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Trauma and Injury Severity Score (TRISS) in Head Injury Patients

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Abstract

Background : **Injury severity classifications have been developed for the past decades. Milestone study in the quest for the best possible method to predict outcomes of injured trauma patients has been studied continuously. Quantitative characterizations of injury are essential for research, meaningful evaluations of patient outcome, quality improvement, and prevention programs. Trauma and Injury Severity Score (TRISS) is a combination index based on then state-of-the-art severity indices, the Trauma Score (TI) and the Injury Severity Score (ISS), patient age, and mechanism of injury. Since its development, TRISS has been a frequently used method for predicting survival or mortality of trauma inpatients, but unfortunately not many studies had reported about using TRISS with neurotrauma cases.**

Materials and Methods : **A retrospective study to determine the accuracy of TRISS in head-injured patients was made by review of medical records of patients admitted between December 2000 and May 2001 to Trauma Unit of Saraburi Hospital were reviewed by trauma audit staffs consisting of various specialties such as general surgeons, neurosurgeons, urologists and plastic surgeons.**

Results : **The results of this study showed that there were man y drawbacks of using TRISS in predicting the death of neurotrauma patients. TRISS model did not work well in predicting survival for neurotrauma patient.**

Conclusion : **Because of the limitations of TRISS, peer reviews or other new models such as ICISS should supersede it. Some possible refinements such as the mechanisms of injury, timing of injury, nature of diseases, hospital charges, and the prognosis should be included in the models in predicting the neurotrauma outcome.**

Characterization of injury severity emerged in the 1950s.[1] Since then more methodologies were subsequently developed.[2,3] Up to now, numerous scoring methods had been designed and proposed. One of the most popular trauma classification, especially for neurosurgical trauma, is Glasgow Coma Scale (GCS) described by Teasdale and Jennett.[4]

Abbreviated Injury Scale (AIS) and Injury Severity Score (ISS) are classified as anatomic scores, whereas Trauma Score (TS), Revised Trauma Score (RTS), and GCS are physiologic scores. Trauma and Injury Severity Score (TRISS) is the combined anatomic and physiologic score.[5-15] RTS, ISS and TRISS were the

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well-known scoring methods widely employed in the late 1990s. International Classification of Disease-9 based Injury Severity Score (ICISS) has been shown to be a much better predictor of survival than ISS in injured patients in one study.[16]

RTS was developed from the original Triage Index (TI) and Trauma Score (TS) derived from application of code values for GCS, Systolic blood pressure (SBP), and Respiration rate (RR) by the following formula[17-19]:

RTS = 0.9368 GCS(c) + 0.7326 SBP(c) + 0.2908 RR(c)

ISS correlates reasonably well with mortality probability but it has the main drawback in that it can not be accounted for severe multiple injuries within one region.[16,20-25]

TRISS combines the physiologic RTS together with anatomic ISS and then formulate together with patient age, injury type and become a well-known trauma patient triage. It is calculated using the collected information databases and expressed as the survival chance of trauma victims.[26]

All of the injury scores methods are related to each other in some aspects. For example, Trauma Score (TS) has some linkage with the original Glasgow Coma Scale (GCS). However, each method has its shortcomings and drawbacks. There had been several debates regarding which method is the best under certain specific events. So "new and improved systems" were frequently put forth. The most recent revision in the year 2000 was ICISS 10 (ICD-10 based).

Although several reports had pointed out the main drawbacks of TRISS method, but it is still a widely used system for outcome analysis. However, not many had discussed about TRISS as regarded to the neurological outcome. This study analyzed the data obtained from hospital medical records of a provincial hospital in Thailand during a recent 6-month period to identify the accuracy of TRISS method in predicting the chance of survival in head injury patients.

Materials and Methods

Saraburi Hospital is a provincial hospital situated in close proximity of major highways just north of Bangkok. The hospital maintains an active Emergency and Trauma services.

The medical records of patients admitted between December 2000 and May 2001 to Trauma Unit of Saraburi Hospital were reviewed by trauma audit staffs consisting of various specialties such as general surgeons, neurosurgeons, urologists and plastic surgeons.

The following inclusion criteria were used: (1) Patients with history of trauma (traffic accidents, body assault, etc.); (2) patients with co-existing head injuries; and (3) patients that succumbed. Patients without head injuries and/or age less than 15 years were excluded from this review.

All patients had records of their ages, vital signs (systolic blood pressure, heart rate, respiratory rate), and their neurosurgical signs using the Glasgow coma scale from the time of admission. Data were reviewed and calculated into Glasgow coma score (GCS) and Trauma Score-Injury Severity Score (TRISS). Using multiple logistic regression models, the differences between blunt and penetrating injuries related to TRISS is accommodated. Then, together with RTS, ISS, and patient age, they were placed in a logistic transformation to yield a survival probability (Ps) in the range from 0 to 1.[27]

The logistic formula is :

"Ps = 1 / (1 + e -b)"

Where b is calculated from :

"b= b0 + b1(RTS) + b2(ISS) + b3(Age Index)"

e = 2.7183 (based of Napierian logarithm)

Age index = 1 for patient's age > 54 years

Age index = 0 for patient's age <= 54 years

The coefficients b0 to b3 are derived from multiple regression analysis of MTOS database and are different from blunt to penetrating injury.[28]

Thus, the determination of Ps varies according to 6 variables of GCS, SBP, RR, Age, Mechanism of trauma, and the ISS.

There were 176 patients matched with the above criteria. The patients who met the above criteria with TRISS > 0.8 and should have a predicted chance of survival were divided according to GCS into 3 groups. Group I were those with GCS 13-15, Group II 9-12, and Group III 3-9. Trauma audit teams serving as peer review teams, were assigned to study each medical record in details.

Conclusions were reached from peer review to address the chance of individual survival of all patients. The cause of death and the reason or factor contributing to management and survival failures were identified in those withTRISS > 0.8 who should have a chance of survival. For those without any chance of survival, TRISS < 0.8, only the possible cause of death was determined.

Results

There were 176 patients matched with the above criteria. Among them were 145 males and 31 females.

Table 1 Cause of injury in TRISS < 0.8

Cause of Injury	No. of Patient	Percent
Motorcycle Accidents	62	47.7
Car Accidents	22	16.9
Body Assaults	22	16.9
Gun Shot Wounds	10	7.7
Falls from Height	9	6.9
Others	5	3.9
Total	**130**	**100.0**

Table 2 Causes of death in patients with TRISS < 0.8

Cause of Death	No. of Patient	Percent
Severe Shock	74	42.0
Brain Herniation	44	25.0
Respiratory Failure	32	18.2
Sepsis	23	13.1
Unknown	3	1.7
Total	**176**	**100**

The most common cause of trauma was motorcycle accident (143/176 cases or 81.25 %). The others were car accident, body assault, gunshot wound, falling from height.

One hundred and thirty patients had TRISS < 0.8 at time of arrival at the Emergency Room. There were 46 of 176 patients who had TRISS above 0.8 and they were divided into 3 groups according to their GCS. There were 28 patients in Group III, 11 in Group II, and 7 in Group I. For those patients with TRISS <0.8, their types of injury and causes of death were shown in Tables 1 and 2 respectively.

The Group I patients were considered should have a survival chance because of their high GCS and TRISS > 0.8 (Table 3). In this group, however after details peer review, 6 patients were considered having high probability of death by the following conclusions.

Case 1 and Case 6 were the cases of severe brain edema (fungating brain) that resulted from high speed motor cycle accident (MCA). The patients came to the hospital very soon after the accident, so their GCS were high. Despite aggressive management for brain edema, the patients died. In case 1, his family agreed not to receive further postoperative aggressive treatment due to the unacceptable poor prognosis. His family could not afford the living cost at home for his prolonged vegetative state.

Case 2 and Case 5 were the cases of posterior fossa epidural hematoma. These two patients showed no early signs of uncal herniation. The only complaints

Table 3 Summary of Group 1 patients (N = 7)

	Sex	Age (yr)	Cause of Injury	GCS at adm.	Ps	Diagnosis on Admission	Final Diagnosis	Cause of Death	Ls. (D)
1	M	19	MCA	13	0.98	SDH with brain edema	Same with Severe brain edema	Tonsillar herniation	3
2	F	20	MCA	15	0.89	Brain concussion	Posterior fossa EDH	Tonsillar herniation	6
3	M	33	MCA	13	0.90	Brain concussion	Ruptured liver with massive hemorrhage	Brain hypoxia and edema from prolonged shock	12
4	M	18	GSW	13	0.87	Open skull fracture	Ruptured traumatic intracranial aneurysm	Massive SAH with severe brain edema	24
5	M	21	Assault	13	0.94	Brain contusion	Posterior fossa EDH	Tonsillar herniation	9
6	F	24	MCA	13	0.82	Bilateral SDH	Same with severe brain oedema	Tonsillar herniation	6
7	M	23	MCA	14	0.88	EDH	EDH	Delayed surgery	11

(Abbreviation code: yr - year, SDH-Subdural haematoma, EDH-Epidural haematoma, ICH-Intracerebral haematoma, SAH-Subarachnoid haemorrhage, MCA-Motorcycle accident, GCS-Glasgow Coma Score, Ps-Probability of survival, Ls-Length of stay as Day, Adm.-Admission)

Table 4 Summary of Group 2 patients (N = 11)

	Sex	Age (yr)	Cause of Injury	GCS at adm.	Ps	Diagnosis on Admission	Final Diagnosis	Cause of Death	Ls. (D)
1	F	18	MCA	10	0.82	SDH with brain oedema	Severe brain oedema	Tonsillar herniation	8
2	F	45	Fall from height	10	0.82	SDH	Severe brain oedema	Respiratory failure	12
3	M	20	MCA	12	0.92	ICH	Same with SDH	Tonsillar herniation	1
4	M	21	MCA	9	0.96	Posterior fossa EDH	Same	Respiratory failure	4
5	M	35	MCA	8	0.89	Open skull fracture	Same with SDH-ICH	Tonsillar herniation	7
6	M	65	Car accident	8	0.95	Brain concussion	Fracture pelvis	Hypovolemic shock	2
7	F	16	Fall from height	10	0.97	Spinal cord injury (SCI)	Same	Respiratory failure	21
8	M	18	MCA	12	0.86	SDH-ICH	Same	Sepsis	16
9	M	19	Body Assault	11	0.88	Spinal cord injury (SCI)	Same	Respiratory failure	7
10	F	23	MCA	10	0.90	ICH	Same with SCI	Respiratory failure	12
11	M	31	Car accident	9	0.90	SAH with Severe brain edema	Ruptured intracranial aneurysm	Brain herniation	6

N.B.
a) Case 2, 4, 6, 7, 8, 9, and 10 died from complications related to respiratory and infectious problems, not from the diseases themselves.
b) Case 11 died from process of ruptured intracranial aneurysm, not from the injury of accident.

Table 5 Summary of Group 3 patients (N = 28)

GCS on Admission	**No. of Patients**
GCS = 3	15
GCS = 4	4
GCS = 5	2
GCS = 6	5
GCS = 7	1
GCS = 8	1
Causes of Death	
Tonsillar herniation	18
Severe Shock	5
Sepsis, Respiratory failure, etc.	5

N.B.
a) This group was not studied in details because peers review agreed that most patients had high possibility of death due to low GCS on admission.
b) Most patients died because of tonsillar herniation from severe head injury despite their Ps > 0.8.

were headache, nausea and vomiting which were commonly found in most of cases of mild head injury. The correct diagnosis could not be made prior to further deterioration. The progression of this type of injury was rapid and moribund.

Case 3 was a referred case from a rural hospital with the diagnosis of head injury with abdominal trauma. He died from cardiovascular collapse resulted from prolonged shock during transportation, despite early surgery for stopping bleeding from rupture of the liver. His GCS of 13 at the time of admission resulted from hypovolemic shock, not from primary brain injury.

Case 4 died from ruptured traumatic aneurysm of intracranial vessel injury. He received open fracture of skull from gunshot wound. His condition was stable and GCS was much improved 7 days after admission. But on the 8th day, his GCS rapidly dropped to 5 and the investigation showed traumatic intracranial aneurysm at right pericollosal artery with massive intracranial and subarachnoid hemorrhage. Despite aggressive immediate surgery by craniectomy, he could not survive.

Case 7 was the only case with a predicted chance of survival after studied by peer review. This patient had epidural hematoma from motorcycle accident and arrived at the hospital with TRISS > 0.8 and GCS of 14. Early craniotomy could have saved his life but unfortunately he died due to delayed diagnosis and surgery after the admission.

Groups II and III patients (11 and 28 cases respectively) despite the favorable TRISS > 0.8, were considered to have very poor chance of survival after studied by peer review. Data of cases in Group II and III were summarized in Tables 4 and 5 respectively.

Discussion

Among patients with multisystem trauma, the head is the most frequently part of the body injured. Head injury contributes significantly to the outcome in one half of all deaths from trauma.[29] Almost 75% of victims of fatal traffic accidents demonstrate post-mortem evidence of brain injury.[30] One can not deny the fact that majority of trauma mortality is head injury. Such statistics become more alarming when one realizes that, unlike those who succumb to the other leading causes of death, the victims of head-injury are often adolescents or young adult.[31] This causes much financial burden in terms of both lost productivity and cost of medical care. So numerous predictive formulas have been suggested for evaluation of head-injured patients.[32]

In head-injured patients, there are specific events that made the cases different from other traumatized cases, abdominal injury for example. It has been known that once the impact occurred at the scene, there are 2 specific events that occurred. The first is primary injury of the CNS, and the latter more serious ongoing event is secondary injury. What happened at the scene of accident does not matter for the neurosurgeon because once the impact has occurred we could do nothing to lessen the force that already struck the victims. What neurosurgeons can do is to treat the oncoming secondary injury, i.e. intracranial hematomas such as epidural hematoma, subdural hematoma, and intracerebral hematoma. Using TRISS method as the means of predicting the probability of survival (Ps) may correlate well with this group of neurotrauma patients. The mortality can be reduced by early evacuation of the secondary expanding lesion (blood clots). In most cases, the faster evacuation made, the better the outcome of the patients is. This is especially true if the pre-operative status of the patients is good. The nature of expanding hematomas in the cranium is also important. Patients with subdural hematomas usually have much worse prognosis than that of epidural hematomas of equal size, mass effect, duration of neurologic impairment, and duration of time since the impact.[31] In subdural hematoma, mechanical force applied to the head is usually diffuse throughout the brain parenchyma and resulted in both intracranial clots and extensive underlying parenchymal damage.

For brain edema and other types of lesion that present as the sequelae of severe head injury such as subarachnoid hemorrhage, diffuse axonal injury, surgical method plays less important role or in some cases takes no role. In case of brain edema, neuro-surgeons can not remove the brain tissue so much to lessen the increased intracranial pressure effect. Intracranial pressure (ICP) may decrease after craniectomy but the edematous process continues. If ICP is decreased much enough to comfort the cranium, the edematous process is not much dreadful, and the patients' condition is healthy enough; the patient may be improved by aggressive medical treatment for the stage of increased ICP. If not, patients will die no matter we do. In most cases of diffuse axonal injury, we can hardly see any abnormal anatomical lesions on the imaging investigation but the functional aspect of brain neuronal integrity had been damaged,[33,34] and there is no effective treatment for diffuse axonal injury at present. If the axon is not severely injured, then the optimal internal milieu and proper medical care may allow it to recover, whereas secondary insults may seal itself.[35] This group is clear for what we call "time-dependent process." The patient may look well immediate after injury or at first seen in the emergency room (ER), but the process is going to develop silently. May be a few hour after, he may be look much different from the past few hour. If TRISS is calculated at the first seen at ER, the Ps will be high so that it seems impossible to death. But in the peers review process, it is not surprised to find that the patient died. It is clear that predicting the chance of survival using TRISS method alone is unreliable in these situations.

From the analysis of this study, based on TRISS > 0.8 alone, 46 out of 176 patients (26.14 %) were considered to have a chance of survival when they arrived at the hospital. But when considered together with GCS, their chance of survival was reduced to 7 patients (3.98%) only. Of these 7 patients, peer review committees considered that 6 patients had high possibility of death. The only patient that TRISS, GCS and peer review study were in agreement to suggest a good chance of survival was the case of epidural hematoma who actually failed to survive because of delayed surgery.

There are many factors that TRISS has many flaws in prediction the probability of survival.

First, pre-existing medical conditions is not included in TRISS.[36]

Second, TRISS is derived from part of RTS which is also derived from GCS.[37,38] The main drawback of GCS is that intubation precludes reliable assessment of the verbal score upon arrival at the hospital. Patients with intubation will have lower GCS as compared with ones without intubation; even they have the same trauma conditions. So the patient with intubation will be accounted for poorly. Respiratory rate and verbal response are not accurately obtained in this group.[39,40]

Third, TRISS cannot distinguish between two patients of similar age, anatomic injury, vital sign, and type of injury but present with different timing after injury. The patient who presents shortly after injury has different Ps to the one who presents several hours beyond injury. The problem is that the ability to detect physiologic derangement after injury is time dependent.[39,40] Patients may not manifest physiologic changes immediately after the impact. This is especially true in young, and previously healthy adults. They have greater ability to compensate the body themselves and mask the true extent of injury initially. For instance, rising of intracranial pressure in young and healthy adult may present no abnormality in the compensated GCS status. But at the point of decompensation, pressures change rapidly and compromise brainstem function. This is especially true in case of infratentorial hematoma in which the intracranial pressure changes more rapidly despite the small increment of blood clots.

Fourth, TRISS depicts only the probability of survival regardless of additional resource utilization factors such as cost and duration of admission.[22,23]

Fifth, TRISS does not concern in the outcome of the patients. It points out only the chance of survival regardless of the outcome quality of patients. To say simply, only quantitative but not qualitative is considered.

Sixth, there are many neurotrauma patients who seem to have a greater chance of survival (high Ps) when obtained by TRISS method, but have a less chance and worst prognosis with multidisciplinary peer review process. This is clear when evaluated with radiological examination such as computed tomography of the brain. The study by Fallon and his colleagues[11] supported this notion. They concluded that peer review process by experienced traumatologists in that field may outperform and more effective than computer-generated TRISS method. There were also many reports that showed the lack of correlation with peer reviewed assessment of unexpected death compared to TRISS method.

Seventh, hence it derived from ISS, it is unable to account for multiple severe injuries to a single body part, head and neck including brain for instance.[10,11] In case of traffic accident especially in the highway with high speed driving, victims may have brain contusion, brain edema, together with cervical spine fracture or dislocation. According to ISS, these patients will fall in only 1 category of BR1 (as of ISS), despite the cervical spine fracture may endanger the brain oxygenation leading to increased severity.

Eighth, TRISS does not distinguish between the sizes, mass effect, duration of neurologic impairment and duration of time since injury but different mechanism. For example, the patients with epidural hematomas tend to do well after evacuation of hematoma, whereas those with subdural hematomas have poorer outcomes. In subdural hematoma, there is usually coexisting damage to the underlying brain parenchyma.

Thus, TRISS model did not correlate well in predicting survival for neurotrauma patients. Some possible refinements such as the mechanisms of injury, timing of injury, nature of diseases, hospital charges, and the prognosis should be included in the models in predicting the neurotrauma outcome. Recent studies by Rutledge and coworkers claimed that ICISS is a better indicator of survival that outperforms TRISS as an indicator in injury severity grading, quality assessment, improvement effort and of resource utilization. ICISS may be a new model in predicting such outcome more precisely. Further studies are needed to further support that ICISS methodology is an accurate predictor of survival in neurotrauma patients.

Conclusion

In conclusion, the major drawbacks of TRISS are obviously addressed and pointed out by data from several recent papers and in this study. TRISS method is not accurate as a predictor of the chance of survival in head-injured patient group.

Until now, there is no infallible method of scoring in predicting the outcome and chance of survival in head-injured patients and they should never intend to replace the individual judgement by neurosurgeons themselves. The data from Rutledge and coworkers suggesting that ICISS may be a better indicator of survival that outperforms TRISS as an accurate predictor of survival in neurotrauma patients requires further studies to support.

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