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Trauma scoring systems and databases

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Editor's key points

- Physiological variables such as arterial pressure are unreliable for the diagnosis of injury severity.
- There is a strong association between Glasgow coma score and outcome.
- Clinicians should be aware that triage tools and decision rules have varying sensitivity and specificity.
- Trauma registry data allow tracking of the performance of individual hospitals and of trauma systems.

This review considers current trauma scoring systems and databases and their relevance to improving patient care. Single physiological measures such as systolic arterial pressure have limited ability to diagnose severe trauma by reflecting raised intracranial pressure, or significant haemorrhage. The Glasgow coma score has the greatest prognostic value in head-injured and other trauma patients. Trauma triage tools and imaging decision rules—using combinations of physiological cut-off measures with mechanism of injury and other categorical variables—bring both increased sophistication and increased complexity. It is important for clinicians and managers to be aware of the diagnostic properties (over- and under-triage rates) of any triage tool or decision rule used in their trauma system. Trauma registries are able to collate definitive injury descriptors and use survival prediction models to guide trauma system governance, through individual patient review and case-mix-adjusted benchmarking of hospital and network performance with robust outlier identification. Interrupted time series allow observation in the changes in care processes and outcomes at national level, which can feed back into clinical quality-based commissioning of healthcare. Registry data are also a valuable resource for trauma epidemiological and comparative effectiveness research studies.

Keywords: clinical governance; epidemiology; medical audit; wounds and injuries

Physiological scoring systems

The Glasgow coma scale and score

It is hard to believe that 2014 marks the 40th anniversary of the Glasgow coma scale.[1] At its inception, the creators, Sir Graham Teasdale and Mr Brian Jennet, reflected upon the confusion that characterized the assessment of patients with a head injury or other acute brain insult in the early 1970s. A lack of standardized assessment impaired communication between clinicians and with nursing staff. The consequences were delayed detection of clinically important changes and avoidable mortality and morbidity.

The landmark Glasgow coma scale publication in the *Lancet* in 1974 avoided the problem of trying to define 'comatose', 'stuporose' obtunded, etc.—which meant different things to different people and brought the problem back to first principles, which is defining responsiveness. In the first publication of the Glasgow coma scale, responsiveness is defined by best eye opening, verbal, and motor responses. There was no numbering in this first publication of the Glasgow coma scale, but as the scale is ordinal, it allowed a graphical representation of change over time—which is crucial when assessing the trauma patient.[1]

As the science of clinometrics grew, it became too much of a temptation to put numbers to the various graduations of the Glasgow coma scale; it was also recognized later on that there were different levels of flexion and so the original 14 gradations on the scale became 15 each with a numerical score (eye opening 1–4, verbal response 1–5, motor response 1–6). This gave a potential range of the Glasgow coma scale of between 3—equivalent to unresponsive in all domains—and 15—equivalent of being fully responsive in all domains. From the outset, the Glasgow coma scale was felt to have large degree of face validity for assessing severity and prognosis in traumatic brain injury (TBI). Probably, the best validation of its ability to do this was provided by the first CRASH Trial conducted worldwide between 1998 and 2002.

This trial was a simple randomized trial of steroids in TBI. Ten thousand patients with suspected TBI and a Glasgow coma score (GCS) of <15 in over 100 centres worldwide were recruited. Within the CRASH cohort, the GCS (3–14) was shown to have an almost linear relationship with 14 day mortality.[2]

The same study also showed an almost linear relationship in the likelihood of a good recovery after injury (as defined by the Glasgow outcome scale)[3] at 6 months with $<10\%$ of patients with a GCS of 4 having a good recovery compared with 70% of patients with a GCS of 14 (I. Roberts, personal communication). There is no doubt about the central place of the GCS in assessing the likelihood of TBI and overall prognosis in trauma patients.

The Advanced Trauma Life Support shock classification

Other than TBI, the major killer after injury is death from undetected internal haemorrhage, this is addressed by a shock table within the Advanced Trauma Life Support (ATLS) manual.[4] The table in the ATLS manual is unreferenced and in 2007, investigators from the UK tried to reproduce that Shock Table using data on patients with an injury severity score (ISS) of >15 (indicating the presence of life-threatening injuries) submitted to the largest European Trauma Registry, The Trauma Audit and Research Network (TARN).[4 5]

It was not possible to reproduce the ATLS shock table from the TARN data (Table 1).[5] Increasing heart rate, as a marker of shock, was associated with increasing severity of injury, reduced age, and increasing mortality. However, changes in other physiological variables with increasing severity of shock did not follow the pattern described by the ATLS manual. There were no significant differences in the median systolic arterial pressure or median respiratory rate between the four shock classifications indicated by heart rate. GCS changed more markedly between the groups, but this sample did contain a high prevalence of patients with TBI.

A further study from TARN indicated that injured children tend to be hypertensive compared with their age-adjusted resting norms regardless of the severity of injury.[6] This suggests that reduced systolic arterial pressure, particularly in the young, is only a late indicator of haemorrhage. There is an extensive animal model literature demonstrating that in blunt trauma (the predominant mode of trauma in the western world), nociception attenuates the cardiovascular response to haemorrhage, postponing decompensation up to the point where almost 40% of the blood volume is lost.[7] The ability of abnormal values of single physiological measures to diagnose severe trauma is hence limited with GCS probably performing best.[8]

The revised trauma score

Historically, within Emergency Medicine Systems, the physiological responses of an injured patient have been assessed by the revised trauma score (RTS). The physiological parameters that make up the RTS are respiratory rate, systolic arterial pressure, and GCS. The RTS was developed after statistical analysis of a large North American database to determine the most predictive independent outcome variables.[9] The selection of variables was influenced by their ease of measurement and clinical opinion led to the exclusion of capillary refill and respiratory expansion from the score. In practice, the RTS is a complex calculation combining coded measurements of the three physiological values to obtain a value out of 12. However, latterly, the superiority of GCS compared with other predictors has been recognized[8 9]—adjustment for this adds excessive complexity to clinical scoring—consequently, the RTS has become less widely used in clinical practice.

The RTS is still used in North American Trauma Registries where the coded value for each variable is multiplied by a weighting factor derived from regression analysis, with GCS having much the strongest weighting. After injury, the patient's physiological response is constantly changing, but for the purposes of injury scoring by convention, the first measurements, when the patient arrives at hospital, are used.[9]

Trauma triage tools

Trauma triage tools use a combination of single physiological variables with diagnostic 'cut-offs'; combined with categorical variables based on the mechanism of injury, for example, flags for high-energy trauma such as high-speed road traffic collision or ejection from vehicle. Some trauma triage tools also include variables which describe obvious anatomical injuries such as an obvious flail chest or obvious sucking chest wound[10] or an additional filter for older patients. Most trauma triage tools are used in the pre-hospital environment to identify which patients should bypass the nearest emergency department and be taken to a major trauma centre and to generate pre-alert or standby calls for a trauma team. They can also be used for triage to resuscitation areas and to trigger calling the trauma team on arrival at the emergency

Table 1 Attempt to reproduce ATLS shock table using TARN data on severely injured patients 1989–2007.[5] [Shock classifications are defined 1–4 by presenting heart rate as per the ATLS manual;[4] the median and inter-quartile ranges (IQR) of other presenting physiological recordings are shown for patients in each shock category]

Shock category	1	2	3	4
Heart rate (beats min^{-1})	≤100	101–120	121–140	>140
Number of patients	19383	4615	1924	839
Median age (IQR)	41 (27–61)	36 (24–56)	33 (23–50)	32 (22–47)
Median ISS (IQR)	24 (17–26)	25 (18–33)	26 (21–35)	27 (22–35)
% Dead	20.0 (19.4–20.5)	25.6 (24.4–26.9)	33.6 (31.5–35.7)	39.7 (36.4–43)
Median systolic BP (IQR)	133 (118–150)	132 (110–152)	129 (100–150)	130 (100–152)
Median respiratory rate (bpm) (IQR)	19 (16–24)	20 (18–28)	24 (18–30)	25 (18–33)
Median GCS (IQR)	14 (8–15)	14 (7–15)	12 (5–15)	9 (4–15)