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Shock index identifies compensated shock in the 'Normotensive' trauma patient

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ABSTRACT

Introduction: Hemorrhagic shock is a life-threatening condition that requires rapid identification for timely intervention. Although shock is easily discernible in the hypotensive patient, compensated shock in the "normotensive" patient is not. This study aimed to evaluate the utility of shock index (SI) in trauma patients with compensated shock.
Methods: Patients with SBP $>$ 90 mmHg on arrival were identified from our trauma center registry. SI was calculated by arrival heart rate divided by arrival SBP. Patients were stratified by SI using the following thresholds: $\leq$ 0.7, $>$ 0.7 to 0.9, $>$ 0.9 to 1.1, $>$ 1.1 to 1.3, and $>$ 1.3. Cross tabulations were used to estimate the odds of transfusion within 1 hour of arrival for each SI category with $\leq$ 0.7 as the referent.
Results: 5958 trauma patients were included. Blood products were transfused within 1 hour of arrival in 211 (3.5 %) patients. A main effect was observed for shock index with increased risk for required transfusion for patients with admission shock index $>$0.7 ($P < 0.001$). In comparison to shock index of $\leq$ 0.7, odds ratios were 2.5(1.7 – 3.8), 8.2(5.4 – 12.2), 24.9(15.1 – 41.1), 59.0(32.0 – 108.6) for each categorical increase in SI.
Discussion: Among trauma patients presenting without hypotension, elevated SI was associated with an increase in odds of receiving transfusion within one hour. SI may be useful in determining the presence of compensated shock in non-hypotensive patients.

Introduction

Rapid identification of trauma patients experiencing hemorrhagic shock is critical and time-sensitive for optimizing patient outcomes. Conventional vital signs of heart rate (HR) and systolic blood pressure (SBP) are used to quickly evaluate the hemodynamic stability of such patients [1]. Nonetheless, it is well-known that relatively normal values of such measurements may conceal significant underlying hemorrhagic shock [2].

Shock index (SI), defined as HR/SBP, was first described in 1967, with normal values described between 0.5–0.7 in healthy adults [3]. In the setting of medical patients with acute gastrointestinal bleed, SI was observed to be increased to values as high as 2.5 [3]. Multiple studies of trauma patients have evaluated SI as a predictive tool. Abnormal SI has been demonstrated to be associated with increased mortality, hospital length of stay (LOS), injury severity score (ISS) $\geq$16, intensive care unit (ICU) admission rate, and incidence of blood transfusion [4–9]. Furthermore, SI has been demonstrated to outperform other predictive scores in predicting massive transfusion [9,10].

A shortcoming of these prior studies is the inclusion of hypotensive patients in the studied cohorts. Hypotensive patients are clearly experiencing shock; in the presence of hypotension, SI does not inform clinical decision making. The goal of our study was to evaluate the utility of SI in identifying trauma patients with compensated shock,

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using early transfusion as a surrogate marker of shock. We hypothesized that abnormal SI (>0.7) in non-hypotensive trauma patients would be associated with early blood transfusion.

Materials and methods

Upon approval of our institutional review board, records for patients admitted to our Level I trauma center between January 2016 and March 2023 were reviewed in this retrospective study. Patient demographics, injury characteristics, vitals upon hospital arrival, blood products administered during the first hour following arrival, and hospital disposition were collected. Patients with arrival SBP ⟨ 90, age <18, pregnancy, interfacility transfers, and who died within 60 min from arrival were excluded. SI was calculated by arrival heart rate divided by arrival SBP. Patients were stratified by SI using the following thresholds: ≤ 0.7, ⟩ 0.7 to 0.9, > 0.9 to 1.1, > 1.1 to 1.3, and > 1.3.

The odds of transfusion within 1 hour of arrival for each SI category with ≤ 0.7 as the referent were calculated using contingency tables from the cross tabulation function and are reported with 95 % confidence intervals This analysis was replicated for both heart rate and SBP divided at the following quartiles (heart rate: <81, 81- 94, 95 – 108, ≥109; SBP 90–127, 128–140, 141–156, ≥157). Receiver operating characteristic curve analysis was done to determine the optimal threshold to predict early transfusion based on the Youden index. Sensitivity, specificity, positive predictive value, and negative predictive values are shown. Missing data for race and ethnicity are reported. There were no other variables with missing data. A small proportion of patients seen by the trauma service do not have documentable injuries and are coded as such. SPSS version 27 was used for analysis. P-values <0.05 were considered statistically significant.

Results

During the study time frame our trauma center admitted 11,703

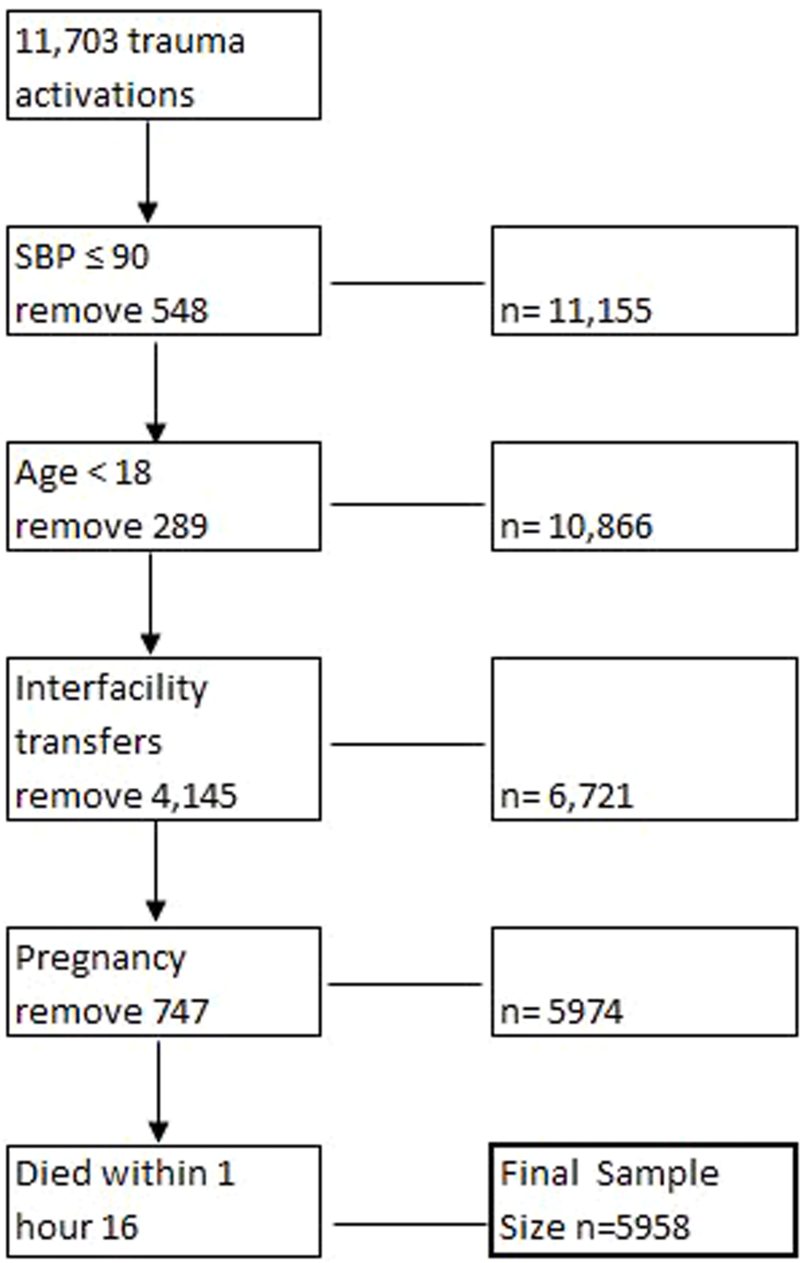


Fig. 1. Patient flow diagram.

patients. Following exclusion of specific patient groups as outlined in the methods section, our final sample consisted of 5958 patients of whom, 211 were transfused within 1 hour of hospital arrival (Fig. 1). Massive transfusion protocol was initiated for 91 (43.1 %) of the 211 transfused patients (1.5 % of the total study population). Of note, no patient had received any transfusions prior to arrival (i.e. during transport).

Patient demographics and injury characteristics are shown in Table 1 for the overall cohort with stratification by transfused vs. not transfused. 79.1 % of the transfused patients were male, White (55.0 %), and Hispanic (26.1 %) with an average age of 41 years. Penetrating injuries were more common in the transfused cohort (42.2 %) vs. the non-transfused (20.6 %). 23.7 % of patients in the transfused cohort expired or were discharged to hospice vs. 2.4 % of patients in the non-transfused cohort. 128 (60.7 %) patients in the transfused cohort went directly from the emergency department to the operating room or interventional radiology suite for hemorrhage control vs. 623 (10.8 %) in the non-transfused cohort. Initial lactic acid values were significantly higher for the transfused group [7.1(5.0) mmol/L vs 2.9(2.3) mmol/L, $P < 0.001$].

The blood products transfused during the first hour are shown in Table 2. All 211 transfused patients received one or more units of packed red blood cells (PRBCs). The median number of PRBCs transfused in the first hour was 4 (25th – 75th percentile: 2 – 9). 133 (63 %) of the transfused patients also received pre-thawed plasma, 92 (43.6 %) received platelets, and 62 (29.4 %) received Cryoprecipitated Anti-hemophilic Factor.

For the 56.1 % ($n = 3343$) of patients with SI ≤ 0.70 upon hospital arrival, 1.3 % ($n = 42$) were transfused blood product within one hour (Table 3). As SI increased, the percentage of transfused patients increased with shock index to 42.9 % of patients transfused with shock index > 1.3. As SI increased, the proportion of patients in each SI category group decreased linearly, down to 0.9 % with SI > 1.3.

Odds ratios (OR) for early transfusion with 95 % confidence intervals are reported in Table 3 and shown in Fig. 2A. There was a 3-fold increase in the odds ratios with each increase in SI category.

A similar model was constructed for the subgroup of patients with SBP > 110 mmHg (Table 3). We observed a similar increase in the odds of early transfusion with increasing shock index (Fig. 2B). For both the SBP > 90 and SBP > 110 regression models, higher shock index was associated with likelihood of transfusion ($P < 0.001$).

Heart rate and SBP were used in place of SI to test these variables as predictors of early transfusion (Table 3). For heart rate, transfusion rates by quartile were: heart rate: <81, 1.7 %; heart rate 81- 94, 1.4 %; heart rate 95 – 108, 2.3 %; heart rate ≥109, 8.6 %. The odds of transfusion for only the highest quartile (≥109) were significantly greater than the lowest quartile (< 81), OR 5.4(3.5 – 8.4), $P < 0.001$; Table 3. Early transfusion rates also decreased with each increasing SBP quartile: SBP 90–127, 7.7 %; SBP 128–140, 2.7 %; SBP 141–156, 2.3 %; SBP ≥157, 1.4 %). The odds of transfusion for each of the upper 3 quartiles were significantly less than the referent group of SBP 90–127.

Average admission lactic acid levels and proportion of patients that went from the emergency department to the operating room or interventional radiology suite for hemorrhage control, stratified by SI

Table 1
Patient demographics and injury characteristics.

	Entire Sample (n = 5958)	Nontransfused patients (n = 5747)	Transfused patients (n = 211)
Age	40.6 (17.4)	40.6 (17.4)	40.7 (16.8)
Sex, male	4362 (73.2 %)	4195 (73.0 %)	167 (79.1 %)
Race			
American Indian/ Alaska Native	198 (3.3 %)	188 (3.3 %)	10 (4.7 %)
Asian	46 (0.8 %)	46 (0.8 %)	0
Black	719 (12.1 %)	690 (12.0 %)	29 (13.7 %)
Other	1458 (24.5 %)	1403 (24.4 %)	55 (26.1 %)
White	3532 (59.3 %)	3416 (59.4 %)	116 (55.0 %)
Missing	5 (0.1 %)	4 (0.1 %)	1 (0.5 %)
Ethnicity			
Hispanic	1857 (31.2 %)	1802 (31.4 %)	55 (26.1 %)
Non-Hispanic	4095 (68.7 %)	3940 (68.6 %)	155 (73.5 %)
Missing	6 (0.1 %)	5 (0.1 %)	1 (0.5 %)
Penetrating injury	1272 (21.4 %)	1183 (20.6 %)	89 (42.2 %)
Injury Severity Score			
<9	3323 (58.2 %)	3309 (57.6 %)	14 (6.6 %)
9–15	1296 (22.7 %)	1258 (21.9 %)	38 (18.0 %)
16+	1095 (19.2 %)	936 (16.3 %)	159 (75.4 %)
No injury	244 (4.1 %)	244 (4.2 %)	0
SBP, mean (SD)	142.5 (24.0)	143.1 (23.8)	126.9 (24.9)
SBP quartiles			
25th	127	128	106
50th	140	140	124
75th	156	156	141
ER Disposition			
ED Death	13 (0.2 %)	9 (0.2 %)	4 (1.9 %)
Floor	2537 (42.6 %)	2534 (44.1 %)	3 (1.4 %)
Home	861 (14.5 %)	861 (15.0 %)	0
ICU	1771 (29.7 %)	1695 (29.5 %)	76 (36.0 %)
OR/IR	751 (12.6 %)	623 (10.8 %)	128 (60.7 %)
Other	25 (0.4 %)	25 (0.4 %)	0
Hospital Disposition, death or hospice	187 (3.1 %)	137 (2.4 %)	50 (23.7 %)

Table 2
Blood products transfused in the first hour.

	Packed Red Blood Cells	Plasma	Platelets	Cryoprecipitated Antihemophilic Factor
Count (%) of the 211 transfused patients administered product	211(100 %)	133 (63.0 %)	92 (43.6 %)	62 (29.4 %)
For patients given the product, median units administered (25th – 75th) percentile	4 (2 – 9)	4 (2 – 9)	2 (1–2)	4 (4–8)
Average blood units by SI category, if given the product				
≤ 0.7	7.7 (8.1)	8.0 (7.1)	2.1 (1.3)	7.1 (9.8)
>0.7 to 0.90	6.5 (6.6)	6.8 (7.9)	1.9 (1.2)	8.1 (6.0)
>0.9 to 1.1	7.4 (7.5)	6.8 (6.1)	2.0 (1.2)	5.9 (5.5)
>1.1 to 1.3	5.9 (5.1)	5.9 (5.1)	1.7 (1.0)	10.0 (11.3)
>1.3	9.1 (13.7)	7.8 (9.4)	2.2 (1.8)	5.1 (4.0)

Table 3
Distribution of Shock Index with Corresponding Transfusion Rates.

	Distribution (in column percent)	Not transfused (row percent)	Transfused) (row percent)	Odds Ratio (95 % CI)
Shock Index, SBP > 90				
≤ 0.7	3344 (56.1 %)	3302 (98.7 %)	42 (1.3 %)	1
>0.7 to 0.90	1829 (30.7 %)	1772 (96.9 %)	57 (3.1 %)	2.5 (1.7 – 3.8)
>0.9 to 1.1	596 (10.0 %)	540 (90.6 %)	56 (9.4 %)	8.2 (5.4 – 12.2)
>1.1 to 1.3	133 (2.2 %)	101 (75.9 %)	32 (24.1 %)	24.9 (15.1 – 41.1)
>1.3	56 (0.9 %)	32 (57.1 %)	24 (42.9 %)	59.0 (32.0 – 108.6)
Shock Index, SBP > 90 and age ≥ 65				
≤ 0.7	519 (77.7 %)	513 (98.8 %)	6 (1.2 %)	1
>0.7 to 0.90	112 (16.8 %)	101 (90.2 %)	11 (9.8 %)	9.3 (3.4 – 25.8)
>0.9 to 1.1	24 (3.6 %)	21 (87.5 %)	3 (12.5 %)	12.2 (2.9 – 52.2)
>1.1 to 1.3	11 (1.6 %)	7 (63.6 %)	4 (36.4 %)	48.8 (11.2 – 212.2)
>1.3	2 (0.3 %)	2 (100 %)	0	NA
Shock Index, SBP > 110				
≤ 0.7	3287 (59.5 %)	3250 (98.9 %)	37 (1.1 %)	1
>0.7 to 0.90	1688 (30.6 %)	1633 (96.7 %)	55 (3.3 %)	2.9 (1.9 –4.5)
>0.9 to 1.1	461 (8.3 %)	423 (91.8 %)	38 (8.2 %)	7.9 (5.0 –12.5)
>1.1 to 1.3	73 (1.3 %)	57 (78.1 %)	16 (21.9 %)	24.7 (13.0 – 46.9)
>1.3	14 (0.3 %)	9 (64.3 %)	5 (35.7 %)	48.8 (15.6 – 152.6)
Heart Rate				
< 81	1405 (23.6 %)	1381 (98.3 %)	24 (1.7 %)	1
81 - 94	1510 (25.3 %)	1489 (98.6 %)	21 (1.4 %)	0.8 (0.5 – 1.5)
95 – 108	1513 (25.4 %)	1478 (97.7 %)	35 (2.3 %)	1.4 (0.8 – 2.3)
≥109	1530 (25.7 %)	1399 (91.4 %)	131 (8.6 %)	5.4 (3.5 – 8.4)
SBP				
90–127	1511 (25.4 %)	1395 (92.3 %)	116 (7.7 %)	1
128 –140	1554 (26.1 %)	1512 (97.3 %)	42 (2.7 %)	0.3 (0.2 – 0.5)
141 – 156	1452 (24.4 %)	1419 (97.7 %)	33 (2.3 %)	0.3 (0.2 – 0.4)
≥157	1441 (24.2 %)	1421 (98.6 %)	20 (1.4 %)	0.2 (0.1 – 0.3)

category, is demonstrated in Table 4. Both were observed to rise with respective increase in SI category.

Receiver operating characteristic curves

Receiver operating characteristic curves (ROC) analysis of shock index predicting early transfusion produced an area under the curve of 0.77 (0.73 – 0.81), $P < 0.0001$. The associated Youden index criterion of SI > 0.825 with model diagnostics are shown in Table 5. Model diagnostics are also reported considering SI criteria of 0.80, 0.90, 1.0, 1.1, and 1.2.

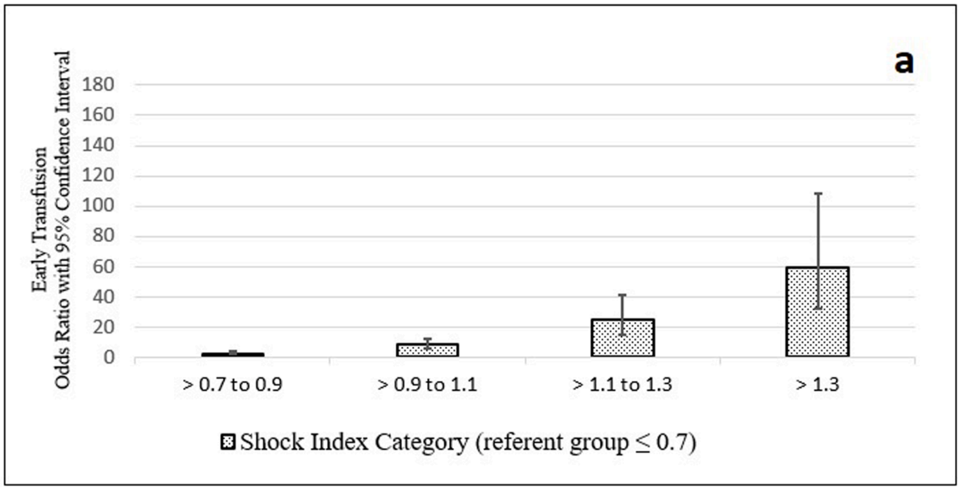
Discussion

SI is a well-known and easily calculated marker of hemorrhage in trauma patients [11]. In fact, it is recommended for use in the latest iteration of the United States national trauma field triage guideline [12]. Nonetheless, it is our perception that SI may be talked about, but it is seldom used in clinical practice in real time. In fact, SI is not described in the most recent iteration of the Advanced Trauma Life Support course [2]. We believe that the reason for this is that hypotension in and of itself is often pathognomonic for hemorrhagic shock, rendering the calculation of SI superfluous and unnecessary. It is, however, well understood that many patients in early hemorrhagic shock can maintain a normal blood pressure using compensatory measures such as the release of endogenous catecholamines [13]. In this study, by excluding hypotensive patients we have demonstrated that SI is well suited to the identification of early compensated hemorrhagic shock.

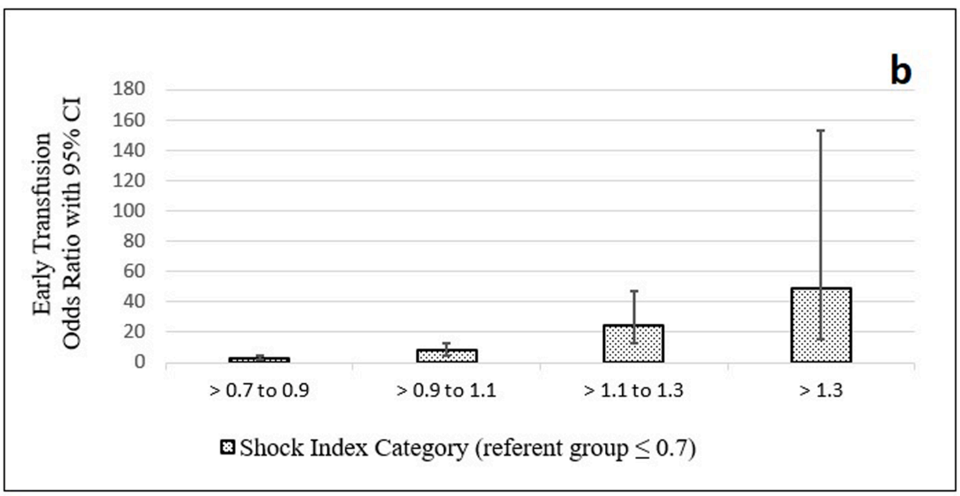
We restricted our study population to those patients with initial emergency department systolic blood pressure above 90. We chose this threshold as it is historically considered the lower limit of what is considered “normotensive” or not hypotensive. As demonstrated in our results, SI was associated with increased frequency of early transfusion among these patients in a stepwise manner. It is also understood, however, that higher systolic blood pressure in some patients may result in relative hypotension (e.g. older and/or baseline hypertensive patients) [14]. Therefore, we performed a subgroup analysis restricting the study population to those patients with initial emergency department systolic blood pressure above 110. In this subgroup, SI remained associated in stepwise manner with increased frequency of early transfusion, with similar pattern and magnitude to the primary findings. We are thus confident that SI is a useful marker of early transfusion amongst all “normotensive" patients irrespective of what threshold for normal systolic blood pressure is used.

SBP, one of the variables needed to calculate SI; heart rate (HR) is the other. We evaluated HR as a potential predictor of compensated shock and determined that although higher HR was associated with early transfusion in non-hypotensive patients (Table 3), the association was weak relative to SI in the same group of patients. In a previous study, Brasel et al. demonstrated that admission HR was a poor indicator of subsequent mortality [15]. Similarly, as SBP approached 90, a weak association between decreasing SBP and early transfusion was observed (Table 3). From this we conclude that the interplay of SBP and HR in non-hypotensive patients as represented by SI is a more useful clinical metric than either SBP or HR alone for the identification of compensated shock.

This raises the question as to how to best utilize SI in clinical practice. Although we have no doubt that some physicians calculate SI for all trauma patients seen in the emergency department, as stated above it is our sense that most do not routinely do this. For plainly hypotensive patients, calculating SI is unnecessary; the need for expedient treatment in such patients to simultaneously resuscitate the shock state and identify the source of bleeding is collectively recognized and the cornerstone of Advanced Trauma Life Support. For trauma patients who present with an initial systolic blood pressure that is within normal range or elevated, we do recommend that the treating physician calculate SI as a next step in determining whether compensated shock may be present. The next question, then, is what value of SI should be considered of concern? The Youden index cut point was determined to be 0.825, but this value is somewhat cumbersome, and, in our opinion, there is a more practical cut point that can be gleamed from the data herein and for simplicity. Evaluation of the sensitivity/specificity and positive/negative predictive values in Table 5 suggest that very high specificity is achieved at SI values greater than 1. Similarly, the positive predictive value for SI increases steadily (up to 40 % for SI > 1.2) while a very high negative predictive value is maintained for all SI values. We believe the positive predictive value associated with SI > 1.0 (23 %) represents a point of inflection whereby the risk of underlying



¥Pairwise comparisons between all groups including referent (SI<=0.7) were statistically significant at P<0.001.



¥Pairwise comparisons between all groups including referent (SI<=0.7) were statistically significant at P<0.001.

Fig. 2. (a) Association of shock index and early transfusion including patients with SBP > 90. (b) Association of shock index and early transfusion including patients with SBP > 110.

Table 4
Mean lactic acid values and proportion of patients to OR/IR by shock index category.

Shock Index, SBP > 90	Count(%) of patients with trauma disposition to OR/IR	Lactic Acid, mmol/L
≤ 0.7	353 (10.6 %)	2.4 (1.7)
>0.7 to 0.90	216 (11.8 %)	3.2 (2.5)
>0.9 to 1.1	124 (20.8 %)	4.7 (3.8)
>1.1 to 1.3	38 (28.6 %)	5.9 (3.9)
>1.3	20 (35.7 %)	8.4 (5.2)
	$P < 0.001$	$P < 0.001$

compensated shock (i.e. greater than 1 in five chance) is of meaningful clinical concern. Additionally, using a cutoff of 1.0 for SI brings with it a level of simplicity that avoids mental arithmetic (or use of calculator) to make the SI calculation. Simply recognizing that HR is greater than SBP signifies SI > 1.0 and should alert the clinician that early and/or compensated shock may be present despite the initial systolic blood pressure being normal or even elevated [16].

Limitations

This study suffers from limitations related to study design. The primary outcome of the study was blood transfusion within one hour of trauma center arrival. We chose this outcome as we felt it was a strong surrogate measure of shock. The observation in this study that early transfusion was associated with relatively elevated lactic acid levels supports this. Nonetheless, transfusion remains a surrogate measure and we cannot be certain that it was representative of shock in all study patients. That said, the decision for early transfusion in our trauma center is generally related to clinical recognition of the shock state or other signs of active blood loss and not based on laboratory results. Along similar lines, given the retrospective study design, it is important to consider how the decision to transfuse was made, and specifically if SI was used in making that decision. Although we cannot discern if SI was ever used in the decision to transfuse the patients in this study, we do know that it is not our practice to transfuse based on any single clinical value (including hypotension). It is possible that initial SI alone triggered the decision to order transfusion, but we believe that it is far more likely that the decision to transfuse was made following assessment of the patient's physical condition, serial vital signs, and adjuncts such as plain x-ray or bedside ultrasound (Focused Assessment with Sonography in Trauma, FAST exam). Also, we did not assess the subsequent hospital

Table 5
Summary of Receiver Operating Characteristic Curve Analysis.

	Sensitivity (95 % CI)	Specificity (95 % CI)	Positive Likelihood Ratio (95 % CI)	Negative Likelihood Ratio (95 % CI)	Positive Predictive Value (95 % CI)	Negative Predictive Value (95 % CI)
Shock Index						
>0.800	67.8 (61.0 – 74.0)	77.0(75.9 – 78.1)	2.9(2.7–3.3)	0.4(0.3 – 0.5)	9.8(8.9 – 10.7)	98.4 (98.2 – 98.8)
>0.825	*65.4(58.6 – 71.8)*	*80.0(79.0 – 81.0)*	*3.3(3.0 – 3.7)*	*0.4 (0.4 – 0.5)*	*10.7(9.7 – 11.8)*	*98.4(98.1 – 98.7)*
>0.900	52.6(45.6 – 59.5)	88.7(87.8 – 89.5)	4.6(4.0 – 5.4)	0.5(0.5 – 0.6)	14.6(12.8 – 16.5)	98.1(97.8 – 98.3)
>1.000	36.0(29.5 – 42.9)	95.0(94.4 – 95.5)	7.1(5.8 – 8.8)	0.7(0.6 – 0.8)	22.8(17.5 – 24.5)	97.6 (97.3 – 97.8)
>1.100	27.0 (21.2 – 33.5)	97.7 (97.2 – 98.0)	11.6(8.8 – 15.3)	0.8(0.7 – 0.8)	29.8(24.4 – 36.0)	97.3(97.1 – 97.5)
>1.200	18.5(13.5 – 24.4)	99.0 (98.7 – 99.2)	18.0(12.3 – 26.3)	0.8(0.8 – 0.9)	39.8 (31.1 – 49.2)	97.1 (96.9 – 97.2)
	True Positive	True Negative	False Positive	False Negative		
>0.800	143	4424	1323	68		
>0.825	138	4598	1149	73		
>0.900	111	5095	652	100		
>1.000	76	5457	290	135		
>1.100	57	5613	134	154		
>1.200	39	5688	59	172		

course for each patient (hemorrhage control procedures, mechanical ventilation, ICU admission as examples) as it was beyond the purpose of this study. We chose to focus on early transfusion as the primary outcome given that it implies that compensated shock was determined in the emergency department for this cohort of non-hypotensive patients. Lastly, given our prehospital emergency management system did not have any transfusion capabilities over the period of the study, no study patients received any prehospital transfusions. Therefore, the observations from this study may not be applicable to hospitals that receive injured patients who have received transfusion products during transport.

Conclusions

In summary, this study has demonstrated that among non-hypotensive trauma patients, irrespective of mechanism of injury, elevated SI was associated with early transfusion. Although it is well accepted that elevated SI is associated with shock, resource utilization such as blood, and even mortality among trauma patients, we feel that it has not been embraced as a routine clinical calculation given that the presence of hypotension frequently negates its need. For non-hypotensive patients, however, we recommend that SI be considered as an early identifier of compensated shock, and that a cutoff of 1.0 is most useful given the positive and negative predictive values observed in this study, along with the practicality of recognizing that HR>SBP means that SI is greater than 1.0.

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CRediT authorship contribution statement

Theodore M Lin: Writing – review & editing, Visualization, Validation, Conceptualization. **Ali M. Memon:** Writing – review & editing, Data curation. **Emily A. Reeson:** Writing – review & editing, Data curation. **Grace C. Tolan:** Writing – review & editing, Data curation. **Trevor M. Low:** Writing – review & editing, Data curation. **Kristina M. Kupanoff:** Writing – review & editing, Writing – original draft, Project administration, Formal analysis, Data curation. **Dih-Dih Huang:** Writing – review & editing, Writing – original draft, Supervision, Conceptualization. **Michael D. Jones:** Writing – review & editing, Writing – original draft, Project administration, Conceptualization. **Brian R. Czarkowski:** Writing – review & editing, Writing – original draft, Conceptualization. **Hahn Soe-Lin:** Writing – review & editing, Writing – original draft, Supervision, Conceptualization. **James N. Bogert:** Writing – review & editing, Writing – original draft, Supervision, Conceptualization. **Jordan A. Weinberg:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Conceptualization.

Declaration of competing interest

None.

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