Is a maximum Revised Trauma Score a safe triage tool for Helicopter Emergency Medical Services (HEMS) cancellations?


ABSTRACT

Background
The Revised Trauma Score (RTS) is used worldwide in the prehospital setting and provides a snapshot of patient’s physiological state. Several studies have shown that the reliability of the RTS is high in trauma outcomes. In the Netherlands, Helicopter Emergency Medical Services (HEMS) are mostly used for delivery of specialized trauma teams on-scene and occasionally for patient transportation. In our trauma system, the Emergency Medical Services (EMS) crew performs triage after arrival on-scene and cancels the HEMS-dispatch if deemed unnecessary. In this study we assessed the ability of a maximum on-scene RTS (≤12) to be used as a triage tool for HEMS dispatch cancellation.

Methods
All patients with a maximum on-scene RTS after blunt trauma (with or without receiving HEMS care) who were presented in the trauma resuscitation room of two Level-1 trauma centers during a period of six months, were included. Information concerning prehospital and inhospital vital parameters, severity and localization of the injuries, and the inhospital course were analyzed. Major trauma patients were classified using the following parameters: ISS≥16, emergency intervention, ICU admission and inhospital death.

Results
Four-hundred and forty blunt trauma patients having a maximum RTS were included between July 1st and December 31st 2006. Eighty patients received on-scene HEMS care. Almost 16% of the total population concerned major trauma patients, of which only 25 (36%) received HEMS care. In 17 patients (3.9%) the RTS deteriorated during transportation. Major trauma patients sustained more injuries to the chest, abdomen, and lower extremities.

Conclusion
The RTS alone is not a reliable triage tool for HEMS cancellations in our trauma system and will lead to a considerable rate of undertriage with 1 in every 6 cancellations being incorrect. Other criteria based on patient’s vital signs, combined with anatomical and mechanism of injury parameters should be developed to safely minimize triage errors.
INTRODUCTION

Trauma patients present with varying degrees of injury, from minor to life threatening. A variety of scoring systems has been devised to grade and classify patient’s injuries. By providing a quick assessment of a patient’s injury, prehospital scoring systems aid in the prehospital triage of injured patients, separating the severely injured from those with lesser degrees of injury.

In prehospital trauma care, one of the most widely used physiologic scoring systems is the Revised Trauma Score (RTS), firstly introduced in 1981 as the Trauma Score by Champion et al.\(^1\) as a tool for field triage of injured patients. In its current, commonly used form, the RTS ranges between 0 and 12 and is calculated from three physiologic parameters: the Glasgow Coma Scale (GCS), respiratory rate (RR) and systolic blood pressure (SBP), which are weighted to compute a final score.\(^2\)

A recent study showed that the predictive value of the RTS is high, with a discriminatory power significantly better than the above mentioned physiologic parameters alone for predicting trauma outcomes.\(^3\)

Helicopter Emergency Medical Services (HEMS) are intended to provide specialist prehospital care to seriously injured trauma victims by a medical team in complement to ground ambulances with Emergency Medical Services (EMS) crew. Although it is still not clear whether HEMS care has effect on the outcome of trauma patients, several studies have shown that multitrauma patients and patients with neurological injury indeed benefit from its care.\(^4,5\)

HEMS in The Netherlands consist of a specially trained physician (trauma surgeon or anesthesiologist) and an Emergency Department or EMS nurse. Their interventions include airway management, rapid sequence induction, placement of chest tubes, administration of specific medication and limited surgical interventions. The aim of this concept is the delivery of a specialized trauma team to the scene of the accident as quickly as possible in addition to the EMS crew. The Dutch HEMS are occasionally used for patient transportation, this in contrast with most other countries.

Most deployments of the HEMS are initiated by the operator from a dispatch centre based on information from non-medical public. Although protocolized criteria are used, it is inevitable that this rough information from lay people leads to dispatches for patients with less severe injuries, the so called overtriage. On the other hand, the HEMS is sometimes not dispatched to seriously injured patients, which is called undertriage. The current protocols are developed in such a way that undertriage is prevented as much as possible. The consequence of this policy is that the HEMS is activated in a relatively large number of patients for whom specialized medical care is not necessary.\(^6\) This leads to unnecessary costs, unjustifiable safety risks, and the temporarily unavailability of the medical team for truly seriously injured patients.

In daily practice, whenever the ground ambulance arrives first, the already airborne helicopter is cancelled by the EMS crew if the condition of the patient makes the HEMS superfluous. However, in contrast to the use of dispatch protocols and the debate around the criteria, there are no standardized criteria in the literature to cancel the deployed HEMS. In most cases the HEMS is cancelled for patients with stable vital signs (RTS=12) after (high energy) blunt trauma but many actual HEMS on-scene involvements still concern many patients in this category.\(^6\) The aim of this study was to assess if a maximum on-scene RTS (>12) can be used as a safe triage tool for HEMS cancellation.
PATIENTS AND METHODS

The VU University medical centre and the Academic Medical Centre are two Level-1 trauma centers, both located in Amsterdam. These two hospitals cover the trauma regions of the North-West of the Netherlands. Together with the surrounding affiliated hospitals they are responsible for the trauma care of the 2.7 million inhabitants in these regions. Patients transported to one of these hospitals after being involved in high energy accidents and patients who are clinically suspected for having severe injury (trauma team activation criteria) are always presented in the trauma resuscitating room and treated by a complete trauma team according to the Advanced Trauma Life Support (ATLS) guidelines. Approximately 700 trauma patients are annually admitted at the TR of each trauma centre, of which roughly 25% are multitrauma patients (Injury Severity Score (ISS) ≥16).

One of the four Dutch HEMS is located at the VU University Medical Centre in Amsterdam which covers a territory of almost four million inhabitants with five EMS dispatch centers. Each year, the HEMS is dispatched approximately 1200 times, of which almost 92% are trauma-related dispatches. The cancellation rates are between 30% and 50%. Primary HEMS dispatch criteria are shown in Figure 1.

In this retrospective study we collected data concerning all trauma patients admitted to the TR of both Level-1 trauma centers of Amsterdam by ambulance / HEMS with full trauma team activation between July 2006 and December 2006. Only trauma patients with a maximum on-scene RTS (=12) after blunt injury were included and analyzed for this study. Patients with missing data were excluded.

Data were extracted from the patient’s charts and the regional trauma registries, including the original ambulance forms. For each patient we collected prehospital information related to the mechanism of injury, vital signs (RR and SBP), scores (GCS and RTS) and prehospital on-scene time, defined as the time from EMS arrival at the scene until patient departure. Inhospital data were collected related to the condition of the patient at the emergency department, (vital parameters and scores), emergency intervention within 6 hours (craniotomy, thoracotomy, laparotomy, angio-embolization, external fixation of pelvis / femur), primary admission at the Intensive Care Unit (ICU), inhospital mortality and ISS.

Major trauma patients were identified according to the following criteria 7:
- ISS≥16 and / or
- Emergency intervention within 6 hours after emergency department admission and / or
- ICU admission within 24 hours and / or
- Inhospital death
- Patients not fulfilling these criteria were classified as minor trauma patients.

The total study population was divided in two groups: major and minor trauma patients. Special attention was given to patients with a deteriorated RTS (<12) during transportation.

Continuous variables were described as median with interquartile ranges (P25 – P75). Categorical variables were described as percentages. Statistical analysis was performed using the SPSS software package (SPSS 16.0 for Windows; SPSS, Chicago, IL, USA).
RESULTS

During the study period 708 trauma patients were presented by ambulance or HEMS in the two trauma centers. Twenty-four patients were excluded due to penetrating trauma, 127 patients had an on-scene RTS lower than 12 and 117 patients (26.6%) had missing on-scene data. In total, 440 patients (62.1%) met the inclusion criteria and were analyzed.

The mechanism of injury is described in Table 1. In total, almost 73% of all patients were involved in traffic accidents, mostly concerning motor-vehicle accidents.

Table 2 lists the characteristics of the included patients. Median age was 32.7 years, the majority of the patients was male (64.8%). Eighty patients received on-scene HEMS care. Despite having a maximum RTS on-scene, almost 16% (n=67) of the included population met major trauma criteria. Of these patients 25 (37%) received HEMS care.

Table 1. Mechanism of injury of the total population

<table>
<thead>
<tr>
<th>Mechanism of injury</th>
<th>N=440</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic accident</td>
<td>319</td>
<td>72.5%</td>
</tr>
<tr>
<td>Pedestrian</td>
<td>27</td>
<td>6.1%</td>
</tr>
<tr>
<td>Bicycle</td>
<td>55</td>
<td>12.5%</td>
</tr>
<tr>
<td>Scooter / Motorcycle</td>
<td>81</td>
<td>18.4%</td>
</tr>
<tr>
<td>Motor Vehicle</td>
<td>148</td>
<td>33.6%</td>
</tr>
<tr>
<td>Truck / Bus / Train</td>
<td>8</td>
<td>1.8%</td>
</tr>
<tr>
<td>Fall from standing height</td>
<td>28</td>
<td>6.4%</td>
</tr>
<tr>
<td>Fall from height</td>
<td>71</td>
<td>16.1%</td>
</tr>
<tr>
<td>Hit by heavy object</td>
<td>18</td>
<td>4.1%</td>
</tr>
<tr>
<td>Assault</td>
<td>4</td>
<td>0.9%</td>
</tr>
</tbody>
</table>
In 17 patients (3.9%) the RTS deteriorated during transportation (based on two patients on abnormal RR, in three patients on hypotension, in 10 patients on a GCS lower than 13 and in two patients on a combination of abnormal vital signs). The ISS in the deteriorated group was significantly higher (17.7 vs. 5.8; p<0.001). Eleven of these patients received HEMS care, of which seven required rapid sequence induction and intubation. Nine patients with a deterioration of the RTS concerned major trauma patients, of which one did not receive HEMS care. The other eight patients concerned minor trauma patients and had a deteriorated RTS mostly due to hyperventilation and lowered GCS due to cerebral concussion. Two of the 17 patients in the deteriorated group (11.8%) died during hospitalization (vs. one of the 423 patients in the non-deteriorated group (p<0.001)).

The median on scene time was 21 minutes. In eight patients the HEMS arrived at the scene before the EMS crew. In the remaining HEMS assists (n=59) the EMS crew arrived earlier with an average time interval of 7 minutes. After primary assessment in the emergency department 39 patients underwent an emergency intervention and 21 patients were directly admitted to the ICU. Three patients died during admission.

Patient’s injuries were described for both groups using the Abbreviated Injury Scale (AIS) (Figure 2). The majority of injuries in both groups were to the head. As shown in Figure 2 most injuries in minor trauma patients were classified as AIS 2 (47.2%) as well as in major trauma patients (44.3%).

**DISCUSSION**

In the Dutch trauma care system the HEMS handles a low activation threshold and is dispatched at the same time as the EMS crew. After arrival of the first EMS crew at the scene, a quick assessment of patient’s injuries is performed to decide whether HEMS support is necessary. Until now, there is no consensus regarding standardized HEMS cancellation criteria in the Netherlands. The HEMS is mostly cancelled by the on-scene EMS crew based on stable vital parameters, respectively having a maximum RTS. This study showed that a maximum RTS as the only triage tool to cancel HEMS dispatches is not safe because a major trauma patient rate of 16% is considerable. In other words, one in every six cancellations based on maximum RTS would be incorrect. From the included 67 major trauma patients only 25 (37%) received on-scene HEMS...
Seventeen patients had a deterioration of vital parameters during transport, which is a powerful independent predictor of mortality (almost three times higher) after hospitalization. These patients showed a significantly worse ISS and mortality. Remarkably, more than one third of them did not receive on-scene HEMS care. This can be partially explained by noncompliance of the EMS dispatch centers with the HEMS dispatch criteria.

One of the major aims of the RTS is to identify severely injured patients who require specialized care. However, the triage version of the RTS was developed from component data collected in emergency departments. Several studies have shown that the highest sensitivity for identifying major trauma patients occur at an RTS value less than 12.

Overall, the RTS based on observations in the field appears to be a good predictor of mortality, though its ability to predict other outcomes such as ISS or the need for emergency care.
intervention is not impressive. In another study the authors concluded that the RTS was no more predictive of death or emergency interventions than the judgment of the EMS crews.

The results of the above mentioned studies suggest that the RTS is a good predictor for mortality in severely injured patients and less useful for classifying patients into less severe outcomes.

On the other hand, 69% of all minor trauma patients received HEMS care on-scene despite having a maximum RTS, which can be considered as overtriage. This high rate of inappropriate dispatches means increased costs, additional safety risks to the flight crew and lowered availability of HEMS for severely injured patients who really do benefit from its care.

Prehospital HEMS care has been shown to have beneficial effects on the outcome of trauma patients. Some categories of patients (i.e. polytrauma patients and patients with severe head injury) benefit most of this care. In particular, airway management is a key component of the advanced life support among severely injured patients; failure to achieve adequate airway patency has been identified as a major contributor to preventable death in trauma care. It is therefore of importance to early identify major trauma patients. In addition, a recent study concluded that HEMS should be considered as cost effective, once the costs of HEMS assistance per quality adjusted life years (QALy) remain below an acceptable threshold in the Netherlands.

In order to prevent undertriage within our trauma system, the most logical policy seems to keep the threshold of HEMS dispatch low and develop standardized and validated criteria for the EMS crew to cancel HEMS dispatches. One suggestion for criteria could be based on clinical diagnosis of injuries because major trauma patients had sustained more injuries to the chest, abdomen, and lower extremities. Criteria based on clinical judgment seem feasible because one study concluded that the ability of EMS personnel to judge overall injury severity was highly sensitive, even when physiologic derangement and overtly severe injuries to specific body regions were not present. Other criteria could concern the mechanism of injury. These suggestions could provide new insights to develop additional cancellation criteria which should be assessed in future studies.

A limitation of this study was the retrospective analysis of a prospectively collected database in a consecutive cohort of patients. As a result a number of patients was excluded because of missing on-scene data (n=117). From experiences in daily practice we know that missing data is mostly due to hectic and sometimes stressful situations of on-scene trauma care in severely injured patients. Therefore, these patients would probably have been excluded for the study because they would not have had a maximum RTS. We only selected patients who were presented in the trauma room which could be another limitation. However all patients after high energy accidents and/or patients with potential severe injury are presented in the trauma resuscitation room. Therefore we did not include patients with single mild injury after low energy accidents, for whom the on-scene RTS is not calculated. Several studies showed that a certain interobserver variability of the RTS in the prehospital setting can be present within a trauma system which can also be a drawback.
CONCLUSION
The Revised Trauma Score as the only triage tool for cancelling HEMS results in a considerable rate of undertriage (1 in every 6 cancellations) and thereby withholds HEMS care to major trauma patients. This study also showed that the amount of inappropriate assists of the HEMS (overtriage) is high. For the near future, we suggest the development and subsequent validation of standardized additional HEMS cancellation criteria based on patient’s vital signs, combined with anatomical and mechanism of injury parameters.

DECLARATION OF INTEREST
The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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REFERENCES
15. Hübner BL. Evaluation of the immediate effects of preclinical treatment of severely injured
trauma patients by Helicopter Trauma Team in the Netherlands. PhD Thesis. Amsterdam, 1999


