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Pattern and Distribution of Shock Index and Age Shock Index Score Among Trauma Patients in Towards Improved Trauma Care Outcomes (TITCO) Dataset

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ABSTRACT

Objective: To compare the shock index (SI – which is the ratio of heart rate to systolic blood pressure) and Age SI (Age in years multiplied by SI) with survival outcome of the patients across multicenter trauma registry in India.

Methods: Study is based on Towards Improved Trauma Care Outcomes (TITCO) project. Records with valid details of age, heart rate, systolic blood pressure, Injury Severity Scale (ISS) and Glasgow Coma Scale (GCS) score was considered. SI was categorized into four groups; Group I (SI<0.6) as no shock, group II (SI≥0.6 to <1.0) as mild shock, group III (SI ≥1.0 to <1.4) as moderate shock and group IV (SI≥1.4) as severe shock. Age SI was categorized decade wise into six groups. Mortality was dependent variable. GCS and ISS were considered as secondary variables.

Results: 10843 participants from TITCO registry satisfying inclusion-exclusion criteria were considered for study. Mean SI score in group I to IV was increasing with 0.53 to 1.72 respectively. Age SI was seen to be increasing across its six groups. Gender wise no difference was found among SI group. For severe ISS and critical ISS, mortality in SI group IV was 50% and 56 % respectively. Mortality was increasing across mild to severe GCS among all SI groups.

Conclusion: The categorized SI and Age SI had shown increase in death percentages from mild to severe severity of injuries. Similar to GCS and ISS, SI and Age SI should also be calculated and categorized in all health care and further plan for management aspects.

Keywords: Shock index; Age shock index; Heart rate; Blood pressure; Mortality; Trauma.

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Introduction

Alterations in physiological parameters documented during initial condition assist in determining the severity of trauma injury. These changes help to determine further management aspects of the emergency. Age also has significant effect on trauma outcome. The common physiological parameters that determine outcome after injury are age, heart rate, blood pressure, respiratory rate and pupil condition [1-4]. Uncontrolled blood loss leads to hypotension and it is recognized as one of the important cause of early mortality in trauma patients [5-8]. To assess the presence of hypovolemic shock measurements of the isolated vital parameters, like heart rate and/or systolic blood pressure have not found much reliable [9]. To overcome these limitations studies have explored the role of the admission Shock Index (SI), as a clinical indicator to predict the outcome [9-11]. Shock index is defined as ratio of heart rate divided by systolic blood pressure. Further, Age in years multiplied by SI is termed as Age SI, and it is also appears as an important predictor of outcome among trauma patients [3]. In low middle income countries (LMICs) due to limited resources as well as incomplete imaging different types of trauma scores are needs to be validated. These trauma scores mainly includes, injury severity score (ISS), renal trauma score (RTS), Glasgow coma scale (GCS), Trauma Injury severity score (TRISS) [12].

Assuming this in mind we've consider study hypothesis, whether Shock Index and Age Shock Index are useful in predicting overall mortality in Trauma Patients. Our primary objective is to study effect of SI and Age SI with overall mortality in trauma patients. In addition, our secondary objective is to explore the effect of GCS and ISS score among study participants.

Materials and Methods

Study Population

We used data from the Towards Improved Trauma Care Outcomes (TITCO) registry of India. TITCO was prospective, observational, multi-center trauma registry, contains data of trauma patients admitted to four public university hospitals in Mumbai, Delhi and Kolkata [13]. TITCO data was collected from the period from October 1, 2013 to September 30, 2015. Patient details of trauma cases were recorded by trained data collectors at each identified center of TITCO. All the methodological details of TITCO registry, like inclusion exlcusion-criteria, record validation, study population and other details are published elsewhere [13]. TITCO registry contains all the relevant data of all trauma patients who visited selected hospitals during study period. Inclusion criteria considered, to have all the patients with valid records of heart rate and systolic blood pressure. While patient's with missing values of these variables were excluded from further consideration of the study.

Study Protocol

The shock index (SI) is a computational assessment, defined as heart rate divided by systolic blood pressure. It is a simple and effective means of gauging the degree of hypovolemia in haemorrhagic and infectious shock states. We further classified SI, by distributional convenience into four groups, Group-I as no shock SI<0.6, group-II as mild shock in the range SI≥0.6 to <1.0, group III as moderate shock with range SI ≥1.0 to <1.4 while group IV as severe shock with values SI≥1.4. Age has a strong influence on trauma victims, which can be seen by multiplication of Age with SI. We've computed Age Shock Index (AGE SI) for all the participants and further categorized in 6 groups. AGE SI groups were ranged between ten and sixty, with ten points score in each distinct group. Overall mortality recorded among study participants was considered as an important variable to assess relationship with SI and Age SI status. GCS and ISS score on admission are considered as secondary variables. Based on specified range of GCS, it was further classified as mild (GCS>12), moderate for (GCS between 8 in 12) and severe <8), while patients with missing values of GCS analysed separately. Similarly, ISS score grouped as minor for <9, moderate for 10 to 15, severe 16 to 24 and critical for ≥25 while missing ISS score patients analysed separately. All the patients from TITCO registry with valid SI score are considered for this study.

Statistical Analysis

Data was analyzed using SPSS version 24.0 (SPSS Inc., Chicago, IL, USA) for Mac and Microsoft Excel version 2016.Sample size was not specifically calculated, since study is based on registry database. All the patients satisfying Inclusion-Exclusion criteria were considered for the study. Primary and secondary variables under consideration were analyzed to estimate statistical parameters including mean, standard deviation and percentages. Categorical groups of study variables were compared using chi square test. A 2-sided p-value of less than 0.05 was considered statistically significant. Logistics regression analysis was performed assuming as overall mortality as dependent variable.

Results

Among 16047 participants of TITCO registry, 10843 patients with valid records of shock index, GCS and ISS score were included for this study. Median age of study subject was 30 years. 81% of trauma patients were males while female were 19%, gender wise no significant difference found in overall mortality (*p*=0.686). However, among age group paediatric, adults and geriatric proportion mortality was significantly different (*p<0.001*) (Table 1).

Among shock Index (SI) groups, mortality percentages were 17% to 45%. Compared to SI group-I, group II had lower odds [0.793, 95% CI (0.654-0.961)], while relatively higher risk was seen across group III [1.034, 95% CI (0.825-1.296)] and IV (1.803, 95% CI [1.325-2.455)]. Across ASI overall mortality was increasing between 9% and 44% across group I to group VI respectively. Taking ASI group I as referent category, odds was found to be increasing from group II [1.517, 95% CI (1.195-1.926)] to highest at group VI [5.485, 95% CI (4.198-7.165)]. However, poor diagnostic value of SI and ASI was seen in terms of with area under the curve of Receivers Operating Characteristic (ROC) Curve, article on this by the same group is published elsewhere [14]. GCS and ISS appears as strongly associated predictor of overall mortality among trauma patients. Severe GCS and Critical ISS score seen to be associated with 53% and 45% of fatality (Table 2). Significantly higher mortality (68%) was reported across SI group 4 and severe GCS score, which was 56% in critical ISS patients. ASI group VI with sever GCS and ISS seen to be associated with 69% and 60% mortality. Cross tabulation of SI and ASI with GCS and ISS appears statistically significant (*p<0.001*) (Table 3).

Discussion

The present study reports that categories of SI in terms of increase in hemodynamic shock represent higher percentages of deaths. Patients with moderate to severe group of SI have increase in percentage mortality. This increase continues in severity with injuries as assess by GCS and ISS scores. The SI groups of moderate and severe category shows higher death percentages among elderly age group of patients. The death percentage was increasing from lower age group to higher age group as reflected by Age SI groups. The mortality among each category of Age SI was increasing with increase in severity of injuries.

Studies have reported that higher SI reflects development of organ failure especially cardiovascular system. SI>0.9 and one have shown higher priority at emergency, as they need immediate admission and treatment [9, 15-17]. In the present study patients with severe injury in group 3 & 4 of SI have >1 value where higher mortality rates are present. The trauma data from the present study reflects that SI value more than one have similar outcome as reported in the literature. The studies

Table 1. Age-sex wise distribution of Shock Index and Age SI

Narration	**Age Group**					**Gender**			
	<18 Years	**18-60 Years**	**>60 Years**	**Chi-Square**	***p value***	**Male**	**Female**	**Chi-Square**	***p* value**
Shock Index (SI)									
Group-1	42 (17%)	706 (21%)	148 (40%)	574.947	<0.001	758 (23%)	138 (30%)	39.267	<0.001
Group-2	1238 (8%)	6093 (18%)	519 (32%)			6397 (17%)	1453 (17%)		
Group-3	569 (13%)	1059 (35%)	49 (59%)			1269 (30%)	408 (23%)		
Group-4	108 (29%)	301 (49%)	11 (82%)			337 (46%)	83 (37%)		
Age Shock Index									
Group-1	1336 (9%)	27 (33%)	-	376.76	<0.001	872 (9%)	491 (9%)	9883.048	<0.001
Group-2	589 (14%)	2404 (14%)	-			2618 (13%)	375 (17%)		
Group-3	31 (42%)	2794 (19%)	15 (67%)			2396 (19%)	444 (20%)		
Group-4	1 (0%)	1830 (24%)	110 (31%)			1567 (25%)	374 (24%)		
Group-5	-	684 (35%)	294 (31%)			746 (36%)	232 (27%)		
Group-6	-	420 (45%)	308 (41%)			562 (44%)	166 (42%)		

Table 2. Shock Index and Age SI comparison with gender and age group -No of patients (% mortality)

Narration	**Gender**		**Age Group**			**Total (% died)**
	Male	**Female**	**<18 Years**	**18-60 Years**	**>60 Years**	
Shock Index (SI)						
Group-1 (< 0.60)	758 (23%)	138 (30%)	42 (17%)	706 (21%)	148 (40%)	896 (24%)
Group-2 (0.60-1.00)	6397 (17%)	1453 (17%)	1238 (8%)	6093 (18%)	519 (32%)	7850 (17%)
Group-3 (1.00-1.40)	1269 (30%)	408 (23%)	569 (13%)	1059 (35%)	49 (59%)	1677 (28%)
Group-4 (> 1.40)	337 (46%)	83 (37%)	108 (29%)	301 (49%)	11 (82%)	420 (45%)
Age Shock Index (ASI=SI x Age)						
Group-1 (< 10)	872 (9%)	491 (9%)	1336 (9%)	27 (33%)	-	1363 (9%)
Group-2 (10-20)	2618 (13%)	375 (17%)	589 (14%)	2404 (14%)	-	2993 (14%)
Group-3 (20-30)	2396 (19%)	444 (20%)	31 (42%)	2794 (19%)	15 (67%)	2840 (19%)
Group-4 (30-40)	1567 (25%)	374 (24%)	1 (0%)	1830 (24%)	110 (31%)	1941 (25%)
Group-5 (40-50)	746 (36%)	232 (27%)	-	684 (35%)	294 (31%)	978 (34%)
Group-6 (>50)	562 (44%)	166 (42%)	-	420 (45%)	308 (41%)	728 (44%)

Table 3. Distribution and effect of SI, ASI and GCS and ISS on overall mortality

Narration	Patients (% Deaths)	Mean±SD	Odds Ratio (95% CI)	*p* value
Shock Index				
Group-I (0.14-0.60)	896 (24%)	0.53±0.07	Referent Category	<0.001
Group-II (0.60-0.99)	7850 (17%)	0.76±0.10	0.793 (0.654-0.961)	0.018
Group-III (1.00-1.40)	1677 (28%)	1.13±0.11	1.034 (0.825-1.296)	0.772
Group-IV (1.40-4.13)	420 (45%)	1.72±0.35	1.803 (1.325-2.455)	<0.001
Age Shock Index				
Group – 1 (0-9.98)	1363 (9%)	5.12±2.65	Referent Category	<0.001
Group – 2 (10-19.98)	2993 (14%)	15.51±2.75	1.517 (1.195-1.926)	0.001
Group-3 (20-29.98)	2840 (19%)	24.68±2.83	2.186 (1.735-2.755)	<0.001
Group-4 (30-39.93)	1941 (25%)	34.44±2.83	3.104 (2.451-3.931)	<0.001
Group-5 (40-49.99)	978 (34%)	44.12±2.93	4.718 (3.652-6.094)	<0.001
Group-6 (≥50)	728 (44%)	63.03±15.06	5.485 (4.198-7.165)	<0.001
Glasgow Coma Scale				
Mild (13-15)	6698 (8%)	14.85±0.48	Referent Category	<0.001
Moderate (9-12)	1559 (18%)	10.49±1.08	2.591 (2.205-3.045)	<0.001
Severe (≤8)	2586 (53%)	5.60±1.77	12.14 (10.73-13.73)	<0.001
Injury Severity Score				
Mild (≤9)	5500 (15%)	6.68±2.96	Referent Category	<0.001
Moderate (10-14)	2875 (19%)	11.33±1.71	1.002 (0.874-1.149)	0.978
Severe (16-24)	1595 (26%)	18.23±2.10	1.454 (1.244-1.7)	0.000
Critical (≥25)	873 (45%)	28.29±7.63	3.292 (2.746-3.947)	<0.001

have attributed poor outcome is due to multi organ damage which may further leads to organ failure. In such conditions immediate attention is must and expected outcome is also poor.

Age is an important factor that influence and associated with outcome after injury. Increasing age with decreased physiologic reserve, diminished metabolic, and hormonal response are well-recognized risk factors for poorer outcomes after injury [14, 18, 19]. The present study result reports that increase in age group have higher percentages of mortality in group 3 & 4 of SI. The same is true in literature where old aged are at higher risk for poor outcome after injury. Age SI is an important tool for predicting outcome among trauma patients especially old aged group [3]. The Age SI values from our study reports that mortality percentage increases with increase in age group and higher among severe/crucial group of injury patients. An emergency data based study from Korea reported that Age SI better predicted in hospital mortality than SI in old age group. Therefore Age SI considering age factor along with changes in physiological factors at injury serves as an important tool in predicting outcome. SI and Age SI are at no cost used as bed side tools and serve as an adjuvant to notify treating physician at emergency for which patient to prioritize for immediate management. Compared to SI, Age SI have reported to have better predictive values with higher values of area under the curve (AUC) for their corresponding ROC curves [14].

We are unable to compare effect of SI and Age SI on short term and long term mortality of trauma patients. The SI is calculated based on the recorded heart rate and systolic blood pressure with a presumption that it was accurately recorded chances of error may be there. Factor of error are beyond the scope of this study. Modified shock index calculated as a ratio of heart rate to mean blood pressure was not calculated. The patients who are on earlier medications particularly beta-blocker medications for co morbid conditions shows changes in heart rate and systolic blood pressure values that may not be true representative. Studies have shown that SI decrease with increase in age due to decline in physiological reserve among aged group [10, 11, 20-22]. This age wise effect of SI is considered precisely with Age SI. This study documents the effect of both of these indicators for the treatment guidelines of the trauma patients.

The present study discusses effect of SI and Age SI with overall mortality among trauma patients. Further, evidence to that finding that that moderate to severe SI and Age SI have increase in proportion of deaths. Both SI and Age SI showed increase in mortality with increase in severity of injuries. The SI and Age SI may be used as a simple cost effective tool to assess the presence of hypovolemic shock in trauma where the higher and advanced technologies are not available.

Conflicts of Interest: None declared.

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