Trauma Care in a Military Hospital

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SUMMARY: The results of a quinquennial audit of trauma care in the Cambridge Military Hospital using the TRISS method is presented. 113 cases were analysed.

The mean age was 32 years and the mean Injury Severity Score 16. Twenty-five deaths occurred of which 12 were potentially preventable.

Means of reducing the number of preventable deaths are discussed.

Introduction

Approximately 14,500 deaths per annum result from accidental injury; 100 deaths per week arise from road traffic accidents (RTAs) alone. It has been estimated that victims of RTAs occupy 850,000 bed nights per year at a total cost of £2.8 billion (1). The scale of this tragedy has, until recently, been ignored; however, the report of the working party of the Royal College of Surgeons on the management of patients with major injuries highlighted deficiencies in care of this group within the United Kingdom. This report also recommended that it would be mutually beneficial for one or two trauma centres to be run in collaboration with the Defence Medical Services (2). It was also considered that military surgery was a valuable source of instruction in the basic surgical techniques and mental attitudes required of a 'trauma surgeon'.

The above prompted us to conduct a quinquennial audit of trauma care in the Cambridge Military Hospital using the TRISS method (vide infra).

The TRISS method

The Trauma Score was first described by Champion et al (3) as a field scoring system to aid triage. It utilised four physiological variables: systolic blood pressure, capillary refill, respiratory rate and respiratory expansion, combined with the Glasgow Coma Scale. The probability of survival has been shown to correlate with the Trauma Score (TS) and therefore, the TS may be an indicator of injury severity. However, with a sensitivity and specificity of 80% and 75% respectively, the TS is not accurate enough to be used as a sole predictor of outcome. The combination of a physiological based score (such as TS) with an index of injury severity based on known anatomical injury, greatly improves the predictive accuracy, thereby reducing the misclassification rate.

In 1970, the American Committee on Medical Aspects of Automotive Safety co-ordinated efforts to develop a method for quantifying injuries resulting from road traffic accidents. This led to the development of the Abbreviated Injury Scale (AIS) in which injury severity is assessed on a scale from 1 (minor) to 6 (fatal) in each of five body systems. The thoracic section of AIS is illustrated in Table 1. This system has proved inadequate in describing the situation in a multiply injured patient. In order to overcome this deficiency, Baker et al (4) designed a method based on AIS, to express the cumulative effect of injury to several body systems. Each of six anatomical regions is scored with the highest AIS grade for any injury in that region. The AIS values of the three highest scoring body regions are squared then summed. A score of 6 in any one region incurs the maximum score of 75, indicating a fatal outcome. This Injury Severity Score (ISS) has been found to correlate better with mortality than AIS. The most recent revision AIS—85 (5) includes appropriate scoring for penetrative injuries.

The Major Trauma Outcome Study (MTOS) initiated by the Committee on Trauma of the American College of Surgeons in 1982 has gathered information on 80,000 trauma patients from 136 American and Canadian Hospitals (6). The probability of survival in the MTOS (US) is based on the TRISS Index, derived from the TS
on admission, the ISS on death or discharge, and the patient's age. Patient survival probability (Ps) is calculated from the logistic function:

\[ Ps = \frac{1}{1 + e^{-b}} \]

where \( e = 2.718282 \) (the base of Napierian logarithms) and \( b \) is the sum of weighted coefficients derived from Walker-Duncan regression analysis of the MTOS (US) outcome data. The first norms were calculated in 1985 from 24,187 injured adults and form the basis for comparison with study populations.

The relationship between TS and ISS is known as TRISS. The value of TS and ISS can be plotted against each other in a scatter diagram (Fig 1). The 50% probability of survival for a given group can be represented by a diagonal line as shown (determined by setting \( b = 0 \) in the above equation). Survivors above the line or deaths below the line are classed as unexpected outcomes.

Most recently a Revised Trauma Score (RTS) has developed from a critical analysis of those patients whose outcome was not statistically predicted by the TRISS methodology (principally CNS predominant injuries). The RTS employs three physiological parameters to quantify injury — Glasgow Coma Scale (GCS), systolic blood pressure (SBP) and respiratory rate (RR). Specific ranges of each parameter are assigned coded values (Table 2). The coded value for each variable is then multiplied by an assigned weight, derived from regression analysis of patients from the MTOS (US) study. The sum of these products is the RTS i.e.

\[ \text{RTS} = 0.9368 \times \text{GCS} + 0.7326 \times \text{SBP} + 0.2908 \times \text{RR} \]

where \( c \) = coded value for RTS variables.

M and Z statistics, as illustrated by Boyd et al (7), can be calculated to allow comparison with reference MTOS (US) data. The M statistic enables a comparison to be made with the reference MTOS (US) data in terms of probability of survival. A good match (as indicated by a value >0.88) shows equivalence of injury severity between the study and MTOS (US) populations. A value < 0.88 invalidates any difference in outcomes in any given study group and the MTOS (US) study. The Z statistic may be used to quantify differences in outcome between two subsets of a population. When considering trauma deaths, a positive value indicates that more deaths occurred in a study sample than by data from a reference (i.e. MTOS) sample. The converse applies when \( Z \) is negative.

**Table 1**

<table>
<thead>
<tr>
<th>AIS Severity</th>
<th>Injury Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Minor</td>
<td>Rib contusion/fracture*</td>
</tr>
<tr>
<td></td>
<td>Sternal contusion</td>
</tr>
<tr>
<td>2 Moderate</td>
<td>2-3 rib fractures, stable chest*</td>
</tr>
<tr>
<td></td>
<td>Multiple fractures of single rib</td>
</tr>
<tr>
<td></td>
<td>Sternal fracture</td>
</tr>
<tr>
<td>3 Severe, not life threatening</td>
<td>&gt;3 rib fractures, stable chest*</td>
</tr>
<tr>
<td></td>
<td>Flail chest (unstable chest wall)</td>
</tr>
<tr>
<td>4 Severe, life threatening</td>
<td>Severe flail (usually requires ventilatory support</td>
</tr>
<tr>
<td>5 Critical, survival uncertain</td>
<td></td>
</tr>
</tbody>
</table>

*Add AIS for presence of haemothorax, pneumothorax, haemo- or pneumomediastinum

**Patients and Methods**

The Cambridge Military Hospital is a 309 bed general hospital with an Intensive Care Unit. It has an Accident and Emergency Department which, in 1988-1989, had 28,000 attendances. Eighty per cent of these were civilian patients. The Department has usually been supervised by a consultant surgeon and the casualty officers were most often general practice vocational trainees. Throughout most of the study period (1985-1989) the consultant staff included general surgical, orthopaedic and maxillo-facial surgeons. The nearest neurosurgical facility (including CT scanner) is based at the Wessex Neurosurgical Centre, Southampton, 35 miles distance.

The Accident and Emergency Department register did not allow those patients admitted to the resuscitation room to be distinguished from the larger minor injuries.
group. Therefore, the records of the Intensive Care Unit were examined as trauma patients were likely to be admitted to the unit as part of a continued pre-operative resuscitation or for post operative observation. To allow for possible omissions, the in-patient wardmaster’s records were studied for cause of death for all patients dying within the study period. Post mortem results were collected (including cases referred to the Coroner). Anatomical injuries were coded according to the AIS-85 edition and the ISS calculated. Where a fatal outcome occurred, the ISS was corroborated by the results of the post mortem examination. The RTS was determined from the accident and emergency notes. Where the respiratory rate was not recorded a normal value was assigned in order to bias towards patient survival and prevent exclusion from the study. The probability of survival (Ps) for each fatal outcome was calculated using the TRISS Index. The M and Z statistics were calculated for the study subsets.

Results
One hundred and twenty-five patients were identified for the study; 12 case notes were either incomplete or missing. Therefore, a total of 113 cases were available for analysis. The mean age of the study population was 32 (SD19) years; the range being 6-73. Eighty-three were male patients (74%).

The commonest cause of injury was road traffic accidents (Table 3).

The times of arrival in the Accident and Emergency Department revealed the expected peaks during the evening rush hour and after closure of public houses (Fig 2).

The mean value of Injury Severity Score was 16 (SD14) with a range of 1-75 (Table 4). Forty-eight patients (42%) had an ISS of 16 or greater (indicative of severe trauma). Patients were divided into two age related groups (<55 and >54 years). The outcome for patients in each group is shown (Table 5). Twenty-five deaths occurred in the study period; 12 could be considered as preventable by the TRISS method (Ps range 0.69-0.99). Six were CNS predominant injuries. Of the remainder, two patients died from adult respiratory distress syndrome (ARDS), two from septicaemic shock and two from cardiac complications (myocardial infarction in a patient with known ischaemic heart disease; refractory heart failure in an elderly alcoholic).

In each age sub group, the M value of 0.931 indicated equivalent injury severity with the MTOS (US) reference. For the group under 55 years of age, the Z statistic value was 3.65 (P<0.001) indicating that more deaths occurred in this study than could have been predicted. For the group of older patients, the Z value did not reach statistical significance.

The results have been depicted in TRISS Pre-charts (Figs 3 & 4); these demonstrate the unexpected deaths and the lack of unexpected survivors.

### Table 3

<table>
<thead>
<tr>
<th>Cause of Injury</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road Traffic Accidents</td>
<td>76</td>
</tr>
<tr>
<td>Assault</td>
<td>8</td>
</tr>
<tr>
<td>Work/Industrial Accident</td>
<td>8</td>
</tr>
<tr>
<td>Domestic Accident</td>
<td>8</td>
</tr>
</tbody>
</table>

### Table 4

<table>
<thead>
<tr>
<th>ISS</th>
<th>No.</th>
<th>ISS</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5</td>
<td>24</td>
<td>36-40</td>
<td>3</td>
</tr>
<tr>
<td>6-10</td>
<td>30</td>
<td>41-45</td>
<td>4</td>
</tr>
<tr>
<td>11-15</td>
<td>16</td>
<td>46-50</td>
<td>2</td>
</tr>
<tr>
<td>16-20</td>
<td>14</td>
<td>51-55</td>
<td>1</td>
</tr>
<tr>
<td>21-25</td>
<td>10</td>
<td>61-65</td>
<td>-</td>
</tr>
<tr>
<td>26-30</td>
<td>6</td>
<td>66-70</td>
<td>-</td>
</tr>
<tr>
<td>31-35</td>
<td>4</td>
<td>71-75</td>
<td>3</td>
</tr>
</tbody>
</table>
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Table 5
Outcome of Patients Studied

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>M</th>
<th>Survivors</th>
<th>Deaths</th>
<th>Z</th>
<th>Prevenable Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;55 years</td>
<td>0.931</td>
<td>63</td>
<td>22</td>
<td>3.65*</td>
<td>9</td>
</tr>
<tr>
<td>&gt;54</td>
<td>0.931</td>
<td>15</td>
<td>3</td>
<td>1.78+</td>
<td>3</td>
</tr>
</tbody>
</table>

*p<0.001
+ not significant

Discussion

There is evidence that care of trauma victims in the United Kingdom is poorly organised (8). The establishment of trauma centres modelled on those in existence in the USA has been proposed in order to reduce the preventable death rate amongst seriously injured patients. Several studies have challenged the need for the development of this costly system (9, 10) as the incidence of major trauma (defined as ISS >20) in the UK may be only one tenth of that in the USA i.e. 0.01%.

This retrospective audit has produced similar results to other studies from district general hospitals. It has highlighted deficiencies in the care of trauma victims. Although the incidence of severe trauma in this study is low, the M values indicate equivalent injury severity of the study population overall when compared to the MTOS (US) data. A statistically significant excess of deaths occurred in the younger age group. Four out of the six non-CNS predominant, preventable deaths had ARDS or septicaemic shock as a terminal event. Prompt, adequate resuscitation together with early surgery and fracture stabilization has been shown to reduce the septic and respiratory complications of trauma (11). As over 80% of trauma cases have injuries to the musculoskeletal system, early involvement of an orthopaedic specialist is to be encouraged.

Central nervous system predominant injuries were not excluded from analysis and this category accounted for half of the preventable deaths.

Of most in this group that had a CT scan or post mortem examination, the ISS score was inappropriately low. The difficulty lies with the AIS scoring system for this section, which gives coded values dependent on the duration of unconsciousness. This may not correlate with the degree of intra-cranial injury. Therefore, on admission a devastating brain injury may be ascribed too low an ISS, thereby unfavourably biasing results.

The concept of trauma centres has a corollary; reliance on expert paramedical staff to perform on site triage in order to divert the more seriously injured to the appropriate facility. There are, at present, insufficient personnel of this calibre to allow realisation of the scheme in the foreseeable future.

What are the realistic medium term objectives that should be set in order to improve trauma care?

The expansion of a cadre of Advanced Trauma Life Support (ATLS) trained personnel must be the first priority together with the local husbandry of this medical expertise to form dedicated ‘trauma teams’. A more formal system of injury scoring in the casualty department must be encouraged in order that the more seriously injured cases be quickly identified and senior assistance called.

The scenario of a junior, inexperienced doctor assessing the majority of trauma cases out of working hours (12) is one which is likely to exist for some time yet. The above system would reduce delays in diagnosis and treatment that are often a cause of poor outcome in trauma care.

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REFERENCES
