Research Article

Pediatric trauma BIG score: Predicting mortality in polytraumatized pediatric patients

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Abstract

Background: Trauma is a worldwide health problem and the major cause of death and disability, particularly affecting the young population. It is important to remember that pediatric trauma care has made a significant improvement in the outcomes of these injured children. **Aim of the Work:** This study aimed at evaluation of pediatric trauma BIG score in comparison with New Injury Severity Score (NISS) and Pediatric Trauma Score (PTS) in Tanta University Emergency Hospital. **Materials and Methods:** The study was conducted in Tanta University Emergency Hospital to all multiple trauma pediatric patients attended to the Emergency Department for 1 year. Pediatric trauma BIG score, PTS, and NISS scores were calculated and results compared to each other and to observed mortality. **Results:** BIG score ≥12.7 has sensitivity 86.7% and specificity 71.4%, whereas PTS at value ≤3.5 has sensitivity 63.3% and specificity 68.6% and NISS at value ≥39.5 has sensitivity 53.3% and specificity 54.3%. There was a significant positive correlation between BIG score value and mortality rate. **Conclusion:** The pediatric BIG score is a reliable mortality-prediction score for children with traumatic injuries; it uses international normalization ratio (INR), Base Excess (BE), and Glasgow Coma Scale (GCS) values that can be measured within a few minutes of sampling, so it can be readily applied in the Pediatric Emergency Department, but it cannot be applied on patients with chronic diseases that affect INR, BE, or GCS.

Keywords: BIG score, mortality, polytrauma in pediatric, trauma, trauma scoring

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Introduction

Trauma is the most serious and major health problem in developing countries. Recently, several trauma scoring systems have been validated for prediction of patient survival,[1] New Injury Severity Score (NISS) is defined as the sum of the squares of the Abbreviated Injury Scale (AIS) of each of the patient's most severe AIS injuries irrespective of the body region in which they occur.[2] The Pediatric Trauma Score (PTS) was devised specifically for the triage of pediatric trauma patients.[3] The pediatric BIG score can be performed rapidly on admission to evaluate the severity of illness and to predict mortality in children with traumatic injuries.[4] International normalization ratio (INR) is a measure of tissue factor-activated arm of the coagulation cascade, coagulopathy, as characterized by increased

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fibrin degradation products, has been shown to predict mortality in children with head trauma[5] while base deficit is a measure of shock and acidosis. A BIG score of <12 points suggests a mortality of <5%, whereas a cutoff of >26 points corresponds to a mortality of >50%.[6] The limitation of the BIG score is that it requires laboratory values to calculate it.[4]

This study aimed at evaluation of pediatric trauma BIG score in comparison with NISS and PTS in Tanta University Emergency Hospital.

Materials and Methods

The study was conducted as a prospective comparative study in a University Emergency Hospital in Egypt for 1 year from February 2014 to February 2015, on fifty multiple trauma pediatric patients admitted to the Pediatric Emergency Department.

Inclusion criteria

All pediatric patients between 1 and 18 years old and within 24 h after trauma were included in the study.

Exclusion criteria

Patients <1 year old, patients who came to the hospital after 24 h of occurrence of trauma, burn, and electric shock without polytrauma, and patients with chronic diseases such as chronic renal failure, hepatic, hematologic, or neurologic diseases were excluded from the study.

Data collected for each multiple trauma patient attended to Emergency Department, include history taking stressing on mechanism of injury, thorough clinical examination, especially systolic blood pressure (SBP), pulse rate, respiratory rate, Glasgow Coma Scale (GCS), and laboratory investigations including arterial blood gas, prothrombin time, partial thromboplastin time, and INR.

PTS was calculated by PTS was calculated by summation of these variables [Table A].[7]

NISS was calculated by summation of square of AIS score of the most three affected regions of body regardless site of injury as follows: NISS = $(AIS1)^2 + (AIS2)^2 + (AIS3)^2$ [Table B].[7]

Pediatric trauma BIG score then was calculated as follows:

Pediatric BIG score equation = (Admission base deficit) + (2.5 × INR) + (15 − GCS).

This equation can then be implemented into a mortality-predicting formula:

Predicted mortality = $1/(1 + e^{-x})$, where $x = 0.2 \times$ (BIG score) − 5.208.

Thirty-day mortality was used as the primary outcome parameter of our analysis.

Testing the mortality prediction of the BIG score on our trauma patients and compared observed and expected mortality by BIG score.

Comparing between BIG score, PTS, and NISS as regard validity and observed outcome.

Trauma management at patient arrival includes primary then secondary survey in the first 10–15 min. Primary survey aims simultaneous assessment and treatment of life-threatening injuries. Initial observations of the patient as he or she was being wheeled in by emergency medical service (EMS), airway was evaluated with cervical spine precautions, assisted bag valve mask ventilation may be indicated, assess the breathing. Evaluation of chest wall motion, lung sounds, respiratory rate, and oxygen saturation was done. Early intubation was done for poor respiratory effort, inadequate oxygenation, or GCS score of eight or less.

For assessment of the circulation, examination of Focused Assessment Sonography In Trauma(FAST) and two large –bore aintravenous acess were established. Neurologic assessment was done by assessment of

Table (A): Variables for calculation of Pediatric Trauma Score(PTS) (Citated from Emergency Medical Journal 2011)[7]

Variables	+2	+1	−1
Weight (kg)	>20	12-20	<10
Systolic blood pressure (mmHg)	>90	50-90	<50
Mental status	Awake	LOC	Unresponsive
Airway	Patent	Maintainable	Unmaintainable
Skeletal fracture	None	Closed or suspected	Multiple closed or open
Open wounds	None	Minor	Major or penetrating

Table (B): Abbreviated Injury Scale of New Injury Severity Score (NISS) (Citated from Emergency Medical Journal 2011)[7]

Abbreviated Injury Scale	Injury
Minor	1
Moderate	2
Serious	3
Severe	4
Critical	5
Unsurvivable	6

GCS score. Pitfalls included "lucid interval."[7] Brief synopsis of what happened, asking about prehospital vitals.[7] Effort was made to maintain body temperature as hypothermic patients have worse outcomes.[7]

Routine imaging studies include chest X-ray, anteroposterior, pelvis, and lateral cervical spine. Computed tomography scan of the cervical spine, FAST or extended-FAST to evaluate for intraperitoneal blood, pneumothorax, and hemothorax as well.[7] A Foley catheter was placed for evaluation for hematuria as well as monitoring urine output. Rectal examination was done before placement to evaluate for signs of urethral injury such as high-riding prostate as well as blood at the urethral meatus.[7]

Secondary assessment is an organized, head-to-toe assessment, especially difficult to see areas such as the axillae and perineum.[7]

Signs/symptoms, allergies, medications, past medical history, last meal, and events history was obtained from the patient, family, or EMS.[7]

By this time, the initial resuscitation and stabilization of most patients were completed, and the patient was ready to leave the trauma bay to (a) the operating room if immediate surgery was indicated, (b) the imaging suite if he or she was stable, (c) the Intensive Care Unit if observation was the planned course of action, or (d) a regular gurney/stretcher in the Emergency Department for observation before discharge home.[7]

Statistical analysis

The collected data were analyzed using SPSS version 20 software (SPSS Inc., Chicago, IL, USA) and Microstat-W software (India, CNET download.com). Categorical data were presented as number and percentages whereas quantitative data were expressed as a mean ± standard deviation. Chi-square test, Fisher's exact test, Z-test, Student's *t*-test, Mann–Whitney U-test, and McNemar's test were used as tests of significance. Receiver operating characteristic (ROC) curve was used to determine cutoff values of the studied mortality scores with optimum sensitivity and specificity. Binary logistic regression model was used to detect the significant predictors of mortality and to design an equation for predicted mortality from BIG score. The accepted level of significance in this work was stated at 0.05 ($P < 0.05$ was considered significant).[8] $P > 0.05$ is nonsignificant, $P < 0.05$ is significant, and $P \leq 0.001$ is highly significant.

Results

This study was done on fifty polytraumatized children. Age ranged from 1 to 16 years, 48% males and 52% females. Mortality rate was 30%. Table 1 shows that there was a significant decrease in the age, body weight, SBP, and GCS and a significant increase in both INR and base excess of nonsurvivor patients when compared to survivor patients.

Table 2 and Figure 1 show trauma characteristics of the studied children as regard systems injured by trauma, regarding airway, 11 patients were with patent airway, 28 patients with maintainable airway, and 11 patients unmaintainable airway.

Table 1: Demographic, clinical, and laboratory variables as regard patient outcomes

Variable	Mean±SD		Student's *t*-test	*P*
	Nonsurvivors (*n*=15)	Survivos (*n*=35)		
Age	5.2±5.3	9.9±5.22	2.57	0.012 (S)
Body weight	24.7±18.6	40.1±17.3	2.54	0.011 (S)
SBP	79.3±24.91	97.1±16.37	2.99	0.004 (S)
GCS	4.8±1.59	10.6±3.71	4.88	<0.001 (HS)
INR	1.23±0.12	1.15±0.08	3.0	0.004 (S)
Base excess/deficit	7.58±6.12	2.37±1.44	2.06	0.039 (S)

SBP: Systolic blood pressure; GCS: Glasgow Coma Scale; INR: International normalization ratio; HS: Highly significant; S: Significant; SD: Standard deviation

Table 2: Trauma characteristics of the studied children as regard patient outcomes

	Nonsurvivors		Survivors		Total number	
	n=15	30%	*n*=35	70%	*n*=50	100%
System injured by trauma						
Airway condition						
Patent	0	0	11	22	11	22
Maintainable	8	16	20	40	28	56
Unmaintainable	7	14	4	8	11	22
CNS (head trauma)						
Awake	0	0	17	34	17	34
Comatosed	15	30	18	36	33	66
Mechanism of injury						
Fall from height	4	8	18	36	22	44
Pedestrian collision	5	10	5	10	10	20
MVA	2	4	8	16	10	20
Motorcycle	4	8	4	8	8	16
Diagnosis causes of death						
CNS failure (brain death)	10	20	-	-	50	100
Respiratory failure	1	2	-	-		
Hemorrhagic shock	3	6	-	-		
Multiple system organ failure	1	2	-	-		
Total	15	30	35	70		

CNS: Central nervous system; MVA: Motor vehicle accident

Regarding level of consciousness, 17 patients were awake and 33 patients were comatosed.

Table 2 also and Figure 2 show that the most common mechanism of injury among studied patients was fall from height by 44%, and motorcycle was the least common mechanism of injury by 16%. They show also that the most favorable prognosis was in fall from height, and the poorest prognosis was in both pedestrian collision and motorcycle. Table 2 also shows that the most common diagnosis of cause of death among studied patients was central nervous system lesion (brain death) (20%), followed by hemorrhagic shock (6%) while respiratory failure and multiple system organ failure were the least common diagnosis of cause of death (2% for each).

Figure 3 shows no significant difference between mean value of NISS among died and survived patients, whereas there was a significant increase in mean value of PTS among survived patients and a significant decrease in mean value of BIG score among survived patients.

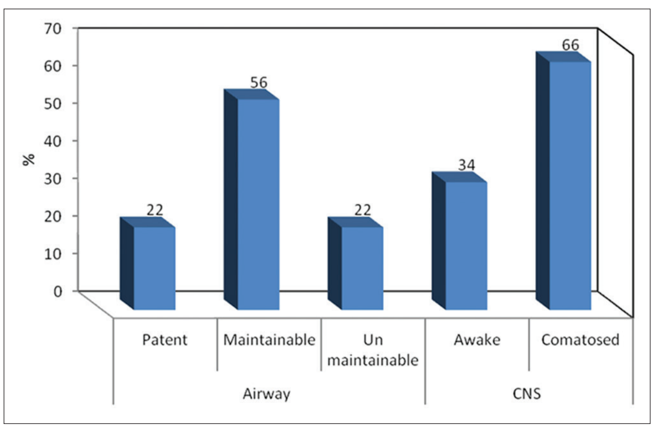

Figure 1: Comparison between airway and central nervous system status among studied patients

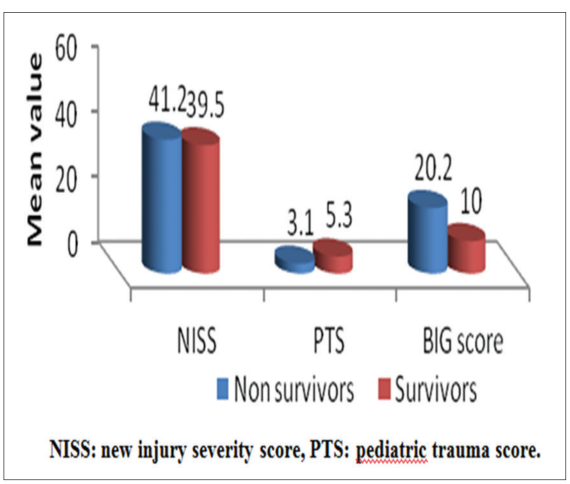

Figure 3: Comparing survivors and nonsurvivors regarding trauma scores

Figure 4 compares ROC curve for validity of the three studied trauma scores (BIG, PTS, and NISS) in prediction of mortality, BIG score ≥12.7 has sensitivity 86.7%, specificity 71.4%, positive predictive value (PPV) 56.5%, negative predictive value (NPV) 92.6%, and confidence index (CI) 0.77–0.97, whereas PTS at value ≤3.5 has sensitivity 63.3%, specificity 68.6%, PPV 42.2%, NPV 77.4%, and CI 0.57–0.85 and NISS at value ≥39.5 has sensitivity 53.3%, specificity 54.3%, PPV 33.3%, NPV 73.1%, and CI 0.48–0.79. Hence, the highest sensitivity and specificity of the three studied scores was to BIG score at cutoff value of ≥12.7, while the lowest sensitivity and specificity was to NISS at cutoff value NISS ≥39.5, while PTS showing moderate specificity and sensitivity at cutoff value ≤3.5. Figure 4 shows also that areas under the ROC curve of NISS, PTS, and BIG were 0.87, 0.71, and 0.63 respectively.

Table 3 and Figure 5 show relation of BIG Score to observed mortality rate, there was a significant positive correlation between BIG score values and mortality

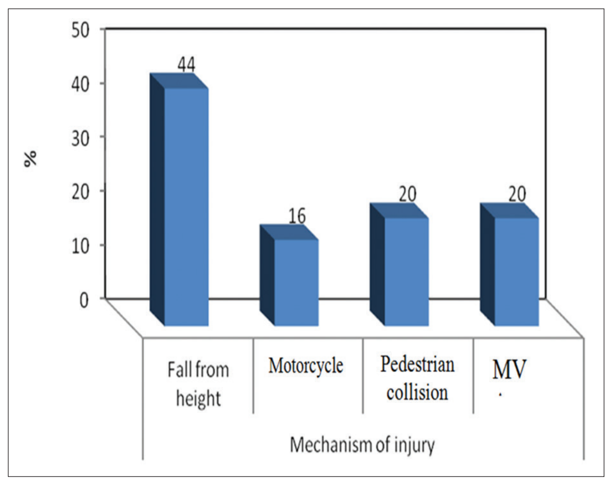

Figure 2: Mechanism of injury among studied patients

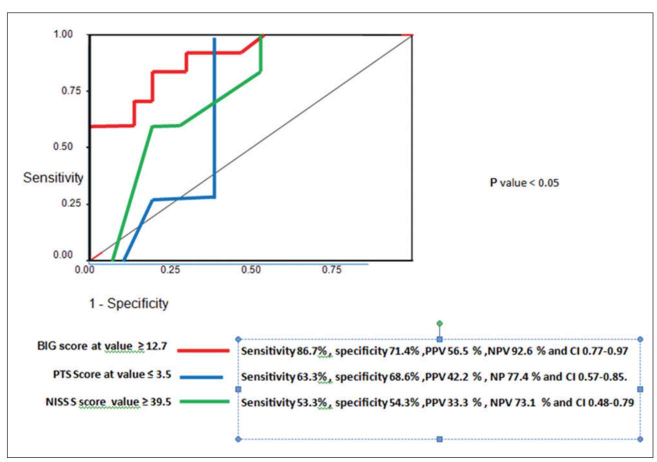

Figure 4: Receiver operating characteristic curves for the validity of BIG, Pediatric Trauma Score, and New Injury Severity Score trauma scores in prediction of mortality

Table 3: Comparing observed and predicted mortality by BIG score

BIG score	Nonsurvivors		Predicted/observed (%)
	Observed	Predicted	
<1.5	0	0	-
1.5-5	0	0	-
5-10	0	0	-
10-16	7	5	71
>16	8	7	87.5
Total	15	12	80

Fisher's exact test=21.7; $P<0.001$ (HS). HS: Highly significant

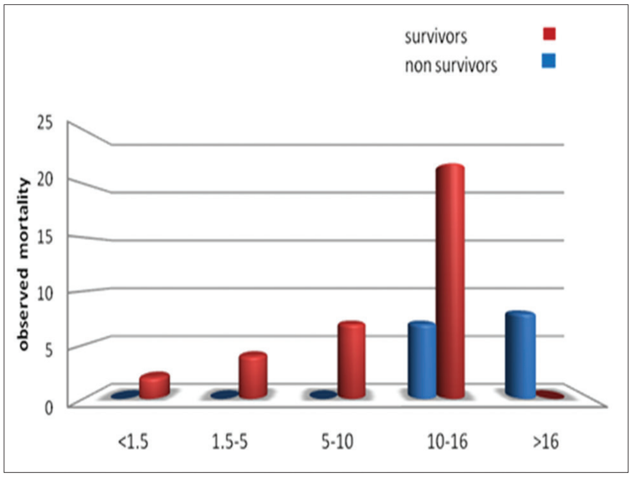

Figure 5: Relation of BIG score to observed mortality rate

rates as the higher the value of BIG score, the higher the incidence of mortality.

Discussion

Easy-to-use trauma scoring systems inform physicians of the severity of trauma in patients and help them decide the course of trauma management. The use of trauma scoring systems can be used before the patient reaches the hospital, to decide whether to send the patient to a trauma center, and can also be used for clinical decision-making when the trauma patient has just arrived at the Emergency Department (ED). When the patient is in the ED, trauma scoring systems can be used to prepare the patient for surgery, to call on medical staff for trauma support, and to inform the family of the severity of the patient's condition in the early stage.[9]

In the present prospective comparative study, pediatric trauma BIG score, PTS, and NISS scale, has been conducted on fifty polytraumatized pediatric patients attended to Tanta emergency university hospital. In this study, we choose to register the subjects from only one center to avoid the possible variability in the triage system in different settings. The mortality rate was 30% of the patients. As regarding mechanism of injury, we found that fall from height was the most common cause of admission in polytraumatized pediatric patients (44%) and this coincide with the study done by Fiorentino *et al*. in Hospital de Niño "Ricardo Gutiérrez" in Sao Paolo (54%).[10] Another study made by Derakhshanfar *et al*. found that pedestrian car accidents and falling down were the most common causes of injuries (23.3% and 21.3%), respectively.[11] Letts *et al*. in their study on The Children's Hospital of Eastern Ontario, a major pediatric trauma center, found that fall from height was the third common cause of trauma in children was by 14% and the most common cause was motor car accidents by 38.9%.[12]

In this study as regarding the age of patients, there was a significant decrease in age of nonsurvivors when compared to survivors ($P = 0.01$). It was against the study made by Nakayama *et al*. concluded that survival after childhood injury is independent on the age groups in their study after controlling injury severity.[13]

In the present study as regarding body weight, there was a significant decrease in body weight in nonsurvivors and when compared to survivors ($P = 0.011$). It was against the study made by Derakhshanfar *et al*. who found that there was no significant relation between body weight of patients and their outcome.[11]

As regarding SBP, we found a significant decrease in SBP in nonsurvivors when compared to survivors ($P = 0.004$).

Vallipakorn *et al*. conducted their cross-sectional study included injured children from 34 emergency services showed that when compared with children with normal relative risk (RR) and SBP, children with an abnormal SBP and RR had a 5.0 (95% CI: 3.9–6.4) and 2.2 (95% CI: 1.5–3.1) times higher odds of death, respectively.[14]

Derakhshanfar *et al*. conducted their study in Tehran, Iran, on 151 pediatric trauma patients and showed that the mean SBP was 96 ± 11 mmHg.[11]

There have been several previous studies on the importance of BE in evaluating trauma patients, but only a few examined its importance in the pediatric population.[14] Those studies suggested that BE was a good indicator of injury severity in pediatric trauma patients. In this work, we found that there was a significant increase in BE in nonsurvivors when compared to survivors ($P = 0.039$).

Kincaid *et al*. found that admission BE reflected injury severity.[15]

Randolph *et al*. found that admission BE was a strong indicator of injury severity, and a BE below −5 was predictive of severe injury and mortality.[16]

In severely injured children (all requiring mechanical ventilation), BE <−8 predicted a higher incidence of infectious complications and a less favorable outcome.[16]

Borgman *et al*. reported that admission base deficit was also found to be an independent predictor of mortality in 707 children injured in Iraq and Afghanistan.[4]

GCS is the most widely used scoring system for the evaluation of disorder of consciousness. It was developed by Teasdale and Jennett in 1974.[17] The modified GCS is used for infants and young children to obtain the most accurate score.[18]

In this study, there was a significant decrease in GCS of nonsurvivor patients when compared to survivor patients. Most of the cases of death (66%) were due to head trauma, so GCS work better in these cases than other causes of death such as other, hemorrhagic shock, respiratory failure, or multiple system organ injury. This coincides with a study made by Gill *et al*. that proved that GCS provides a prediction about morbidity and mortality after head injury.[19]

In this study, there was a significant increase in INR of nonsurvivor patients when compared to survivor patients. That increases specificity and accuracy of BIG score in predicting mortality.

Hess *et al*.[20] found that abnormal coagulation tests were increasingly frequent with increasing injury severity. Verma and Kole study showed that INR is indeed a good predictor of mortality in trauma patients, with a high diagnostic accuracy.[21]

In this study, PTS showing moderate specificity and sensitivity at cutoff value ≤3.5 with sensitivity 63.3% and specificity 68.6%. There are conflicting reports on the effectiveness of the PTS as a tool for assessing prognosis and in identifying those who will need a transfer to a pediatric trauma center. Narci *et al*. studied the prognostic value of PTS in pediatric trauma patients on 151 pediatric patients in Tehran and found it to be an independent predictor of morbidity.[22] Kaufmann *et al*. reported that the PTS has no advantage in children, even in children younger than 14 years.[23] Another study made by Eichelberger *et al*. has reported no difference between the predictive capabilities of the trauma score and the PTS in identifying severely injured children.[24] Further refinements of the PTS include the age-specific PTS and the triage age-specific PTS. These scoring systems, however, have not yet been validated and are rarely used.

In 1997, a simple modification of injury severity score (ISS) was formulated by Osler *et al*. and referred to as the NISS,[25] In the present study, we found that NISS at cutoff value ≤39.5 has sensitivity 53.3% and specificity 54.3% for predicting mortality. Sullivan *et al*. found that The NISS performs as well as the ISS in predicting mortality in pediatric trauma patients who are not severely injured (ISS <24).[26]

NISS has disadvantage of not taking physiologic derangements or chronic health into account. It is not intended to reflect patient outcomes, but only to score an individual injury.[10]

An adult trauma study made by Brockamp *et al*., to compare the BIG score with other trauma scores revealed that BIG score is a good predictor of mortality in the adult trauma population,[27] and they added that in a penetrating trauma population, the BIG score performed better than in a population with blunt trauma. The BIG score has the advantage of being available shortly after admission and may be used to predict clinical prognosis or as a research tool to risk stratify trauma patients into clinical trials.[27]

In the present study, we found that pediatric trauma BIG score was more sensitive and specific and easily applicable score in predicting mortality than PTS and NISS, and this coincides with the study done by Borgman *et al*.[4]

Conclusion

Paediatric trauma BIG score may be applied as a mortality prediction tool in pediatric emergency for its ease and simplicity of application at the time of entry at the Emergency department. This would also help in evaluating for early invasive monitoring and treatment decisions in the Intensive Care unit.

Recommendation

We recommend that leaflets for BIG score be formed and calculated easily in the Emergency Department to help predicting mortality and decision-making regarding polytraumatized pediatric patients.

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Conflicts of interest

There are no conflicts of interest.

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