ORIGINAL ARTICLE

Comparing Pediatric Trauma, Glasgow Coma Scale and Injury Severity scores for mortality prediction in traumatic children

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ABSTRACT

BACKGROUND: Trauma is a major cause of disability and death among children worldwide, particularly in developed countries. The present aim was to compare efficacies of the Pediatric Trauma score (PTS), the Glasgow Coma Scale score (GCS), and the Injury Severity Score (ISS) in the prediction of mortality in children injured by trauma.

METHODS: A total of 588 children admitted to the emergency ward of the Poursina Medical and Educational Center from 2010–2011 with trauma were included. The PTS, GCS, and ISS were calculated for all patients. Predictive efficacy of these scores was compared using receiver operating characteristic (ROC) curve with 95% confidence interval.

RESULTS: Of the patient population, 62.1% were male and 37.9% female, with a mean age of 7.31±3.8 years. Road accident (42.2%) was the most common cause of injury. Overall, 2.4% of participants died. Regarding the prediction of mortality, the best cut-off point for the GCS was ≤8, with 98.4% sensitivity and 92.3% specificity. The same point for the PTS was ≤0.5, with 100% sensitivity and 31% specificity. For the ISS it was ≥16.5, with 92.5% sensitivity and 62% specificity. All variables based on mortality prediction were statistically significant (p<0.0001).

CONCLUSION: When compared to the PTS and ISS, the GCS may be a better predictor of mortality in cases of childhood trauma.

Key words: Children; Glasgow Coma Scale; Injury Severity Score; Pediatric Trauma Score; trauma.

INTRODUCTION

In developed countries, trauma is one of the most significant causes of childhood morbidity, with the potential to lead to disease, long-term disability, or death in the early years of life.[1] Pediatric trauma remains a major health issue in the US, is the primary cause of over 10000 annual child mortalities worldwide, and is the cause of approximately 10% of pediatric hospitalizations. According to data recorded in Iran in 2005, trauma, irrespective of gender, was the second leading cause of mortality[2] and the most common cause of death between the ages of 1 and 14 years.[3] Damage caused by major trauma can be reduced with prompt pre-hospital and in-hospital intervention.[4,5] A quantitative scale has been deemed necessary to assess trauma severity, triage, and outcome in trauma centers.[6–9] These scoring systems have played a vital role in the advancement of trauma care over the past 20 years. However, many emergency physicians are still unfamiliar with these systems.[1] The Pediatric Trauma score (PTS), Glasgow Coma Scale (GCS), and Injury Severity Score (ISS) can be used to evaluate trauma in children.[10]

The PTS is easily calculable and can be used by care providers with any level of skill. It is effective in cases of emergency because, in addition to assessing injury severity, it can also be used to identify risk of immediate death if no appropriate treatment is administered in time.[1] The GCS is the scale most commonly used to measure severity of traumatic brain injury, in adults as well as in children, following a modification.[1,11] The pediatric GCS is utilized for pre-verbal children.[1] The ISS is an anatomic score and independent predictor of death following severe trauma, appropriate for patients with

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multiple injuries.[1] This scale correlates well with mortality, disability, and hospitalization.[12] Given the importance of scoring systems in recognizing risk in immediate, as well as general, outcome, the present aim was to identify the scale that could be used most quickly and accurately to assess childhood trauma.

MATERIALS AND METHODS

The present retrospective study included 588 children with trauma admitted to the emergency ward of Poursina Medical and Educational Center in Rasht (Gilan province) between 2010 and 2011. A checklist was used for data collection

Table 1. Pediatric Glasgow Coma Scale

	Pediatric GCS	Score value
Eye opening	None	1
	To pain	2
	To voice	3
	Spontaneously	4
Verbal response	None	1
	Inconsolable, agitated	2
	Inconsistently consolable, moaning	3
	Cries, but is consolable, inappropriate interaction	4
	Smiles, oriented to sounds, follows objects, interacts	5
Motor response	None	1
	Extension to pain	2
	Flexion to pain	3
	Withdrawal from pain	4
	Localizing pain	5
	Obeys commands	6

Table 2. Calculation of Pediatric Trauma score

Clinical parameter	Parameter category	Score value
Weight (kg)	≥20	+2
	10–19	+1
	<10	–1
Airway	Patent	+2
	Maintainable	+1
	Unmaintainable	–1
Systolic blood pressure	>90	2
	50–89	1
	<50	–1
Central nervous system	Awake	+2
	Obtunded or loss of consciousness	+1
	Coma or decerebrate	–1
Open wound	None	+2
	Minor	+1
	Major or penetrating	–1
Skeletal	None	+2
	Closed fracture	+1
	Open or multiple fractures	–1

from the hospital information system. Necessary information obtained from patient records included demographic characteristics, injury (site and type, mode of transportation to hospital), primary assessment (vital signs), and evaluation of mortality (time and cause of death). Outcome of trauma was defined as death or survival.

Patients with incomplete records or previous history of disease (cardiovascular, renal, pulmonary, or cerebral, such as stroke) were excluded. The GCS (in which motor, verbal, and ocular responses are classified from 3–15) was used, according to clinical condition.[13] A score of 3 corresponded to worst outcome (coma or death), 15 corresponded to best outcome (no neurological deficit) (Table 1).

To calculate PTS, 3 physiological and 3 anatomical conditions were assessed, including body mass index (BMI), condition of access to airways, fracture, level of consciousness, systolic blood pressure, and condition of wounds. Scores range from -6 to +12 (Table 2).[13]

The ISS is derived from the Abbreviated Injury Scale (AIS). The AIS can be used to accurately rank injury severity, and is graded from 1 (minor injury) to 6 (unsurvivable injury). The sum of the square of AIS values higher than 3 (corresponding to the most severely injured regions) is used to calculate ISS.

Accuracy in the prediction of survival was compared among these scoring systems, and included specificity, sensitivity, and cut-off points, according to receiver operating characteristic (ROC) curve with 95% confidence interval. Statistical analysis was conducted using SPSS software (version 18.0; SPSS Inc., Chicago, IL, USA).

RESULTS

Of the 588 children included, 62.1% were male and 37.9% were female, with a mean age of 7.31±3.8 years, and a range of 3 months to 14 years of age. Road accident (42.2%, n=248) and falling (39.8%, n=234) were the most common causes of injury. The majority of children were car passengers (44.3%). Demographic information and means of scales (ISS, GCS, and PTS) are shown in Table 3.

Overall, 92.2% (n=542) of injuries were blunt, and 7.8% (n=48) were penetrating. Areas most commonly damaged were the extremities (92.9%, n=546), followed by the head and neck (27.4%, n=161), and the face (23.3%, n=137). A total of 97.6% (574) of the population survived, while 2.4%[14] died. Mean GCSs were 14.63±1.31 and 4.71± 2.23 in those who survived and those who died, respectively. Mean PTSs were 9.93±1.55 and 3.85±4.12 in those who survived and those who died, respectively. Mean ISSs were 6.26±5.9 and 17.71±4.34 in those who survived and those who died, respectively. Mean differences in GCSs, PTSs, and ISSs between those who survived and those who died were statistically significant (p<0.001) (Table 4). ROC area under the curve (AUC) for prediction of mortality was highest for the GCS, compared to the PTS and the ISS (AUC: 0.997; p=0.000) (Fig. 1, Table 5).

Table 3. Demographic information and mean of scales in 588 cases of childhood trauma

	n	%	Mean±SD (mid)
Age (yrs), mean (SD)	7.31	3.8	
Age groups			
0–2 years	75	12.8	
3–10 years	386	65.6	
11–14 years	127	21.6	
Gender			
Female	365	62.1	
Male	223	37.9	
Road traffic accident			
Passenger	106	44.3	
Cyclist	37	14.5	
Motor cyclist	50	19.6	
Pedestrian	55	21.6	
Mechanism of trauma			
Falling	234	39.8	
Assault	10	1.7	
Sharp object	43	7.3	
Sport	39	6.6	
Other	14	2.4	
Trauma Score			
GCS			14.39±2.02 (15)
PTS			9.8±1.88 (10)
ISS			6.47±6.07 (4)

SD: Standard deviation; GCS: Glasgow Coma Scale; PTS: Pediatric Trauma Score; ISS: Injury Severity Score.

Table 4. Comparison of scoring systems in two groups of children: Those who survived and those who died

Score status	n	Mean±SD	p
Glasgow Coma Scale			
Deaad	14	4.7±2.2	0.0001
Survived	574	14.6±1.3	
Injury Severity Score			
Dead	14	17.7±4.3	0.0001
Survived	574	6.3±5.9	
Pediatric Trauma Score			
Dead	13	3.8±4.1	0.0001
Survived	562	9.9±1.5	

SD: Standard deviation.

Table 5. Efficacy of the PTS, GCS, and ISS in mortality prediction of childhood trauma

Scoring Systems	AUC*	Std. Error	CI 95%
PTS	0.949	0.021	0.908–0.991
GCS	0.997	0.002	0.993–1
ISS	0.929	0.018	0.894–0.963

GCS: Glasgow Coma Scale; PTS: Pediatric Trauma Score; ISS: Injury Severity Score. *Area Under Curve.

Table 6. Logistic regression analysis using injury scoring systems

Predictor	B	S.E.	OR	95% C.I for OR
ISS	0.36	0.19	1.43	0.98–2.10
GCS	1.60	0.64	4.97	1.41–17.55
PTS	0.55	0.37	1.74	0.84–3.62

GCS: Glasgow Coma Scale; PTS: Pediatric Trauma Score; ISS: Injury Severity Score.

Desired cut-off was ≤8 for the GCS (sensitivity: 98.4%; specificity: 92.3%), ≤0.5 for the PTS (sensitivity: 100%; specificity: 31%), and ≥16.5 for the ISS (sensitivity: 92.5%; specificity: 62%). Multivariate logistic regression analysis using backward stepwise model (likelihood ratio: probabilities of inclusion and exclusion of variables from the model; entry=0.05, removal=0.1) showed GCS as the only predictor of mortality (p=0.015), so that 1-unit decrease in mortality rate increased mortality risk 4.9 times (95% confidence interval: 1.36–17.5).

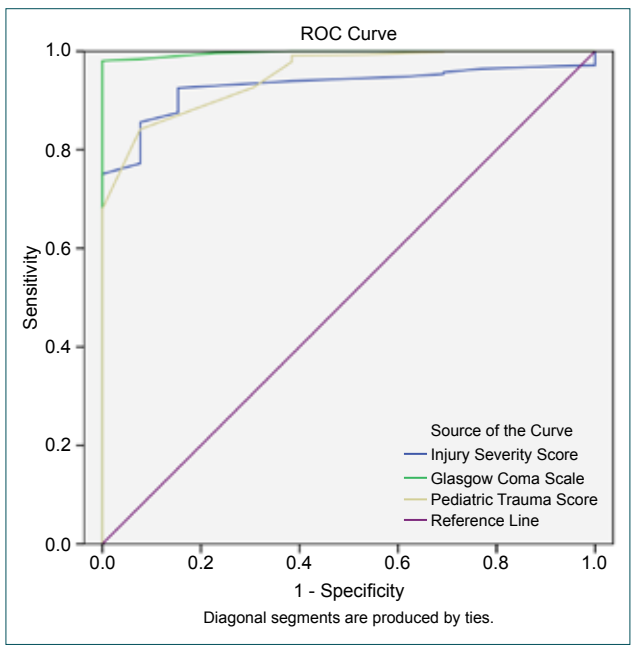

Figure 1. Comparison of the PTS, GCS, and ISS in mortality prediction of pediatric trauma patients.

Although the other parameters (PTS and ISS) were included as predictors in the final model, they were not found to be statistically significant (Table 6).

DISCUSSION

Trauma is considered a threat to childhood survival.[14] More than 30% of these deaths can be prevented by quality primary treatment.[15] Quantitative trauma scoring systems are important methods of evaluating and comparing trauma treatment standards.[16] Males comprised the majority of the present population, in accordance with the findings of others.[1,14,17,18] The most common causes of trauma in the present population were road accident, followed by fall. Franze´n Derakhshanfar et al. reported the same findings,[14,18] while Adegoke et al. reported fall to be the most common cause, followed by road accident.[19] While the most common sites of injury were presently found to be the extremities, followed by the head and neck, Letts et al. reported the head as the area most commonly injured.[20]

Means of GCS, PTS, and ISS were presently found to be 14.4, 9.8, and 6.5, respectively. These means were 4.7, 3.8, and 17.7, respectively, in children who died. Letts et al. reported a PTS mean of 8.5 overall, and 3.8 in the mortality group. Mean GCS was 11.8 overall, and 3.4 in the mortality group.[20] Bulut et al. reported a mean ISS of 8.7 overall, and 2.5 in the mortality group.[17] The best GCS cut-off point was presently determined as 8, with sensitivity of 98.4% and specificity of 92.3%. Grinkeviciūte et al. found the best GCS cut-off point to be 5, with 79% sensitivity and 67% specificity.[1] The best ISS cut-off point was presently determined as 16.5, with sensitivity of 92.5% and specificity of 62%. Bulut et al. found the best ISS cut-off point to be 22, with sensitivity of 90.5% and specificity of 95.4%.[1]

ROC curve analysis indicated that all 3 scoring systems were statistically significant for prediction of mortality, but that GCS was the strongest. In a similar study including children with severe trauma in intensive care, Cantais et al. reported that the same systems had significant association with mortality, though the GCS had the highest predictive ability.[21] Furthermore, in a study in which 11 trauma parameters were compared among children and adults, Otto et al. reported that physical parameters, including the GCS, had higher predictive ability than those that were anatomical, including the PTS and ISS.[22]

Conclusion

Researchers, policymakers, and directors of medical centers should take steps toward implementing precise patient evaluation and preventive programs, in order to improve the quality of services and care. The present results indicate that the GCS, PTS, and ISS can be used to predict mortality with statistical significance in child patients with trauma. The GCS had the strongest significance, and implementation of this

reliable and user-friendly scoring system may positively contribute to timely and proper planning, aid in pre-hospital and in-hospital evaluation and care, and ultimately reduce costs.

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ORİJİNAL ÇALIŞMA - *ÖZET*

Travma geçirmiş çocuklarda mortalite öngörüsünde Pediyatrik Travma, Glasgow Koma Ölçeği ve Comparing Pediatric Trauma, Travma Şiddet Derecesi skorlarının karşılaştırması

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AMAÇ: Dünya ölçeğinde özellikle gelişmiş ülkelerdeki çocuklar arasında travma sakatlık ve ölümün önemli bir nedenidir. Burada amaç travma sonucu yaralanmış çocuklarda mortaliteyi öngörmede Pediyatrik Travma skoru (PTS), Glasgow Koma Ölçeği skoru (GKS) ve Travma Şiddet Derecesi skorunun etkililiklerini karşılaştırmaktı.

GEREÇ VE YÖNTEM: Poursina Tıp ve Eğitim Merkezi'nin Acil Servisi'ne 2010-2011 yılı arasında toplam 588 travmalı çocuk kabul edilmiştir. Hastaların hepsi için PTS, GCS ve ISS hesaplandı. Alıcı işletim karakteristik (ROC) eğrisi kullanılarak %95 güven aralığıyla bu skorların öngördürücü etkililiği karşılaştırıldı.

BULGULAR: Hasta popülasyonunun %62.1'i erkek ve %37.9'u kız çocuklarından ibaretti. Yaş ortalaması 7.31±3.8 yıl idi. Yaralanmanın en sık görülen nedeni trafik kazasıydı (%42.2). Genelde katılımcıların % 2.4'ü ölmüştü. Mortalitenin öngörüsü açısından GKS için en iyi kestirme değeri ≤8 olup %98.4 duyarlılık ve %92.3 özgüllüğe sahipti. PTS için kestirme değer ≤0.5 olup %100 duyarlılık ve %31'lik özgüllüğe sahipti. ISS için bu değer ≥16.5 olup %92.5 duyarlılık ve %62'lik özgüllüğe sahipti. Mortalite öngörüsüne dayalı tüm değişkenler istatistiksel açıdan anlamlıydı (p<0.0001).

TARTIŞMA: Çocukluk çağı travma olgularında PTS ve ISS ile karşılaştırıldığında GKS daha iyi bir öngördürücü faktör olabilir.

Anahtar sözcükler: Çocuklar; Glasgow Koma Ölçeği; Pediyatrik Travma Skoru; travma; Travma Şiddet Skoru.

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