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ORIGINAL ARTICLE

Triage Revised Trauma Score change between first assessment and arrival at the hospital to predict mortality

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Abstract
Objective To assess among seriously injured accident victims whether change of the Triage Revised Trauma Score (T-RTS) between first assessment and arrival at the hospital independently predicts mortality.
Design Prospective cohort study.
Methods The study analysed data on 507 trauma patients with multiple injuries and with a Hospital Trauma Index-Injury Severity Score (HTI–ISS) of 16 or higher, who were presented directly by ambulance services to the Accident & Emergency Department of the University Medical Centre Utrecht (the Netherlands) in 1999 and 2000.
Results Compared to non-intubated patients whose T-RTS remained unchanged (reference category), the mortality risk was 3.1 times higher [95% confidence interval (CI): 1.5–6.3, p=0.001] for patients with deteriorating T-RTS, 2.9 times higher (95% CI: 1.3–6.5, p<0.001) for patients who had an initially good T-RTS but were nevertheless intubated and 5.7 times higher (95% CI: 3.6–9.0, p<0.001) for patients who had an initially poor T-RTS and were intubated. These associations were independent of factors that could be assumed to have a direct effect on T-RTS, that is intravenous therapy, oxygen administration and being attended to by a mobile medical team at the scene of the accident. Along with T-RTS change, more advanced age was associated with a higher mortality risk.
Conclusion Intubation and a deteriorating T-RTS between the time of the accident and patient's arrival at the hospital are powerful independent predictors of mortality after hospitalisation. Together with advanced age, a deteriorating T-RTS should be the main aspect guiding the preclinical procedures.

Keywords Seriously injured accident victims · Triage Revised Trauma Score (T-RTS) · Mortality · Prehospital care · Trauma patients with multiple injuries · Hospital Trauma Index-Injury Severity Score (HTI-ISS) · Ambulance care · EMS · Deteriorating T-RTS · Predictors of mortality after hospitalisation

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Introduction

Traumatologists have developed a wide range of scoring systems for the purpose of triage in prehospital care and to evaluate care outside and inside hospitals. These systems are generally based on physiological parameters (such as respiratory rate, blood pressure and consciousness level), anatomical injuries or a combination of these two. The first scoring system to be widely used was the Trauma Score which uses not only these particular physiological parameters but also aspects like capillary refill and respiratory expansion [1]. For decades, much research has been done to establish whether this score can be used to assess which patient categories must be treated at trauma centres. In view of the many problems associated with the use of the score, the Triage Revised Trauma Score (T-RTS) was developed [2]. This new score, which no longer includes capillary refill or respiratory expansion, has been found to be a valuable practical instrument for triage and objective patient status assessment in ambulance care [3]. It allows ambulance crews to make rational decisions about the choice of hospital, based on the severity of injuries [4, 5]. These assessments are essential, as seriously injured patients have the greatest chance of survival at a trauma centre [6]. The T-RTS has been validated in many studies and is well able to distinguish between patients with good and poor prognoses [7].

This study aimed to assess whether prehospital change of the T-RTS between first assessment and arrival at the hospital is an independent predictor of mortality among seriously injured victims of accidents.

Patients and methods

The University Medical Centre Utrecht (UMCU) is one of the ten trauma centres in the Netherlands. In principle, all seriously injured patients in the region centred around the city of Utrecht, a region with a population of 1.1 million at a density of 813 inhabitants/km^2, are transported to this hospital.

We defined a prospective cohort of multiple-injury patients on the basis of injury severity as routinely assessed upon arrival at the hospital and confirmed at discharge from the hospital. We included all multiple-injury patients with a Hospital Trauma Index-Injury Severity Score (HTI–ISS) [8, 9] of at least 16 who were directly presented by ambulance services to the UMCU Accident & Emergency (A&E) Department between January 1999 and December 2000. The HTI–ISS is a scale combining anatomical and physiological characteristics, which is used to determine the severity of a patient's combined injuries. The HTI represents the severity of injuries to six parts of the body by a score ranging from 1 (minor) to 5 (life-threatening). The ISS is calculated by adding up the squares of each of the three highest HTI components (ISS). For instance, a patient who has an impression fracture to the skull (3 points), has lost 500 ml of blood (2 points) and has a closed fracture of the humerus (2 points) has an HTI–ISS of 17 ($3^2+2^2+2^2$). Patients for whom the HTI-ISS at discharge was not at least 16 were excluded.

Our study of these multiple-injury patients with high HTI-ISS scores used the prehospital data that are routinely collected for every patient requiring ambulance services. Ambulance crews and doctors of the mobile medical team (MMT) write reports on all patient contacts, including information such as:

- The patient's personal details (name, gender, age)
- The time of the accident, the time when the ambulance or MMT arrived at the scene of the accident, the time the ambulance or MMT left for the hospital and the time the patient arrived at the A&E department
- The Triage Revised Trauma Score (T-RTS) at first contact and upon arrival at the hospital [10]
- The diagnoses established at the scene
- Medical interventions administered before arrival at the hospital

The T-RTS, which uses the physiological parameters of respiratory rate, blood pressure and the level of consciousness according to the Glasgow Coma Scale (GCS), is used in ambulance care to classify patients in terms of the severity of their injuries (see Table 2, T-RTS). The T-RTS ranges from 0 (no signs of life) to 12 (normal vital functions). The three components, viz. respiratory rate, circulation and consciousness, each contribute a maximum of 4 points to the overall score. The GCS [11], used as a component of the T-RTS, was devised as an easy scoring method for cerebral functions in patients with head trauma and includes scores for eye response (1–4 points), motor response (1–6 points) and verbal response (1–5 points). Patients are given the maximum score of 15 points if their nervous system functions normally. In the T-RTS, the GCS component is recoded from values of 1–15 to values of 1–4 (Table 1).

Table 2 shows the T-RTS categories we used for analyses of mortality. We made this grouping into the categories based on our a priori assumptions about their importance for outcome. As the reference category, we defined patients whose T-RTS did not change between the incident and their arrival at the hospital. We classified patients as 'improving' if they showed any improvement of the T-RTS, regardless of their initial scores, between the incident and their arrival at the hospital. We classified patients as 'deteriorating' if they showed any prehospital deterioration of the T-RTS, regardless of their initial scores. In addition, we separately classified patients with good initial scores or poor initial scores who had to be intubated in the field and therefore could not be assessed for T-RTS upon arrival at the hospital.

During this study, details of the intake, diagnostic work-up and treatment of patients at the crash room of the A&E department were routinely recorded [12]. For the purpose of the study, this information was supplemented with data derived from discharge letters from the intensive care units, nursing wards and, where applicable, rehabilitation centres. The guidelines and protocols for ambulance care and A&E treatment were not changed during the study period.

Table 1 Triage Revised Trauma Score (T-RTS)

T-RTS			T1	T2
Respiratory rate				
10–29/min		4		
30/min or higher		3		
6–9/min		2		
1–5/min		1		
Nil		0		
Systolic blood pressure				
≥ 90 mmHg		4		
76–98 mmHg		3		
50–75 mmHg		2		
1–49 mmHg		1		
No BP/pulse		0		
Subtotal				
Eye response (GCS)				
Spontaneously	4	*		
To verbal command	3	*		
To pain	2	*		
No eye opening	1	*		
Motor response (GCS)				
Obeying commands	6	*		
Localising pain	5	*		
Withdrawal from pain	4	*		
Flexion to pain	3	*		
Extension to pain	2	*		
No motor response	1	*		
Verbal response (GCS)				
Orientated	5	*		
Confused	4	*		
Inappropriate words	3	*		
Incomprehensible sounds	2	*		
No verbal response	1	*		
Subtotal				
*Glasgow Coma Scale (GCS)				
13–15=4				
9–12=3				
6–8=2				
4–5=1				
3=0				
Total				

The data collected from the patient contact reports written by the ambulance nurses and MMT doctors were further supplemented by mortality data over an 18-month period of follow-up.

Statistical analysis

For descriptive purposes, some baseline characteristics of patients were first summarised for survivors and non-survivors. Univariate Cox regression analysis was used to assess whether changes in T-RTS scores between the time of assessment at the accident (T1) and the time of arrival at the hospital (T2) affected the mortality risk. Multivariate Cox regression models were used to assess whether age and sex influenced the association between T-RTS scores and mortality. We also checked this for other factors that were assumed to influence the T-RTS and the changes in this score.

The chosen significance level α was 0.05. All analyses were done using SPSS version 12.

Results

Between January 1999 and December 2000, 507 poly-trauma patients met the inclusion criteria, including 367 (72.4%) men and 140 women. The Hospital Trauma Index-Injury Severity Score (HTI–ISS) for the group as a whole was between 16 and 75, with a median value of 21.

Table 3 summarises the characteristics of the study population. The mean age of the men was 35.8 years (SD=18.4) and 39.5 years (SD=22.4) for the women. During the 18-month follow-up period, a total of 100 patients died (19.7%), 92 during their stay in hospital and 8 after their discharge from hospital. Table 3 shows that those who died were about 10 years older than the survivors and that they were more likely to have been attended to by an MMT doctor at the scene of the accident. Apart from this, however, there were hardly any differences between those who died and the survivors. The initial Triage Revised Trauma Score (T-RTS) was available for 499 of the 507 patients (98.4%). T-RTS values ranged from 0 to 12, with a median value of 11; 49.7% had a T-RTS of 12.

Of the 507 patients, 75 (14.8%) were intubated in the prehospital phase, and 125 (24.7%) got parenteral analgesics.

The univariate analysis in Table 4 shows that, compared to patients whose T-RTS remained unchanged (the reference category), the mortality risk was 3.1 times higher for

Table 2 T-RTS categories

T-RTS categories	T-RTS at hospital—T-RTS at scene	T-RTS at scene	No. of patients
No change	0		341
Improving	≥1		56
Deteriorating	<0		25
Initially good plus intubated		≥10	20
Initially poor plus intubated		<10	55

Table 3 Baseline characteristics

Variable	Total (n=507)	Survivors (n=407)	Non-survivors (n=100)
Mean age (years) ±SD	36.8±19.6	34.9±18.1	44.4±23.4
Sex (% male)	367 (72)	293 (72)	74 (74)
Intravenous infusion (%)	424 (87)	337 (87)	87 (89)
Oxygen administration (%)	258 (53)	203 (52)	55 (56)
Physician in attendance at scene (%)	98 (19)	69 (17)	29 (29)
Mean total time before arrival at trauma centre (min) ± SD	61.9±26.8	61.9±24.7	62.1±33.4

deteriorating patients, 2.9 times higher for initially good but intubated patients and 5.7 times higher for initially poor and intubated patients. The patients' age and whether or not they had been attended to by a physician at the scene of the accident were also associated with higher mortality rates. The risk of dying was more than twice as high among patients aged over 50 years than among those younger than 30 years [hazard ratio=2.2, 95% confidence interval (CI): 1.4–3.5, p<0.001].

The relation between the change in T-RTS and mortality was only marginally altered when we accounted for age and sex (model 1). Further accounting for other factors that could be assumed to influence T-RTS directly, viz. intravenous infusion, oxygen administration and being attended to by a physician at the scene of the accident, hardly changed these associations (model 2). Among the group of patients with an initially good T-RTS who were intubated (n=20) in the prehospital phase there was one patient with an isolated head injury. The reasons for intubation were combativeness (2), deterioration level of consciousness (1), head injury (3), pain relief (4), hypovolaemic shock (2), prevention, clear airway (2), resuscitation (3) and thoracic injury (3). Rapid sequence intubation had been used in all patients except in one with head injury and in three patients who needed resuscitations.

Discussion

T-RTS is currently used by ambulance personnel to choose the most appropriate hospital facilities based on the severity of trauma. Moreover, it is an independent predictor of mortality in hospital [13–17]. Our study shows that within the group of severe trauma patients, prehospital T-RTS score changes are also an independent predictor of mortality and are very useful to establish prognoses.

The rule currently applied in ambulance care is that ambulance crews should immediately determine patients' T-RTS at first examination at the scene of the accident, as well as upon arrival at the hospital's A&E department. In about 15% of the cases in this study, the T-RTS could not be accurately determined at the A&E department because of intubation. It seems likely that medical treatment and interventions at the scene of the accident and during the

Table 4 Cox regression analysis of T-RTS development, patient characteristics and baseline assessments as determinants of mortality within 18 months

	Hazard ratios (95% CI)		
	Univariate	Multivariate model 1	Multivariate model 2
T-RTS category			
No change	Reference	Reference	Reference
Improving	0.8 (0.3–1.9)	0.8 (0.3–1.9)	1.1 (0.5–2.6)
Deteriorating	**3.1 (1.5–6.3)**	**2.8 (1.4–5.8)**	**3.6 (1.7–7.6)**
Initially good plus intubated	**2.9 (1.3–6.5)**	**2.5 (1.1–5.7)**	**3.4 (1.3–9.0)**
Initially poor plus intubated	**5.7 (3.6–9.0)**	**5.2 (3.3–8.3)**	**7.3 (3.9–13.6)**
Age (years)	**1.02 (1.01–1.03)**	**1.02 (1.01–1.03)**	**1.02 (1.00–1.03)**
Sex (male)	1.1 (0.7–1.8)	1.2 (0.8–2.0)	1.3 (0.8–2.3)
Intravenous therapy (yes/no)	1.2 (0.6–2.2)		0.7 (0.3–1.5)
Oxygen (yes/no)	1.1 (0.8–1.7)		1.1 (0.7–1.8)
Physician in attendance at scene (yes/no)	**1.8 (1.2–2.8)**		0.7 (0.4–1.4)
Time between accident and arrival at hospital (min)	1.00 (0.99–1.01)		0.98 (0.99–1.01)

95% CI confidence interval. Model 1: includes an indicator variable for change in T-RTS, age and sex. Model 2: like model 1, plus fluid replacement, oxygen, presence of physician at scene of accident and total time elapsed between accident and arrival at hospital. Values printed in bold indicate statistical significance ambulance transport influenced the scores. After being recoded, the T-RTS is combined with the HTI-ISS to obtain the Trauma Score and Injury Severity Score (TRISS), which is used to assess patients' chances of survival in the hospital. However, the TRISS is obviously not available to ambulance personnel in the prehospital phase. Nevertheless, it is important particularly in the prehospital phase to determine an individual patient's prognosis, because this determines interventions in that phase and the choice of the type of hospital the patient is to be transferred to.

A deteriorating T-RTS proved to be an accurate predictor of increased mortality risk. Although higher age was also associated with a higher mortality risk, especially among patients aged over 50 years, it did not explain the relation between the change in T-RTS and mortality, indicating that it was the change in T-RTS which was primarily responsible for the higher mortality risk. The greater mortality risk in cases where a physician had been in attendance at the scene of the accident was obviously due to the patients' condition, which was apparently serious enough for an MMT to be called in. Indeed, in our multivariate analysis there was no independent association between physician attendance at the scene and mortality risk.

Even after accounting for variables that may influence T-RTS values, like the type of treatment, change in T-RTS remained a powerful predictor of the mortality risk. Patients who had been given an intravenous infusion may have had a slightly lower mortality risk than those who did not, but this difference was not statistically significant. The time that elapsed between the accident and the patients' arrival at the A&E department was not found to influence the mortality risk.

The high mortality risk among patients who had to be intubated at the scene of the accident is partly explained by their poor initial T-RTS. A remarkable finding, however, was the higher mortality risk for patients who had been intubated at the scene of the accident even though they had a good initial T-RTS. Apparently, intubation is a predictor of poor outcome, irrespective of the initial T-RTS. Obviously, this does not mean that intubation is causally associated with higher mortality risk. Intubation reflected the severity of a patient's condition (three resuscitations) and may indicate that the professionals at the scene are capable of assessing a patient's serious condition despite high T-RTS scores. The guidelines of Advanced Trauma Life Support (ATLS) and Prehospital Trauma Life Support (PHTLS) for trauma patients at the scene include insertion of an intravenous cannula for intravenous infusion, as well as intubation and medication, which are applied at the discretion of personnel at the scene. These procedures have recently been criticised [18]. An observational study by Sampalis et al. [19] showed that intravenous infusion at the scene of the accident was associated with a higher mortality risk, and the literature shows a similar tendency for endotracheal intubation [20]. The latter is in agreement with our findings in this study.

The guidelines of the American College of Surgeons [21] indicate that patients with a T-RTS of 11 or lower should primarily be presented at a trauma centre, and the Dutch Association of Traumatology [22] also recommends that ambulance crews present patients with a T-RTS below 11 primarily at a trauma centre, regardless of whether there are obvious externally visible injuries. The findings of our study suggest that patients who are intubated at the scene of the accident and those whose T-RTS deteriorates in the prehospital phase should also be directly presented at a trauma centre, since these centres are best able to provide the required care [23].

It is necessary to repeat the T-RTS in the transport setting because patients' physiology is dynamic especially when the transport time to the hospital is long. Any change for worse or better is directly obvious and must be communicated with the receiving hospital. The knowledge of a decrease in T-RTS may promote a more aggressive approach to patients in the trauma bay.

Conclusion

Intubation and a deteriorating T-RTS between the time of the accident and patient's arrival at the hospital are powerful independent predictors of mortality after hospitalisation. Together with advanced age, a deteriorating T-RTS should be the main aspect guiding the preclinical procedures.

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