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CLINICAL PRACTICE

A Critical Appraisal of the Revised Trauma Score

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Abstract

Objectives:

The trauma score and its later revision were developed as a triage index which could be readily calculated and interpreted in the prehospital environment. This paper aims to critically examine the available literature to determine if the Revised Trauma Score actually measures what it is intended to measure.

Methods:

A thorough Medline literature search was undertaken of the OVID database. All available journal articles which addressed reliability and validity testing of the Revised Trauma Score were reviewed. Each of the instrument's clinimetric properties are described and critically appraised.

Conclusions:

As a predictive instrument, the Revised Trauma Score has been shown to have a moderate to high ability to accurately predict survival. In its secondary role discrimination, it has been shown to have equivocal 'between-person' sensitivity.

Keywords: Revised Trauma Score, validity, reliability, review

Introduction

Trauma scoring has long been regarded as an integral component of prehospital triage, predicting the likelihood of serious injury or death following trauma and assisting clinicians in deciding on the most appropriate trauma facility to provide specialised care (1). Injury severity scales are also essential for appropriate allocation of resources and evaluating care at different trauma facilities (2). Over 50 trauma scoring systems have been published, highlighting two points. Firstly, there is an appreciable need for such scoring systems, and secondly, few individual instruments are able to meet all the needs of such a tool (3).

Although there appears to be an abundance of instruments to predict mortality in trauma patients, very few have been devised with the prehospital environment in mind. The majority or scores require invasive physiological measurements, laboratory results and radiographic images to derive a score. The Trauma Score (TS) and later the Revised Trauma Score (RTS) were developed specifically as a triage index which could be derived and interpreted in the prehospital environment (3). For the purposes of this paper, the author will concentrate predominantly on the redeveloped Revised Trauma Score given its current use by many prehospital providers. The stated purposes of the instrument in clinimetric terms were as follows:

Discrimination: Refers to the statistically significant separation of those scores in which a patient will survive, and those scores in which the patient dies.

Prediction: Refers to prediction of outcome (survival) of these patients based upon several physiological measurements weighted to obtain a final score at the time of assessment

This paper critically appraises the available literature to determine if the Revised Trauma Score actually measures what it was intended to measure. Furthermore, the clinimetric properties of the tool will be examined, in particular a review of the formal validity and reliability testing undertaken by the developers.

Rationale and purpose for the Instrument

As previously alluded, Champion's Trauma Score (2) and his later refined Revised Trauma Score (4) were developed to provide trauma clinicians with a rapid and reliable instrument which used weighted baseline physiological data to calculate an overall score that could predict severity of injury and the likelihood of death.

This score would then assist the clinician to make informed decisions regarding:

- 1. Appropriate care facility based upon patient acuity,
- 2. Prediction of outcome, and
- 3. Potential resource requirements.

By employing a common instrument that was internationally recognised and utilised, the score also provided for a common language that could be used to compare trauma facility quality control and assurance (3).

The items

The original Trauma Score developed by Champion et al (2) included five domains including respiratory rate, respiratory effort, systolic blood pressure, capillary refill and Glasgow coma scale (see appendix 1). The revision of the Trauma Score (4) retained only three domains; The Glasgow coma scale, systolic blood pressure and respiratory rate (see appendix 2). Champion et al provide little explanation as to how they came about devising what items would be included in their instrument, however they do briefly mention that they based their instrument somewhat upon the Triage Index, modifying it to include respiratory rate and systolic blood pressure which they believed would increase its face validity for treating physicians (2).

Item selection

Item selection involves bringing together a complement of factors believed to be important in answering a question for which an instrument is being developed (5). Items for selection must be relevant, and are generated from literature, expert opinion and existing instruments.

Champion et al (4) were aware that the Revised Trauma Score possessed good face and construct validity based upon previous comparisons to other instruments and for this reason decided to retain the domains of respiratory rate, systolic blood pressure and Glasgow coma score.

The domains retained in the Revised Trauma Score appear to be representative of a tool intended to discriminate between those who should live and those who should die.

Item Scaling

Item scaling refers to the available options for scoring a particular item, and when developing a predictive instrument, Kirshner and Guyatt (5) recommend using response sets which maximise correlations with the criterion measures.

The Revised Trauma Scores item scaling was modified to allow for the adaptation of commonly used and accepted scales. Champion et al (4) consulted neurosurgical experts to find a generally accepted interval for the Glasgow coma score which reflected scores associated with mild, moderate and severe head injury. The Glasgow coma score intervals were altered accordingly. The respiratory rate and systolic blood pressure intervals were also realigned to approximate the survival probabilities associated with each interval of Glasgow coma score.

Item Reduction

During an instrument's design it is possible that significantly more items are selected and tested prior to instrument refinement and item reduction. It is important during validity testing and internal consistency analysis that items which are not useful, or detract from an instrument's usefulness are identified and removed (5).

The revisions made to the trauma score were predominantly due to difficulties encountered within the prehospital environment. Clinicians were having difficulty assessing the capillary refill and retractive respiratory effort items during inclement weather and dim lighting conditions.

The removal of these two domains combined with modifications to the item scaling resulted in a modest improvement in relative information gain and improved the instruments reliability (6).

Reliability

Reliability is primarily concerned with whether the instrument or scale is measuring a particular domain in a reproducible way. For a scale to be truly reliable it would be expected to produce the same result irrespective of the observer, time of day or any other factor. Generally reliability is tested through internal consistency, inter/intra-observer and test-retest reliability (7).

Internal consistency occurs when items designed to measure the same construct, correlate strongly with one another (note the relationship to construct validity).

On reviewing available literature related to the Revised Trauma Score there is no mention of reliability testing. This is potentially an area of concern and could have been easily tested within several of the prospective studies summarised in Table 1. Relatively simple statistical analysis of internal consistency (Cronbach's α), interrater reliability (Pearson's r) and test-retest reliability (Spearman's r_s) should have been performed to determine the instrument's reliability in the trauma setting.

Table 1. Main Characteristics of papers describing the Revised Trauma Score

First Author (Ref. No.)	Study Type	Clinimetric Property Reported	Main Results
Luk (8)	Retrospective Trauma patients (n=2622)	Predictive Validity	RTS Simple to determine Values range 0 – 7.84 Higher values better prognosis Severe Head Injury more accurately reflected by RTS
Champion (4)	Retrospective Trauma patients (n>2600)	Predictive Validity Face Validity Item Reduction Item Scaling	RTS is acceptable predictor of survival whilst TS is not. SBP & RR divided into 5 intervals to approximate those of GCS
Champion (6)	Retrospective Trauma patients (n=80,544)	Predictive Validity	Unweighted sum of RTS Proposed by American College of Surgeons for field triage.
Kuhls (9)	Prospective Trauma Patients (n=9539)	Specificity and Sensitivity Construct Validity	Sensitivity 59% Specificity 82% ISS AUC = 0.93 RTS AUC = 0.84
Biester (10)	Retrospective Pregnant Trauma Patients (n=30)	Predictive Value	RTS lacks predictive value for both risk of adverse pregnancy Outcome and need for prolonged monitoring Larger trial required
Roorda (11)	Retrospective Injured Patients (n=398)	Sensitivity Specificity Predictive Value	Sensitivity 94% Specificity 26% Performance of RTS poorer than previous studies

Validity

Validity is regarded as the ability of a scale or instrument to measure what it claims to measure. There are several types of validity that are commonly assessed, and these are dependent upon the type of tool being developed.

Face validity refers to an observer deciding if they feel that the instrument would sufficiently answer the question it was designed to answer. There is no formal testing involved in assessing face validity, rather observer judgement and knowledge of the area (7). Opinion from an expert panel, including both clinicians and question/content experts may be useful in assessing if the items will measure what it is that they are intended to measure.

Champion et al (4) describe adding the physiological parameters respiratory rate and systolic blood pressure to the Trauma Score due to perceived poor face validity by an expert panel. This appears to have improved the instrument's face validity.

Content Validity is another type of validity that depends very much on personal interpretation, and refers to whether the instrument contains all of the dimensions that would be considered by the observer to be important in measuring the desired outcome. If an instrument possesses high content validity, one is able to draw broader inferences about the individual being measured in relation to the larger community (7). Champion *et al* (4) make no comment on content validity within their revised instrument. From an observer's point of view it appears to contain sufficiently important dimensions with which to measure injury severity in the trauma patient.

Luk *et al* (8) attribute the majority of trauma deaths to severe brain injury. They argue that, given the Revised Trauma Score contains the Glasgow Coma Score as one domain, this significantly improves the instrument's ability to accurately reflect trauma severity. Again, a content expert's opinion may be useful in reaffirming which items are redundant, and to ensure the completeness and representativeness of the remaining item pool.

The Revised Trauma Score's primary objective is to predict the likelihood of mortality (criterion measure) in traumatised patients. Given that the outcome (death) is a gold standard measure, *criterion validity* should be assessed. Criterion validity represents the extent to which the instrument being developed, relates to the criterion measure, or gold standard (5). Champion et al (4) report testing the validity of their instrument against data obtained through The Major Trauma Outcome Study (MTOS) (6). Data was obtained from 51 institutions reporting more than 26,000 consecutive trauma presentations. Data was split into design and test sets. Initially logistic regressions of the revised Trauma score were obtained for the design set. The models were evaluated on the design set using the Hosmer and Lemeshow (H-L statistic 'goodness of fit' measure), and a disparity and relative information gain used as two discrimination measures. Finally data from the design and test sets were combined and once again two measures of survival/death discrimination and one of predictive reliability were analysed. The authors concluded that this score can provide valid data on case mix severity and can compare outcomes over time to assist in the comparison of trauma systems (4).

Construct validity is another type of validity testing concerned with the extent to which a particular measure is consistent with another measure that has been shown to conform to the theoretically derived hypothesis currently being measured (5).

Champion et al (4) tested the Revised Trauma Score against the widely used Injury Severity Score (ISS). The Injury Severity Score is a comprehensive instrument that relies on scores based upon the three most severe injuries from six body regions. The Injury Severity Score is the most widely used system in the world, however is very time consuming to calculate (1). It is for this reason that the Trauma Score in its revised format was developed. The developers of the Revised Trauma Score do not describe any construct validation studies, however a later study by Kuhls et al (9) compared the Injury Severity Score and the Revised Trauma Score. Kuhls et al used an Area Under Curve (AUC) analysis which revealed the Revised Trauma Score has a substantially poorer predictive ability than the Injury Severity Score (AUC) $\frac{1}{1000}$ Severity Score (AUC) $\frac{1}{10000}$ Severity Score (AUC) $\frac{1}{1000}$ Severity Score (AUC

Responsiveness

The responsiveness (or sensitivity to change) of an instrument is depends upon the minimum clinically important change in the variable being measured, and the degree of 'between-subject' variation in stable subjects. Neither of these two measures have been sufficiently investigated in relation to the Revised trauma Score. For this reason it is not possible to accurately measure the true responsiveness of the instrument. Responsiveness is not an attribute of importance to the Revised Trauma Score as it was not intended to detect change, and therefore it is not an instrument that is required to be responsive. Nevertheless, Guyatt, Walter and Norman (12) encourage investigators of newly developed instruments where the minimum clinically important change is yet to be defined, to estimate the instrument's responsiveness by comparing 'within-person' standard deviation to the change in score observed following the implementation of an intervention with known efficacy.

Conclusion

The Revised Trauma Score has been used internationally in both the prehospital and hospital environment primarily as an instrument to predict the likelihood of serious injury and mortality. As a predictive instrument, it has been shown to have a moderate to high ability to accurately predict survival. The Glasgow Coma Score domain appears to increase the tool's predictive ability in the

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cohort of trauma patients who present with severe primary head injury. As a discriminative instrument (its secondary role) it has been shown to have equivocal 'between-person' sensitivity.

Many studies (4, 6, 8, 10, 11) have examined the instrument's ability to predict mortality, but have fallen short of examining the other important clinimetric properties which assist the reader in determining the validity of a measurement tool.

Even though the Revised Trauma Score has been used in practice for many years, it appears timely that a comprehensive validity study be undertaken. Given that the prehospital and hospital environments vary considerably, it would be worth investigating the validity of the instrument in each of these patient populations.

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Appendix 1 - Trauma Score

		Trauma Score	Value	Points	Score
Α.	Respira	itory Rate	10-24	4	
		er of respirations in 15 Sec, multiply by 4	25-35	3	
			>35	2	
			<10	1	
			0	0	A
		atory effort			
		w –markedly decreased chest movement or air exchange	Normal	1	
	Retract	tive –use of accessory muscles or intercostal retraction	Retractive	0	В
С.	C. Systolic blood pressure		>90	4	
	Systoli	c cuff pressure –either arm –auscultate or palpate	70-90	3	
			50-69	2	
			<50	1	
			0	0	C
D.	Capillar				
		-forehead, lip mucosa or nail bed colour refill in 2 sec	Normal	2	
	Delayed	d –more than 2 sec of capillary refill	Delayed	1	
	None –	no capillary refill	None	0	D
			Total		
E.	Glasgo	w coma scale			
	1.	Eye opening	GCS	Scor	
		Spontaneous4		Scor	
		To Voice3	Points	\boldsymbol{e}	
		To Pain2			
		None1	44.45	5	
			14-15	4	E
	2.	Verbal Response	11-13	3	
		Oriented5	8-10	2	
		Confused 4	5-7	1	
		Inappropriate words3	3-4	1	
		Incomprehensible words2			
		None1			
	3.	Motor response			
		Obeys commands6			
		Purposeful movement (pain)5			
		Withdraw 4			
		Flexion (pain)3			
		Extension (pain)2			
		None1			
т.	tal 000	n sint (4 + 2 + 2)	T		
10	iai GCS	point (1+2+3)		uma Score	
			(Total points	H+R+C+D	+⊏ <i>)</i>

Table Reproduced from Champion HR, Sacco WJ, Carnazzo AJ, W C, Fouty WJ. Trauma score. Critical Care Medicine 1981;9(9):672-676.

Appendix 2 – Revised Trauma Score

	Trauma Score	Value Points Score
A.	Respiratory Rate Number of respirations in 15 Sec, multiply by 4	10-29 4 >29 3 6-9 2 1-5 1 0 0 A
B.	Systolic blood pressure Systolic cuff pressure –either arm –auscultate or palpate	>89 4 76-89 3 50-75 2 1-49 1 0 0 B Total
C.	Glasgow coma scale 4. Eye opening	4 1 13-15 3 9-12 2 C 6-8 1
	Oriented5 Confused4 Inappropriate words3 Incomprehensible words2 None1	4 3 3
	6. Motor response Obeys commands6 Purposeful movement (pain)5 Withdraw4 Flexion (pain)3 Extension (pain)2 None1	5 4 3
To	otal GCS point (1+2+3)	Trauma Score (Total points A+B+C)

Adapted from Champion HR, Sacco WJ, Copes WS, Gann DS, Gennarelli TA, Flanagan ME. A Revision of the Trauma Score. The Journal of Trauma 1989;29(5):623-629.

Author Disclosure

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