*Asian Journal of Medicine and Health*

***20(11): 161-173, 2022; Article no.AJMAH.92395***
***ISSN: 2456-8414***

# Comparison of Injury Severity Score, Glasgow Coma Scale and Revised Trauma Score in Predicting the Outcome in Young Patients with Trauma Attending Emergency Department of Suez Canal University Hospitals

**Ahmed El Sayed Abou Zeid [aɷ], Alaa Desoky Ahmed [a#], Rasha Mahmoud Ahmed [a#] and Ahmed Mahmoud Ezzat [a*†]**

[a] *Faculty of Medicine, Suez Canal University, Egypt.*

***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

***Article Information***

DOI: 10.9734/AJMAH/2022/v20i11756

**Open Peer Review History:**
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/92395

***Original Research Article***

***Received 10 August 2022***
***Accepted 20 October 2022***
***Published 22 October 2022***

## ABSTRACT

**Background:** Easy-to-use trauma scoring systems can be used for making good clinical decision before the patient reaches the hospital and at emergency department. These scoring systems can also be used for timely delivering medical support and preparing the patient for surgery in early stage. The objective of this study was to assess the ability of trauma scoring systems such as the Glasgow Coma Scale (GCS), Injury Severity Score (ISS), and Revised Trauma Score (RTS) to predict outcomes in young children with traumatic injuries.
**Methods:** This was a potential cross-sectional study that was conducted in the emergency department of Suez Canal University Hospitals. We included 86 children patients younger than 6 years of age who were presented to hospital via the emergency department with any traumatic injury and compared the trauma outcomes for GCS, ISS, and RTS on patient outcomes.
**Results:** The main type of accident encountered in our study was fall from height (33.7%) followed by road traffic accidents (29.1%). Mortality rate in our study was 4.7%. The mean trauma scores of

---

[ɷ] *Assistant Professor of Emergency Medicine;*
[#] *Lecturer of Emergency Medicine;*
[†] *Resident of Emergency Medicine;*
**Corresponding author: E-mail: ahmedezzat091993@outlook.com*

ISS, GCS, and RTS in our studied population were 11.47, 14.21, and 7.79, respectively. All trauma scores differed with statistical significance (p<0.001, <0.001, <0.030, respectively) between the survivors and mortality groups. We found a mean ISS of 10.30 ± 5.84 in survived children and 35.25 ± 25.97 in those who died. Mean GCS was 14.62 ± 1.10in survivors and 5.75 ± 1.50 in non-survivors. RTS means were7.96 ± 0.33in survived children and 4.25 ± 0.50 in those who died, respectively. ROC curve analysis of the three scores regarding mortality prediction revealed close results; all showed a modest ability to predict mortality. The highest AUC was for RTS and GCS; 0.998 and 0.997, respectively. ISS had a slightly lower AUC of 0.0816. In the current study, RTS and GCS showed the best sensitivity and specificity to predict mortality of 100% and 98.78%, respectively. A slight lower ability was found for ISS with a sensitivity of75%. The desired cut-offs to predict mortality were ≤7 for the GCS, ≤5 for the RTS and ≥17 for the ISS with the previously mentioned sensitivity and specificity. Regarding the need for surgery, among survived patients, those who had surgery had statistically significant higher ISS compared to those who did not have surgery (14.69 ± 9.98 Vs 7.39 ± 6.04) (p<0.001). On the other hand, there was no statistically significant difference between the two groups in regard to GCS (p=0.053) and RTS (p=0.251).
**Conclusion:** In conclusion, we found that worse trauma scores of ISS, GCS, and RTS were associated with increased mortality and prolonged hospital stays among young children's injuries. Among these three trauma scores, we found RTS and GCS to have the best predictive value. The cutoff values of ISS, GCS, and RTS for predicting mortality were >17, ≤7, and ≤5, respectively.

*Keywords: Injury severity score; Glasgow coma scale; revised trauma score; outcome; young patient; trauma.*

## 1. INTRODUCTION

"Trauma is the most common cause of mortality and morbidity in the pediatric population. Caring for the injured child requires special knowledge, precise management, and scrupulous attention to details. All clinicians who are responsible for the care of a pediatric trauma patient, including pediatricians, emergency room clinicians, pediatric emergency room clinicians, and trauma surgeons, must be familiar with every tenet of modern trauma care.The special considerations, characteristics, and unique needs of injured children must also be recognized" [1].

"Injury is the leading cause of death among children older than 1 year. In fact, for children, injury exceeds all other causes of death combined" [2].

"Several factors influence childhood injuries, including age, sex, behavior, and environment. Of these, age and sex are the most important factors affecting the patterns of injury. Male children younger than 18 years have higher injury and mortality rates, perhaps in part because of their more aggressive behavior and exposure to contact sports" [3].

"Trauma scoring has played a central part in the development of quality assurance for the seriously injured" [4].

"There are various systems available for scoring trauma severity. Some are based on anatomical descriptions of injuries, some on physiological parameters and others use combined data. No ideal trauma scoring system is currently available. The ideal trauma scoring system would provide an accurate, reliable and reproducible description of injuries and prediction of morbidity and mortality outcomes in any setting" [4].

"Trauma scoring systems have been developed to evaluate the trauma severity, the degree of the harm in the human body, the prognosis after traumatic injury, and the improvements in trauma care quality" [5].

"The Injury Severity Score (ISS) is the most widely used anatomical scoring system for assessing the combined effect of multiple injuries, and it consists of the squared and summed Abbreviated Injury Scale (AIS) scores of the three most severely injured body regions. The ISS score ranges from 1–75 and its value correlates with the risk of mortality" [6].

"Revised Trauma Score (RTS) is a physiological scoring system, with high inter-rater reliability and demonstrated accuracy in predicting death, and consists of Glasgow coma scale (GCS), systolic blood pressure, and respiratory rate to provide a general assessment of physiological derangement. Values for RTS range from 0–

7.8408. A higher score indicates a better prognosis" [7].

"Various quantitative scoring systems have been proposed to evaluate trauma severity and outcome, but most of them were not age specific, and each had its own limitations"[8]. "Considering the different physiological structures in younger children, we selected the Injury Severity Score (ISS), which emphasizes anatomic criteria and has been validated to predict prognosis. In previous studies, major trauma in the pediatric category has been defined as an Injury Severity Score greater than 15. However, few studies have focused on ISS performance in young children" [9].

"Despite a number of proposed modifications and alternate scoring systems, ISS remains the most widely used to define severely injured patients, which is why we chose it" [9].

"The Glasgow Coma Scale (GCS) indicates level of consciousness and has always been evaluated upon patient arrival. This scale has been frequently used for decades as blunt head trauma is a common cause of mortality and morbidity in pediatric injuries. Since head injury is one of the most common traumatic mechanisms in young children, GCS is also appropriate for our study's main group" [10].

The objective of this study was to assess the ability of trauma scoring systems such as the Glasgow Coma Scale (GCS), Injury Severity Score (ISS), and Revised Trauma Score (RTS) to predict outcomes in young children with traumatic injuries.

## 2. PATIENTS AND METHODS

### 2.1 Study Design

This is a potential cross-sectional study.

### 2.2 Study Site

The study was conducted in the emergency department of Suez Canal University Hospitals.

### 2.3 Population Study

We included all children younger than 6 years of age who were presented to hospital via the emergency department with any traumatic injury and compared the trauma outcomes for GCS, ISS, and RTS on patient outcomes.

### 2.4 The inclusion criteria

- Children with any traumatic injury.
- Patients of both sexes
- Patients under the age of 6 years.

### 2.5 Exclusion Criteria

- Patients with a pre-existing medical condition that contributed to the trauma incident.
- Burn injury in children

### 2.6 Statistical Plan

The sample size was determined by using the following equation [11]:

$$n = \frac{Z_{1-\alpha/2^2} * p(1-p)}{d^2}$$

Where:

n= sample size
Z1-α/2 is the standard deviation that equals to 1.96
P= Mortality rates among young children with traumatic injuries=28.08% based on previous literature (Kumar & Verma, 2017).
d=Absolute error/ precision, usually equals 10%
The calculated sample size is 78 patients. However, by adding 10% drop out; the required sample size was be 86 patients.

### 2.7 Study Procedures

- Patients were interviewed with their parents or caregiver.
- Demographic data, data about the accident, including age, gender, initial vital signs, cause of injury, different types of trauma severity scores, such as: 1- GCS, 2- ISS, 3- RTS. Length of hospital stay (LOS), stay in intensive care unit (ICU), and deaths were collected through a form for each prepared form (Appendix I).
- Vital signs and GCSs in screening to score and compare the accuracy of GCS, ISS, and RTS trauma scores in predicting patient outcomes.

Initial triage and vital signs were obtained by well-trained senior emergency nurses, and a sphygmomanometer was used for young children. The ISS was measured by the traumatologists in charge of the emergency department.

## 2.8 Primary outputs include

- Trauma-related deaths during admission.
- Prolonged stay in the intensive care unit, which is defined as a stay in the intensive care unit longer than 14 days. An extended stay in the ICU is usually defined as a 14-day admission to the ICU, which has been considered with resource use and patient morbidity and mortality [12].
- Length of hospital stay (HLOS), which is a byproduct of patients who survive after hospitalization.

## 2.9 Data Analysis

It includes {data entry, data visualization, data manipulation, and statistical analysis}. It is suggested to use the Statistical Package for the Social Sciences (SPSS) program for data capture and statistical analysis.

The mean and standard deviation were estimated for each continuous variable. Student's t-test and Chi-square test was used to assess the statistical difference between the variables, each test according to the type of variable. The results of the study were described in tables and graphs. ROC curve analysis was used to compare between GCS, revised trauma score and injury severity score for prediction of death among trauma patients.

## 3. RESULTS

Table 1 shows the sociodemographic characteristics of the studied patients. The mean age of the patietns was 3.70 ± 1.50 years with range between (0.5 – 6) years. Males formed about 54.7% of the patients and patients evenly live in urban and rural settings.

Table 2 shows the type of accident and time elapsed from the accident. The top three types of accident were fall of height (33.7%), road traffic accident (29.1%) and direct trauma (24.4%). The mean time elapsed from the accident 0.94 ± 0.73 hours.

Table 3 shows that the mean length of hospital stays of the patients 3.16 ± 3.24 days. Moreover, about 58.5% of the survived patients had Length of hospital stay < 3 days.

Table 4 shows that the mean GCS score was 14.21 ± 2.18 points with a range score between 4 and 15 points, while the mean revised trauma score was 7.79 ± 0.86 points and the mean injury severity score was 11.47 ± 9.18 points.

Table 5 shows that died patients had statistically significant lower GCS (p<0.001), revised trauma score (p<0.001) and injury severity score (p=0.03) compared to survived patients.

Fig. 1 compares the ROC curve analysis of GCS, revised trauma and injury severity for prediction of death among trauma patietns, where the areas under the curve (AUC) were 0.997, 0.998 and 0.816, respectively.

Table 6 shows the best cut-off point of different scales for prediction of death. Both GCS and revised trauma score had the same sensitivity and specificity of 100% and 98.78%, respectively. Meanwhile, for injury severity score, a value of 17 or more was found to be the best cut-off point for prediction of death among trauma patients, with sensitivity = 75% and specificity = 98.75%.

**Table 1. Distribution of the studied cases according to demographic data (n = 86)**

| | No. | % |
|---|---|---|
| **Sex** | | |
| Male | 47 | 54.7 |
| Female | 39 | 45.3 |
| **Age (years)** | | |
| Min. – Max | 6.0–0.50 | |
| Mean ± SD. | 1.50±3.70 | |
| Median | 4.0 | |
| **Address** | | |
| Urban | 43 | 50.0 |
| Rural | 43 | 50.0 |

*IQR: Inter Quartile Range; SD: Standard Deviation*

## 4. DISCUSSION

“In this study, we included all children under the age of 6 years who were admitted to the hospital via the emergency department with any traumatic injury. We included 86 children with a mean age of 3.7 ±1.5 years and evaluated the relation of ISS, GCS, and RTS with mortality, hospital LOS and need for surgery in pediatric patients. A similar study by Huang *et al*. consisted of a total of 938 patients, with a mean age of 3.1 ± 1.82 years” [10].

The main type of accident encountered in our study was fall from height (33.7%) followed by road traffic accidents (29.1%). These findings are quite different from the previous literature which has the road traffic accidents being the most seen mechanism of injury. Allen et al. reported that motor vehicle collision accounted for 32% for injuries followed by 18% PHBC (pedestrian hit by a car) [13]. Yousefzadeh chabok et al. found 42.2% of injuries due to traffic accidents followed by fall which accounted for 39.8% of injuries [14]. Our relatively younger sample (mean age 3.7±1.5) compared to these studies may explain this difference. The mechanism of injury differs according to the age group. Toddlers, from 1 to 4 years, are most commonly injured at home because of fall or by a falling object. Older children, from 5-9 years, are most commonly injured in the street as a pedestrian. Adolescents are most commonly injured during recreation or sports while using an ATV or bicycle. Teenagers suffer the most from MVCs.

Mortality rate in our study was 4.7%. Similar percentages were shown in previous studies which evaluated pediatric polytrauma. For example, in the study by Wendling-Keim et al. evaluating trauma scores and their prognostic value for the outcome following pediatric polytrauma in 97 patients, five children died (5.2%), three of whom presented with traumatic brain injury [15]. Quite lower percentages were depicted in other studies [13,14,10]. For example, 588 children were included in the study of Yousefzadeh-Chabok and colleagues, a total of 97.6% (574) of the population survived, while 2.4% died. Mortality rates vary from centre to centre. Specialized pediatric care in verified pediatric trauma centers decreases mortality in pediatric injuries [13]. Our trauma center is verified as an adult, as well as a pediatric, trauma center, which may account for our mortality rate. Additionally, we included a relatively small sample within limited period of time in our study which does not present the actual mortality rate in our centre.

“The trauma score systems selected in this study were ISS, GCS, and RTS since their values were easy to obtain and calculate. Furthermore, consciousness level is the main domain of these trauma scores since brain injury is the primary cause of mortality and morbidity in pediatric trauma” [16].

The mean trauma scores of ISS, GCS, and RTS in our studied population were 11.47, 14.21, and 7.79, respectively. All trauma scores differed with statistical significance (p<0.001, <0.001, <0.030, respectively) between the survivors and mortality groups. We found a mean ISS of 10.30 ± 5.84 in survived children and 35.25 ± 25.97 in those who died. Mean GCS was 14.62 ± 1.10in survivors and 5.75 ± 1.50 in non-survivors. RTS means were7.96 ± 0.33in survived children and 4.25 ± 0.50 in those who died, respectively.

Similarly, in previous studies, these trauma scores in survivor and mortality populations have traditionally varied. Huang et al., in their similar cross-sectional study on traumatic young children, reported that ISS score was statistically higher in the mortality group (34 ± 19.9 vs. 5 ± 5.1, p = 0.004), while GCS (8 ± 5.0 vs. 15 ± 1.3, p=0.006) and RTS (5.58 ± 1.498 vs. 7.64 ± 0.640, p=0.006) scores were lower in the mortality group [10]. Yousefzadeh Chabok et al. demonstrated an ISS of 6.5 overall and 17.7 in the mortality group, with GCS scores of4.7 in the mortality group and 14.6 in the survivor group [17]. Soni et al. showed RTS scores of 7.13 in trauma survivors and 4.39 in non-survivors, with ISS scores of 11.68 in the mortality group and 11.87 in the survivor group [18]. Allen et al. also showed that ISS was statistically significantly higher in mortality group than in survival group (40 ± 13 Vs 12 ± 11) and both GCS and RTS were higher in survived patients (14 ±3 Vs 6± 5 and 7.493 ± 0.863 Vs 3.727 ± 2.659, respectively) [13].

ROC curve analysis of the three scores regarding mortality prediction revealed close results; all showed a modest ability to predict mortality. The highest AUC was for RTS and GCS; 0.998 and 0.997, respectively. ISS had a slightly lower AUC of 0.0816. In the current study, RTS and GCS showed the best sensitivity and specificity to predict mortality of 100% and 98.78%, respectively. A slight lower ability was found for ISS with a sensitivity of75%.

These results are concordant with the previous literature. Yousefzadeh chabok et al. showed similar findings as RTS was found to be the best score in predicting mortalityamong two other scores (ISS and new injury severity score (NISS)) with an AUC of 0.99 (CI: 0.99-1) [14]. In contrast, in another previous study, ISS showed a better ability to predict mortality than both RTS and GCS with AUC of 0.975, 0.899, and 0.864, respectively [10].

All the three scores have an acceptable ability to predict mortality with slight differences between them. In their study to evaluate predictors of mortality in pediatric trauma, Allen and colleagues reported that the significant predictors of mortality based on univariate analysis were used to identify variables for inclusion in a binary logistic regression model. Independent predictors of mortality were initial Hct [odds ratio (OR) 0.83 (95 % confidence interval 0.73–0.95)], initial HCO3 [0.82(0.67–0.98)], GCS [0.75(0.62–0.90)], and ISS [1.10(1.04–1.15) [13].

The desired cut-offs to predict mortality were ≤7 for the GCS, ≤5 for the RTS and ≥17 for the ISS with the previously mentioned sensitivity and specificity. Huang et al. measured the cutoff values for mortality prediction according to the ROC curves, which were found to be11 for GCS, 7 for RTS, and 15 for ISS (10). Yousefzadeh chabok reported cutoffs of ≤15 and ≥4.8 for ISS and RTS, respectively [14]. The other study by Yousefzadeh chabok showed that the cut-off to predict mortality was ≤8 for the GCS and ≥16.5 for the ISS [17].

“Each of the scoring tools assessed has its own inherent limitations. While the ISS has been widely used, it is unable to account for multiple severe injuries in the same anatomical region, limiting its ability to predict survival within a population or to predict survival at the bedside” [13]. Additionally, ISS calculations are subject to misclassification errors, results may vary depending on when the ISS is calculated [8], and require costly training and expertise for accurate and reliable score determination [19]. “Additionally, as a purely anatomic scoring system, the ISS fails to account for physiologic changes, which can influence mortality. A pediatric patient with an intracranial hemorrhage may have a low ISS but may need significant attention, while a patient with long bone fractures may have a high ISS and be much more stable clinically” [20]. “Since traumatic brain injury is largely responsible for morbidity and mortality in the pediatric trauma population, ISS based systems can lead to significant undertriage” [21].

“Conversely, the RTS, a non-AIS-based scoring tool, does account for dynamic pathophysiology following traumatic injury. However, RTS utilization is restricted by flaws associated with measurement of the GCS and vital signs; for example, verbal responses and spontaneous respiratory rate cannot be appropriately evaluated in mechanically ventilated patients, rendering the GCS and RTS inaccurate in these cases. Furthermore, age and anatomic severity are not considered in the RTS, which is derived from a univariate model” [22].

Regarding the need for surgery, among survived patients, those who had surgery had statistically significant higher ISS compared to those who did not have surgery (14.69 ± 9.98 Vs 7.39 ± 6.04) (p<0.001). On the other hand, there was no statistically significant difference between the two groups in regard to GCS (p=0.053) and RTS (p=0.251).

**Table 2. Distribution of the studied cases according to type of accident and time elapsed from the accident (n = 86)**

| | No. | % |
|---|---|---|
| **Type of accident** | | |
| RTA | 25 | 29.1 |
| Direct trauma | 21 | 24.4 |
| FFH | 29 | 33.7 |
| MCA | 10 | 11.6 |
| Sliding | 1 | 1.2 |
| **Time elapsed from the accident (hours)** | | |
| Min. – Max. | 4.0–0.20 | |
| Mean ± SD. | 0.73±0.94 | |
| Median | 0.75 | |

*SD: Standard deviation*

**Table 3. Distribution of the studied cases according to length of hospital stay**

| Length of hospital stay (days) | Total (n=86) | | Survived (n=82) | |
|---|---|---|---|---|
| | No. | % | No. | % |
| <3 days | 52 | 60.5 | 48 | 58.5 |
| ≥3 days | 34 | 39.5 | 34 | 41.5 |
| Min. – Max. | 15.0–0.0 | | 15.0–0.0 | |
| Mean ± SD. | 3.24±3.16 | | 3.31±3.22 | |
| Median | 2.0 | | 2.0 | |

*SD: Standard Deviation*

**Table 4. Descriptive analysis of the GCS score, revised trauma score and injury severity score**

| | Min. – Max. | Mean ± SD. | Median |
|---|---|---|---|
| GCS score | 4.0 – 15.0 | 14.21 ± 2.18 | 15.0 |
| Eye opening response | 1.0 – 4.0 | 3.70 ± 0.75 | 4.0 |
| Verbal response | 1.0 – 5.0 | 4.84 ± 0.75 | 5.0 |
| Motor response | 1.0 – 6.0 | 5.67 ± 0.85 | 6.0 |
| Revised trauma score | 4.0 – 8.0 | 7.79 ± 0.86 | 8.0 |
| GCS | 1.0 – 4.0 | 3.86 ± 0.58 | 4.0 |
| SBP | 2.0 – 4.0 | 3.74 ± 0.49 | 4.0 |
| RR | 2.0 – 4.0 | 3.95 ± 0.26 | 4.0 |
| Injury severity score | 5.0 – 66.0 | 11.47 ± 9.18 | 9.0 |
| Head or neck | 1.0 – 5.0 | 1.35 ± 0.89 | 1.0 |
| Face | 1.0 – 3.0 | 1.07 ± 0.30 | 1.0 |
| Chest | 1.0 – 5.0 | 1.14 ± 0.74 | 1.0 |
| Abdomen | 1.0 – 4.0 | 1.45 ± 0.82 | 1.0 |
| Extremities | 1.0 – 3.0 | 1.69 ± 0.84 | 1.0 |
| Skin | 1.0 – 3.0 | 1.85 ± 0.45 | 2.0 |

*SD: Standard Deviation*

**Table 5. Comparison between survived and died according to total scores**

| | Survived (n = 82) | Died (n = 4) | U | p |
|---|---|---|---|---|
| **GCS** | | | | |
| Mean ± SD. | 14.62 ± 1.10 | 5.75 ± 1.50 | 1.00* | <0.001* |
| Median (Min. – Max.) | 15.0 (7.0 – 15.0) | 6.0 (4.0 – 7.0) | | |
| **Revised trauma** | | | | |
| Mean ± SD. | 7.96 ± 0.33 | 4.25 ± 0.50 | 0.50* | <0.001* |
| Median (Min. – Max.) | 8.0 (5.0 – 8.0) | 4.0 (4.0 – 5.0) | | |
| **Injury severity** | | | | |
| Mean ± SD. | 10.30 ± 5.84 | 35.25 ± 25.97 | 60.50* | 0.030* |
| Median (Min. – Max.) | 7.50 (5.0 – 43.0) | 34.50 (6.0 – 66.0) | | |

*SD: Standard Deviation; U: Mann Whitney test*
*p: p value for comparing between survived and died*
**: Statistically significant at p ≤ 0.05*

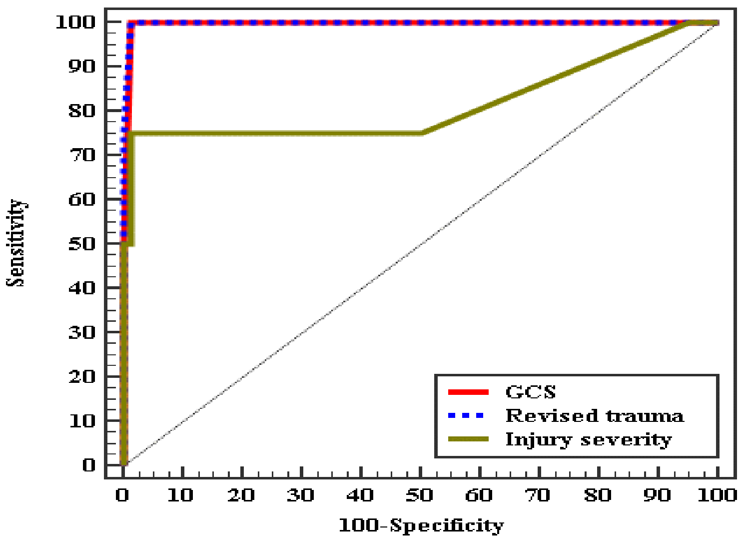


**Fig. 1. ROC curve for GCS, revised trauma and injury severity to discriminate died patients (n = 4) from survived (n = 82)**

**Table 6. Validity (AUC, sensitivity, specificity) for GCS, revised trauma and injury severity to detect death among trauma patients**

| | AUC | p | 95% C.I | Cut off | Sensitivity | Specificity | PPV | NPV |
|---|---|---|---|---|---|---|---|---|
| GCS | 0.997 | 0.001* | 0.988 – 1.006 | ≤7# | 100.0 | 98.78 | 80.0 | 100.0 |
| Revised trauma | 0.998 | 0.001* | 0.992 – 1.004 | ≤5# | 100.0 | 98.78 | 80.0 | 100.0 |
| Injury severity | 0.816 | 0.034* | 0.501 – 1.130 | >17 | 75.0 | 98.78 | 75.0 | 98.8 |

*AUC: Area Under a Curve; p value: Probability value*
*CI: Confidence Intervals*
*NPV: Negative Predictive Value; PPV: Positive Predictive Value*
**: Statistically significant at p ≤ 0.05*
*#Cut off was choose according to Youden index*

Similarly, Wendling-Keim and colleagues performed ROC curve analysis to assess prediction ability of ISS and GCS for the need of emergency surgery. They found a good ability of ISS with AUC of 0.73but not of GCS with AUC of 0.332 in discrimination of patients who needed emergency surgery vs. those who did not [15]. Another study, Yousefzadeh chabok et al. showed that the mean score of ISS in children who required surgery were significantly higher than the children who did not need operation (p=0.001). However, in contrast to our study, it was found that the mean score of RTS was statistically significantly higher in children who did not need surgery compared to the other group (p=0.001) [14].

## 5. CONCLUSION

In conclusion, we found that the trauma scores ISS, GCS, and RTS were able to predict mortality among young children’s injuries. Among these three trauma scores, we found RTS and GCS to have the better predictive value.

## 6. LIMITATIONS

This study was conducted in a single medical center, which may limit the generalizability of the conclusions. All possible confounding factors were unmodifiable, and a cause-and-effect relationship could not be determined. Small sample size of the study within limited period of time.

## CONSENT AND ETHICAL APPROVAL

All procedures of the study were approved by the emergency medicine department, Suez Canal University. The study protocol was approved by the faculty of medicine ethical committee.

Informed consent was obtained from all patients' parents or relatives of the participants before any data were taken.

Explain the purpose of the study in a simple and clear way for the general public to understand.

Patients' parents or relatives were informed about the techniques and their potential side effects.

No harmful maneuvers have been performed or used. There are no anticipated risks from conducting the study in these patients.

All data has been considered confidential and were not used outside of this study without the consent of the patient's parents or the initial consent of the patient's relatives.

The researcher's phone number and all possible contact methods were available for the patients' parents or first relatives to return at any time for any explanation.

Parents or relatives of the patients were announced by the study result.

All patients' parents or relatives have the right to refuse participation or withdraw from the study at any time without giving any reason and without prejudice to the patient's right to treatment or affecting the relationship between the patient and the caregiver.

The signature or fingerprints of the patient's parents or first relatives.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. Lalwani S, Hasan F, Khurana S, Mathur P. Epidemiological trends of fatal pediatric trauma: A single-center study. Medicine (United States). 2018;97(39).
2. Adeloye D, Bowman K, Chan KY, Patel S, Campbell H, Rudan I. Global and regional child deaths due to injuries: an assessment of the evidence. J Glob Health. 2018;8(2): 021104.
3. Halawa EF, Barakat A, Rizk HI, Moawad EM. Epidemiology of non-fatal injuries among Egyptian children: A community-based cross-sectional survey. BMC Public Health. 2015;15:1248.
4. Russell RJ, Hodgetts TJ, McLeod J, Starkey K, Mahoney P, Harrison K, Bell E. The role of trauma scoring in developing trauma clinical governance in the Defence Medical Services. In Philosophical Transactions of the Royal Society B: Biological Sciences. 2011;366:171–191. Royal Society.
5. Feldhaus I, Carvalho M, Waiz G, Igu J, Matthay Z, Dicker R, Juillard C. Thefeasibility, appropriateness, and applicability of trauma scoring systems in low and middle-income countries: A systematic review. Trauma Surg Acute Care Open. 2020;5(1):e000424.
6. Wong TH, Krishnaswamy G, Nadkarni NV, Nguyen HV, Lim GH, Bautista DC, Chiu MT, Chow KY, Ong ME. Combining the new injury severity score with an anatomical polytrauma injury variable predicts mortality better than the new injury severity score and the injury severity score: a retrospective cohort study. Scand J Trauma Resusc Emerg Med. 2016;24:25.
7. Mansour Doaa A, Abou Eisha, Hisham A, Asaad, Amgad E. Validation of revised trauma score in the emergency department of Kasr Al Ainy. The Egyptian Journal of Surgery: 2019;38(4):679-684.
8. Chawda MN, Hildebrand F, Pape HC, Giannoudis PV. 'Predicting outcome after multiple trauma: which scoring system? Injury. 2004;35(4):347–358.
   DOI: 10.1016/S0020-1383(03)00140-2
9. Brown J B, Gestring ML, Leeper CM, et al. The value of the injury severity score in pediatric trauma. Journal of Trauma and Acute Care Surgery. 2017;82(6):995–1001.
10. Huang YT, Huang YH, Hsieh CH, Li CJ, Chiu IM. 'Comparison of injury severity score, Glasgow coma scale, and revised trauma score in predicting the mortality and prolonged ICU stay of traumatic young children: A cross-sectional retrospective study'. Emergency Medicine International. 2019;1–7.
11. Charan J, Biswas T. How to calculate sample size for different study designs in medical research? Indian J Psychol Med. 2013;35(2):121-6.
12. Tobi KU, Amadasun FE. Prolonged stay in the intensive care unit of a tertiary hospital in Nigeria: Predisposing factors and outcome. African Journal of Medical and Health Sciences. 2015;14(1):56–60.
13. Allen CJ, Wagenaar AE, Horkan DB, Baldor DJ, Hannay WM, Tashiro J, Namias N, Sola JE. 'Predictors of mortality in pediatric trauma: Experiences of a level 1 trauma center and an assessment of the International Classification Injury Severity Score (ICISS)'. Pediatric Surgery International. 2016;32(7):657–663.
   DOI: 10.1007/s00383-016-3900-7
14. Yousefzadeh Chabok S, Ranjbar taklimie F, Malekpouri R., Razzaghi A. 'Predicting mortality, hospital length of stay and need for surgery in pediatric trauma patients', Chinese Journal of Traumatology - English Edition. 2017;20(6), 339–342.
   DOI: 10.1016/j.cjtee.2017.04.011
15. Wendling Keim DS, Hefele A, Muensterer O, Lehner M. 'Trauma Scores and Their Prognostic Value for the Outcome Following Pediatric Polytrauma'. Frontiers in Pediatrics, 2021;1–9.
   DOI: 10.3389/fped.2021.721585
16. Morrissey K, Fairbrother H. 'Severe traumatic brain injury in children: An evidence-based review of emergency department management'. Pediatric Emergency Medicine Practice. 2016; 13(10):1–28.
17. Yousefzadeh Chabok S, Kazemnejad Leili E, Kouchakinejad Eramsadati L, Hosseinpour M, Ranjbar F, Malekpouri R, Mohtasham Amiri Z. 'Travma geçirmiş çocuklarda mortalite öngörüsünde

Pediyatrik Travma, Glasgow Koma Ölçeği ve Comparing Pediatric Trauma, Travma Şiddet Derecesi skorlarının karşılaştırması', Ulusal Travma ve Acil Cerrahi Dergisi. 2016;22(4):328–332.
DOI: 10.5505/tjtes.2015.83930

18. Soni KD, Mahindrakar S, Gupta A, Kumar S, Sagar S, Jhakal A. 'Comparison of ISS, NISS, and RTS score as predictor of mortality in pediatric fall'. Burns and Trauma. 2017;5(1):1–6.
DOI: 10.1186/S41038-017-0087-7/TABLES/4

19. Allen CJ, Valle EJ, Thorson CM, Hogan AR, Perez EA, Namias N, Zakrison TL, Neville HL, Sola JE. 'Pediatric emergency department thoracotomy: A large case series and systematic review'. Journal of Pediatric Surgery. 2015;50(1):177–181.
DOI: 10.1016/J.JPEDSURG.2014.10.042

20. Roden Foreman JW, Rapier NR, Yelverton L, Foreman ML. 'Avoiding Cribari gridlock: The standardized triage assessment tool improves the accuracy of the Cribari matrix method in identifying potential overtriage and undertriage'. Journal of Trauma and Acute Care Surgery. 2018;84(5):718–726.
DOI: 10.1097/TA.0000000000001814

21. DiBrito SR, Cerullo M, Goldstein SD, Ziegfeld S, Stewart D, Nasr IW. 'Reliability of Glasgow coma score in pediatric trauma patients'. Journal of Pediatric Surgery. 2018;53(9):1789–1794.
DOI: 10.1016/J.JPEDSURG.2017.12.027

22. Guzzo JL, Bochicchio GV, Napolitano LM, Malone DL, Meyer W, Scalea TM. 'Prediction of outcomes in trauma: Anatomic or physiologic parameters? Journal of the American College of Surgeons. 2005;201(6): 891–897.

## Appendix I

**A- Demographic data:**

- Name:
- Age
- Sex:
- Address:
- Type of accident:
- Time of accident:
- **Time of arrival to ER:**
- **Time of trauma:**

**B- Outcome**

- **Died**
- **Survived**

**C- Length of hospital stay in days:**

**D- GlascoComa scale**

| Glasgow Coma Scale | | |
|---|---|---|
| **Response** | **Scale** | **Score** |
| **Eye Opening Response** | Eyes open spontaneously | 4 Points |
| | Eyes open to verbal command, speech, or shout | 3 Points |
| | Eyes open to pain (not applied to face) | 2 Points |
| | No eye opening | 1 Point |
| **Verbal Response** | Oriented | 5 Points |
| | Confused conversation, but able to answer questions | 4 Points |
| | Inappropriate responses, words discernible | 3 Points |
| | Incomprehensible sounds or speech | 2 Points |
| | No verbal response | 1 Point |
| **Motor Response** | Obeys commands for movement | 6 Points |
| | Purposeful movement to painful stimulus | 5 Points |
| | Withdraws from pain | 4 Points |
| | Abnormal (spastic) flexion, decorticate posture | 3 Points |
| | Extensor (rigid) response, decerebrate posture | 2 Points |
| | No motor response | 1 Point |
| **Minor Brain Injury** = 13-15 points; **Moderate Brain Injury** = 9-12 points; **Severe Brain Injury** = 3-8 points | | |

**E- Revised trauma score:**

Glasgow Coma Scale

| GCS | Points |
|---|---|
| 15–13 | 4 |
| 12–9 | 3 |
| 8–6 | 2 |
| 5–4 | 1 |
| 3 | 0 |

Systolic Blood Pressure

| SBP | Points |
|---|---|
| >89 | 4 |
| 76–89 | 3 |
| 50–75 | 2 |
| 1–49 | 1 |
| 0 | 0 |

Respiratory Rate

| RR | Points |
|---|---|
| 10-29 | 4 |
| >29 | 3 |
| 6–9 | 2 |
| 1–5 | 1 |
| 0 | 0 |

**RTS = 0.9368 GCS + 0.7326 SBP + 0.2908 RR.**

RTS are in the range 0 to 7.8408.

**RTS = 0.9368(------) + 0.7326 (------) + 0.2908 (-----) =**

**F- The Injury Severity Score (ISS)**

| Site of Injury | | AIS score | $AIS^2$ |
|---|---|---|---|
| **Head or neck – including cervical spine** | ☐ Minor injury (1)<br>☐ Moderate (2)<br>☐ Serious (3)<br>☐ Sever (4)<br>☐ Critical (5)<br>☐ Unserviceable (6) | | |
| **Face – including the facial skeleton, nose, mouth, eyes and ears** | ☐ Minor injury (1)<br>☐ Moderate (2)<br>☐ Serious (3)<br>☐ Sever (4)<br>☐ Critical (5)<br>Unserviceable (6) | | |
| **Chest – thoracic spine and diaphragm** | ☐ Minor injury (1)<br>☐ Moderate (2)<br>☐ Serious (3)<br>☐ Sever (4)<br>☐ Critical (5)<br>Unserviceable (6) | | |
| **Abdomen or pelvic contents – abdominal organs and lumbar spine** | ☐ Minor injury (1)<br>☐ Moderate (2)<br>☐ Serious (3)<br>☐ Sever (4)<br>☐ Critical (5)<br>Unserviceable (6) | | |
| **Extremities or pelvic girdle – pelvic skeleton** | ☐ Minor injury (1)<br>☐ Moderate (2)<br>☐ Serious (3)<br>☐ Sever (4)<br>☐ Critical (5)<br>☐ Unserviceable (6) | | |

| Site of Injury | | AIS score | $AIS^2$ |
|---|---|---|---|
| **Skin** | ☐ Minor injury (1)<br>☐ Moderate (2)<br>☐ Serious (3)<br>☐ Sever (4)<br>☐ Critical (5)<br>Unserviceable (6) | | |
| **ISS = A2 + B2 + C2 where A, B, C are the AIS scores of the three most injured ISS body regions**<br>**ISS score: ……..+……….+………=** | | | |



*Peer-review history:*
*The peer review history for this paper can be accessed here:*
*https://www.sdiarticle5.com/review-history/92395*