that those with

abnormal prehospital SI but normal ED SI had a higher risk of 24-hour mortality, emphasizing the importance of considering prehospital physiology in trauma assessment [21].

This further highlights that tracking physiological change over time is crucial and more effective than relying on single measurements in the rapidly evolving context of trauma care.

However, given that mortality, transfusion needs, and ICU admission are multifactorial endpoints influenced by a complex interplay of injury severity, comorbidities, and timely interventions beyond isolated hemodynamic shifts, DSI should be interpreted as a critical adjunct rather than a sole determinant, necessitating its integration with comprehensive clinical assessment and other diagnostic modalities for robust decision-making[8,22].

Other than that, substantial inter-study heterogeneity limits DSI's utility as a standalone predictor. This meta-analysis offers several key strengths. It includes a large cumulative sample size of over 900,000 trauma patients from diverse geographical regions.

By focusing specifically on DSI this study provides valuable insights into its prognostic utility across multiple clinically relevant outcomes, including mortality, transfusion requirements, and ICU admission.

By systematically synthesizing evidence from multiple studies, we have achieved increased statistical power and a more generalizable estimate of dSI's diagnostic accuracy for critical trauma outcomes than individual studies alone could provide.

Our meticulous methodology, including the precise definition of outcomes like in-hospital mortality to minimize temporal heterogeneity and the conduct of a subgroup analysis for massive transfusion, ensures the reliability of our pooled estimates.

Study Limitations and Future Research Directions

However, this meta-analysis has several limitations that warrant consideration. First, substantial inter-study heterogeneity was present, stemming from variations in outcome definitions, and population characteristics.

The inclusion of only retrospective studies may also introduce inherent biases.

Furthermore, the reliance on administrative or trauma registry data limits the granularity of patient-level variables, including the timing and extent of prehospital interventions, comorbidities, and ongoing treatments. Additionally, the diagnostic performance of DSI may be diminished in certain subpopulations, such as elderly patients or those on rate-controlling medications, where physiological compensation is blunted.

Future studies should aim to overcome current limitations through prospective, multicenter designs that incorporate standardized data collection protocols, including detailed information on prehospital interventions, resuscitation measures, and concurrent treatments. Investigating the additive predictive value of DSI when integrated with other clinical scoring tools could also provide a more comprehensive risk stratification model.

Moreover, subgroup analyses in vulnerable populations, such as elderly patients, those with cardiovascular disease, or on beta-blockers are needed to validate DSI's utility and refine its thresholds.

CONCLUSION

Delta Shock Index (DSI) has emerged as a valuable dynamic marker for identifying trauma patients at risk of adverse outcomes, particularly due to its ability to capture time-dependent hemodynamic changes. Our findings highlight that while DSI demonstrates consistently high specificity across key clinical outcomes—including mortality, transfusion needs, and ICU admission—it suffers from limited sensitivity.

This limitation is likely due to physiological compensation, variability in resuscitation, and the multifactorial nature of outcome determinants. Despite these challenges, a significantly elevated DSI remains a reliable indicator of clinical deterioration and may still serve as a useful adjunct in early trauma triage when used in combination with other clinical indicators or scoring systems.

However, its optimal utility lies in its integration with comprehensive clinical assessment rather than standalone use. Continued refinement and validation of DSI through prospective research are essential to improve patient outcomes.

REFERENCES

1 World Health Organization. Preventing injuries and violence: an overview. Technical Report 2022.

2 Dobson GP. Trauma of major surgery: A global problem that is not going away. International Journal of Surgery 2020;81:47–54. https://doi.org/10.1016/J.IJSU.2020.07.017,.

3 Asim M, El-Menyar A, Ahmed K, Al-Ani M, Mathradikkal S, Alaieb A, et al. Delta shock index predicts injury severity, interventions, and outcomes in trauma patients: A 10-year retrospective observational study. World J Crit Care Med 2024;13:99587. https://doi.org/10.5492/WJCCM.V13.I4.99587.

4 Bonanno FG. Management of Hemorrhagic Shock: Physiology Approach, Timing and Strategies. J Clin Med 2023;12. https://doi.org/10.3390/JCM12010260,.

5 Latif RK, Clifford SP, Baker JA, Lenhardt R, Haq MZ, Huang J, et al. Traumatic hemorrhage and chain of survival. Scand J Trauma Resusc Emerg Med 2023;31. https://doi.org/10.1186/S13049-023-01088-8,.

6 Carsetti A, Antolini R, Casarotta E, Damiani E, Gasparri F, Marini B, et al. Shock index as predictor of massive transfusion and mortality in patients with trauma: a systematic review and meta-analysis. Crit Care 2023;27. https://doi.org/10.1186/S13054-023-04386-W,.

7 Hosseinpour H, Anand T, Bhogadi SK, Colosimo C, El-Qawaqzeh K, Spencer AL, et al. Emergency Department Shock Index Outperforms Prehospital and Delta Shock Indices in Predicting Outcomes of Trauma Patients. Journal of Surgical Research 2023;291:204–12. https://doi.org/10.1016/J.JSS.2023.05.008,.

8 Huang YS, Chiu IM, Tsai MT, Lin CF, Lin CF. Delta Shock Index During Emergency Department Stay Is Associated With in Hospital Mortality in Critically Ill Patients. Front Med (Lausanne) 2021;8.

https://doi.org/10.3389/FMED.2021.648375/PDF.

9 Kim DK, Jeong J, Shin S Do, Song KJ, Hong KJ, Ro YS, et al. Association between prehospital field to emergency department delta shock index and in-hospital mortality in patients with torso and extremity trauma: A multinational, observational study. PLoS One 2021;16:e0258811. https://doi.org/10.1371/JOURNAL.PONE.0258811.

10 Joseph B, Haider A, Ibraheem K, Kulvatunyou N, Tang A, Azim A, et al. Revitalizing Vital Signs: The Role of Delta Shock Index. Shock 2016;46:50–4. https://doi.org/10.1097/SHK.0000000000000618.

11 Bardes JM, Price BS, Bailey H, Quinn A, Warriner ZD, Bernard AC, et al. Prehospital Shock Index Predicts Outcomes After Prolonged Transport: A Multicenter Rural Study. J Trauma Acute Care Surg 2023;94:525. https://doi.org/10.1097/TA.0000000000003868.

12 Chen YL, Wu TH, Liu CY, Wang CH, Tsai CH, Chung JY, et al. Delta shock index in the emergency department as a predictor of clinical outcomes in traumatic injury. American Journal of Emergency Medicine 2025;92:10–7. https://doi.org/10.1016/j.ajem.2025.02.041.

13 Wu SC, Rau CS, Kuo SCH, Hsu SY, Hsieh HY, Hsieh CH. Shock index increase from the field to the emergency room is associated with higher odds of massive transfusion in trauma patients with stable blood pressure: A cross-sectional analysis. PLoS One 2019;14:e0216153. https://doi.org/10.1371/JOURNAL.PONE.0216153.

14 Walker PW, Luther JF, Wisniewski SR, Brown JB, Moore EE, Schreiber M, et al. Prehospital Delta Shock Index Predicts Mortality and Need for Life Saving Interventions in Trauma Patients. Prehospital Emergency Care 2024. https://doi.org/10.1080/10903127.2024.2412841,.

15 Victoria Juárez San Juan A, Juárez San Juan P, Artiles Armas M, Cano Contreras L, Beltrán Calero P, Jorge Ripper C, et al. Retrospective study on the Delta Shock Index associated with age and the Glasgow Coma Score (dSIAG) as a prognostic scale for mortality in polytrauma patients. Cirugía Española (English Edition) 2025;103:800111. https://doi.org/10.1016/J.CIRENG.2025.800111,.

16 Flint AWJ, McQuilten ZK, Wood EM. Massive transfusions for critical bleeding: is everything old new again? Transfusion Medicine 2018;28:140–9. https://doi.org/10.1111/TME.12524,.

17 Schellenberg M, Strumwasser A, Grabo D, Clark D, Matsushima K, Inaba K, et al. Delta shock index in the emergency department predicts mortality and need for blood transfusion in trauma patients. American Surgeon 2017;83:1059–62. https://doi.org/10.1177/000313481708301009,.

18 Convertino VA, Wirt MD, Glenn JF, Lein BC. The compensatory reserve for early and accurate prediction of hemodynamic compromise: A review of the underlying physiology. Shock 2016;45:580–90. https://doi.org/10.1097/SHK.0000000000000559,.

19 Lin PC, Liu CY, Tzeng IS, Hsieh TH, Chang CY, Hou YT, et al. Shock index, modified shock index, age shock index score, and reverse shock index multiplied by Glasgow Coma Scale predicting clinical outcomes in traumatic brain injury: Evidence from a 10-year analysis in a single center. Front Med (Lausanne) 2022;9:999481. https://doi.org/10.3389/FMED.2022.999481/BIBTEX.

20 Rossaint R, Afshari A, Bouillon B, Cerny V, Cimpoesu D, Curry N, et al. The European guideline on management of major bleeding and coagulopathy following trauma: sixth edition. Critical Care 2023 27:1 2023;27:1–45. https://doi.org/10.1186/S13054-023-04327-7.

21 Yamada Y, Shimizu S, Yamamoto S, Matsuoka Y, Tsutsumi Y, Tsuchiya A, et al. Prehospital shock index predicts 24-h mortality in trauma patients with a normal shock index upon emergency department arrival. American Journal of Emergency Medicine 2023;70:101–8. https://doi.org/10.1016/j.ajem.2023.05.008.

22 Papadimitriou-Olivgeris M, Panteli E, Koutsileou K, Boulovana M, Zotou A, Marangos M, et al. Predictors of mortality of trauma patients admitted to the ICU: a retrospective observational study☆. Brazilian Journal of Anesthesiology (English Edition) 2021;71:23–30. https://doi.org/10.1016/j.bjane.2020.12.006.