CHAPTER 26

Paediatric Injury Scoring and Trauma Registry

Francis A. Abantanga
Erin A. Teeple
Benedict C. Nwomeh

Introduction

Injury scoring systems are designed to accurately assess injury severity, appropriately triage the injured, and develop and refine trauma patient care.[1] Trauma scores quantify the severity and extent of injury, aid with the prediction of survival and subsequent morbidity,[2] and allow health care providers to communicate in common terms. One disadvantage of injury scoring systems is that patient information is reduced to a simple score, and important details may be lost. To accurately estimate patient outcome, it is necessary to precisely assess the patient's anatomic and physiologic injury, as well as any preexisting medical conditions that can impair the patient's ability to respond to the stress of the injuries sustained.

Understanding and appropriate use of trauma scoring systems, along with the use of specific treatment guidelines, can significantly contribute to improvement in the prognosis of injured children. The majority of the injury scoring systems used in children today are extrapolations of the same systems used in adults but with some modifications.[3]

Injury scoring systems are divided into anatomic, physiologic, and combined categories.[2,3] Some of the scoring systems are discussed in further detail within the following sections, with demonstrations of their use where possible.

Anatomic Injury Scoring Systems

Anatomic injury scoring systems clearly characterise the degree of anatomic disruption but fail to delineate organ system derangements.[2] Examples of injury methods that evaluate anatomic status include the Abbreviated Injury Scale (AIS), Injury Severity Score (ISS), and Anatomical Profile (AP).[2] These injury scoring systems are based upon anatomic descriptions of identified injuries and are retrospectively used to analyse trauma populations.[1] In these systems, the site of the injury is important.

Abbreviated Injury Scale

The AIS was first introduced in 1969 as an anatomic scoring system to categorise automobile victims for epidemiological purposes.[5] It underwent revision in 1990, and body regions for the AIS were identified as follows: head, face, neck, thorax, abdomen and pelvic content, spine, upper extremities, lower extremities, and unspecified. In this revised version, external injuries are dispersed across body regions, and the AIS provides a reasonably accurate way of ranking the severity of injury by body regions.

With the AIS, injuries are ranked on an ordinal scale ranging from 1 to 6, with 1 being considered a minor injury or least severe, 5 being a severe injury or survival uncertain, and 6 being an unsurvivable injury[6] (Table 26.1). The AIS scores can be found in the AIS Dictionary Manual,[7] a compendium of more than 1200 injuries. An AIS score ≥3 is considered serious. The AIS correlates well with the degree of injury but suffers as a prognostic tool because it does not take physiologic derangements or chronic health into account. It is not intended to reflect patient outcomes, but only to score an individual injury. Its other limitation is that it does not provide a comprehensive measure of severity of injury because it focuses on singular but not combined injuries of the patient.

Table 26.1: The Abbreviated Injury Scale.

Type of injury	AIS score
Minor	1
Moderate	2
Severe, but not life-threatening	3
Severe, life-threatening, survival probable	4
Critical, survival uncertain	5
Not survivable/virtually unsurvivable	6

Injury Severity Score

The ISS, like the AIS, is an anatomic scoring system that provides an overall score for patients with multiple injuries.[8] Each injury must be assigned an AIS score, allocated to one of six body regions: head and neck, face, thorax, abdomen and visceral pelvis, extremities and bony pelvis, and external structures.[6] Injuries in each region are given an AIS score, and the highest AIS score in each body region is used. To generate the ISS, square the AIS score of each of the three most severely injured body regions (those with the highest AIS scores, including only one from each body region) and add the squares together.[6,8] The ISS has a good predictive power and correlates well with mortality, morbidity, length of hospital stay, and other measures of severity. The minimum score is 1 and the maximum possible score is 75, with higher scores reflecting an increased injury severity and mortality.[9] The ISS is not calculated when any single body region has an AIS value of 6; in such cases, an ISS value of 75 is automatically assigned.[6] Injury Severity Scores higher than 15 have been used as a proxy for injuries of sufficient magnitude to require hospital or trauma centre care.[4] However, it is inappropriate to use this as the sole criterion for triaging because it does not also measure alterations in the physiology of the trauma patient.

There are several disadvantages to using the ISS.[2] For example, the ISS cannot be used as an initial triage tool because detailed assessment, and in some cases surgical exploration, must be performed before a full description of the injuries can be obtained. Also, the patient's age and comorbidities are not taken into account. Furthermore, multiple injuries to the same body area are not weighted higher than a single injury to that area. Lastly, the ISS uses only three regions, so that injuries from the three remaining regions are not taken into account.

In spite of these limitations, the ISS has been validated as a predictor of trauma mortality, length of hospital stay, and length of intensive care unit stay, and it may have usefulness in predicting morbidity. It is currently the most widely used injury scoring system.[1,9] Automated ISS calculators are available to compute the value of the ISS once the AIS scores are entered. The ISS score can also be computed manually as follows:

$$\begin{aligned}\text{ISS} = \sum \big[&(\text{AIS of most severe injury in ISS region})^2 \\ &+ (\text{AIS score of next most severe injury in another ISS region})^2 \\ &+ (\text{AIS score of most severe injury in any remaining ISS region})^2\big]\end{aligned}$$

An illustration of how to calculate ISS is shown in Table 26.2.

The ISS score for the example in Table 26.2 is 50, which is a very severe injury requiring the patient to be admitted to a hospital for trauma care. Patients with ISS scores ≥15 should be cared for in a hospital or trauma centre with adequate resources and experience in trauma care.

The ISS calculations include spine injuries in the corresponding three ISS body regions: cervical in ISS head or neck, thoracic in ISS chest, and lumbar in ISS abdominal or pelvic contents.

New and Modified ISS

In 1997, a simple modification of ISS was formulated and referred to as the New ISS (NISS).[10] It is defined as the sum of the squares of the AIS of each of the patient's most severe AIS injuries irrespective of the body region in which they occur.[3,5,10] The NISS is reported to predict survival better[3] than the ISS by better predicting mortality in the more severely injured patients,[11] and it is simpler to calculate.

There is also a Modified ISS (MISS), specifically intended for paediatric trauma cases. This modification was made to account for the predominance of head injuries in paediatric trauma patients.[5] In the MISS, the number of body regions is reduced to four: face/neck, chest, abdomen/pelvic contents, and extremities/pelvis.[5] The MISS uses the Glasgow Coma Scale (GCS; see next section) value categories (Table 26.3) to determine the AIS head region scores and also assigns injuries of the skin/general category within any of the four body regions listed above. The MISS is calculated by summing the squared AIS values for the three most severely injured body regions. Several studies have validated the MISS in paediatric trauma and have shown it to accurately identify patients at high risk for mortality and long-term disability.[12] In spite of this, the MISS is not widely used because improvements have been made in the more recent versions of the AIS and ISS.

Anatomical Profile

The AP addresses some of the shortcomings of the ISS. It uses the AIS descriptors of anatomic injury, but includes only four body regions: A = head/brain and spinal cord; B = thorax/neck; C = all other serious injuries other than in the areas of A and B; and D = all nonserious injuries.[1,2] Injuries with an AIS value >2, which are defined as serious, are scored for the first three categories above.[1] All minor injuries, defined as AIS scores of ≤2, are classified as nonserious, regardless of their anatomic location.[2] The total AP score is the sum of the square roots of the sum of the squares of the AIS for all individual injuries within a region[1,2] (Table 26.4). This allows the second and third injuries occurring within a given region to be considered in the final AP score, preventing the loss of information that occurs with the ISS.[1] AP is most useful in an inpatient setting and has neither been widely used nor validated for paediatric trauma.[1,2]

Table 26.2: Sample calculation of ISS.

Body region	Description of injury	AIS score	Square of top three AIS scores
Head and neck	Cerebral contusion	3	9
Face	Minor injury	1	16
Chest	Unilateral flail chest	4	25
	Pneumothorax	3	
Abdomen	Minor contusion of bowel	2	
	Completely shattered spleen	5	
Extremity	Femoral shaft fracture	3	
Skin	Minor injury	1	
Injury Severity Score =			50

Table 26.3: The Modified Injury Severity Score (MISS).

Glasgow Coma Scale	Neurologic score
15	1: Minor
13–14	2: Moderate
9–12	3: Severe, not life-threatening
5–8	4: Severe, survival probable
3–4	5: Critical, survival uncertain

Table 26.4: Sample calculation of AP.

Component	Injury	AIS score
A	1. Head/brain	5
	2. Spinal cord	3
B	1. Thorax	4
	2. Front of neck	3
C	1. Liver laceration	4
	2. Above-knee amputation	4
D	1. All other injuries	1

$AP = \sum[\sqrt{(5^2+3^2)} + \sqrt{(4^2+ 3^2)} + \sqrt{4^2+4^2})] = \sum[\sqrt{34} +\sqrt{25} + \sqrt{32}] = 5.8 +5.0 + 5.7 = 16.5$

The AP score =16.5

Physiologic Injury Scoring Systems

Physiologic scoring systems attempt to measure multiorgan system derangements following trauma. These physiologic scoring systems are strong predictors of mortality and tend to focus on abnormalities of many systems, including respiratory, haematologic, and neurologic. They are especially valuable in triaging patients; hence, they are also referred to as triage scoring systems. They are also valuable in providing data on functional outcomes. Examples of physiologic scoring systems are: the Glasgow Coma Scale (GCS); the Trauma Score (TS) and Revised Trauma Score (RTS); Circulation, Respiration, Abdominal/Thoracic, Motor and Speech Scale (CRAMS); and the Acute Physiology and Chronic Health Evaluation (APACHE) scale.[2] These are mainly used for prehospital triage of patients,[4] with the exception of the APACHE scale, which is widely used in the intensive care unit (ICU) for assessing the severity of illness in acutely ill patients.

Glasgow Coma Scale

The GCS was developed as a means of assessing a patient's level of consciousness by assigning coded values for three behavioural responses including eye opening, motor responses, and verbal responses. The GCS was first introduced in 1970. As shown in Table 26.5, the GCS has been modified for use in infants and children and is referred to as the paediatric GCS.[5,13] The GCS is scored between 3 and 15, with the worst score being 3 (indicating deep coma or death) and the best being 15 (indicating no neurologic deficit).

The GCS is easy to use even in the prehospital setting, and can be applied to the patient on multiple occasions throughout the postinjury period, following changes in level of consciousness over time. It has been found that the trend of multiple measures of GCS taken over time is a more sensitive predictor of outcome than a single, absolute value of the GCS. The ease of use of GCS makes it attractive to clinicians in the field, in the emergency department for triage, and by emergency physicians to document and communicate serial neurological

Table 26.5: Modified Glasgow Coma Scale for infants and children.

Area assessed	Infants	Children	GCS
Eye opening	Open spontaneously	Open spontaneously	E4
	Open in response to verbal stimuli	Open in response to verbal stimuli	E3
	Open in response to pain only	Open in response to pain only	E2
	No response	No response	E1
Verbal response	Alert, coos, and babbles	Oriented, appropriate	V5
	Spontaneous irritable cry	Confused	V4
	Cries in response to pain	Inappropriate words	V3
	Moans in response to pain	Incomprehensible words/sounds	V2
	No response to pain	No response	V1
Motor responses	Moves spontaneously and purposefully	Obeys commands	M6
	Withdraws to touch	Localises painful stimulus	M5
	Withdraws in response to pain	Withdraws in response to pain	M4
	Response to pain with decorticate posturing (abnormal flexion)	Abnormal flexion to pain	M3
	Response to pain with decerebrate posturing (abnormal extension)	Abnormal extension to pain	M2
	No response to pain	No response to pain	M1
Grimace component	Spontaneous normal facial/or motor activity (e.g., sucks tube, coughs)		G5
	Less than usual spontaneous ability or only responds to touch		G4
	Vigorous grimace to pain		G3
	Mild grimace or some change in facial expression to pain		G2
	No response to pain		G1

examinations. One major disadvantage of the GCS is the inability to obtain complete data from patients who are intubated and/or sedated.[14] This is usually signified by placing the letter "T" after the computed score (i.e., 3T indicates a patient with a GCS of 3 who is intubated).

The total GCS score is more meaningful when considered together with its components, that is: eye opening (E3), best verbal response (V3), and best motor response (M4). A GCS score ≤8 signifies coma or severe brain injury; a score of 9–12, moderate brain injury; and a score ≥13, mild or no brain injury.

Some workers add grimace to the GCS for adults and the modified GCS for infants and children, as shown in Table 26.5.[13]

The grimace component appears to be more reliable than the verbal component and may be useful in intubated and nonverbal patients when the verbal response is impossible to use.[14]

AVPU

During prehospital triage and primary assessment, the AVPU method may be used as a quick and simple tool to assess level of consciousness. The AVPU is a simple scale of whether a patient is responsive (**A**lert), responds to verbal stimuli (**V**erbal), responds to painful stimuli (**P**ainful), or is unresponsive to any stimuli (**U**nresponsive). It provides a rough guide as to whether a patient needs airway protection. The AVPU method does not belong to any of the groupings mentioned above—physiologic, anatomic, or combined, and is not a scoring system as such.

Trauma Score

The TS is a physiologic measure based on information gathered in the prehospital setting, and capable of predicting patient outcome.[1,15] It assesses four physiologic components including respiratory rate (RR), degree of respiratory expansion/effort, systolic blood pressure (SBP), and capillary refill, in addition to the GCS (Table 26.6). These are all scored and added together to give the TS value, which ranges from 1 to 16. For each value, the probability of survival [$P(s)$] has been determined. If a patient has a TS value of 1, the associated $P(s)$ is 0, indicating a likely fatal process. A TS value of 16 is associated with a $P(s)$ of 99%.[1]

The advantages of the TS are that it uses parameters that are commonly measured in the prehospital and emergency department settings, it is easy to understand, it accurately predicts outcome, and it has a good interobserver (interrater) reliability.[1] The TS has also been validated for use in paediatric patients. Its limitations lie in its use of two subjective measurements, including respiratory expansion/effort and capillary refill, which can be difficult to gauge in the field. In addition, it is somewhat cumbersome, with five separate measures, and also underestimates the severity of head injury in patients who are in a stable cardiovascular state.[1] A TS value calculated in the field or emergency department will naturally underestimate severity in the trauma patient who becomes unstable later.[1]

Revised Trauma Score

In order to eliminate the subjectivity of TS, the degree of respiratory expansion/effort and capillary refill were removed, resulting in the Revised Trauma Score. The RTS is a physiologic scoring system with high interobserver reliability and demonstrated accuracy in predicting mortality.[1] It is frequently used to rapidly assess patients at the scene of an accident. The score consists of the patient's data from the GCS,

Table 26.6: Trauma Score

Clinical parameter	Parameter category	Coded value
Respiratory Rate (cycle/min)	10–24	4
	25–35	3
	>35	2
	<10	1
	0	0
Respiratory expansion/effort	Normal	1
	Abnormal	0
Systolic blood pressure (mm Hg)	>90	4
	70–90	3
	50–69	2
	<50	1
	0	0
Capillary refill	Normal	2
	Delayed	1
	Absent	0
Glasgow Coma Scale	14–15	5
	11–13	4
	8–10	3
	5–7	2
	3–4	1

Table 26.7: Revised Trauma Score.

Glasgow Coma Scale (GCS)	Systolic blood pressure (SBP)	Respiratory rate (RR)	Coded value (RTS)
13–15	>89	10–29	4
9–12	76–89	>29	3
6–8	50–75	6–9	2
4–5	1–49	1–5	1
3	0	0	0

SBP, and RR (Table 26.7).[16,17] These three elements of the RTS are considered reliable and were selected due to their statistical association with trauma mortality. Thus, the RTS is easier to use than the TS and is a highly sensitive and strong predictor of survival.[2,3] The RTS is calculated by multiplying each component score by a weighting factor and then summing the weighted scores by using the following formula:

$$\text{RTS} = (0.9368 \times \text{GCS value}) + (0.7326 \times \text{SBP value}) + (0.2908 \times \text{RR value}).$$

RTS values range from 0.0 to 7.8408.[1] The RTS correlates well with survival, with higher values being more predictive of survival. However, the use of the RTS as the sole predictor of mortality in paediatric cases is not recommended. It is, however, the most widely used triage scoring system in the world trauma literature.[1]

The Triage-RTS (T-RTS), which is designed for prehospital use,[1] represents the sum of the values of the GCS, SBP, and RR, with the scores ranging from 0 to 12. A score of 0 represents the worst prognosis, with $P(s)$ equalling 0. A score of 12 represents the best prognosis, with $P(s)$ equalling 0.99.[1,2] It is recommended that injured patients with a T-RTS value ≤11 be admitted to a trauma centre for care.[1,17].

Circulation, Respiration, Abdomen, Motor, and Speech Scale

Another physiologic trauma scoring system is the CRAMS scale. It was developed in 1982 as a prehospital score to assist in trauma triage,[4] distinguishing those with major trauma from those with minor injuries. CRAMS scores five physiologic parameters and physical examination findings, including circulation, respiration, trauma to the abdomen and thorax, motor function, and speech on a scale ranging from 0 to 2 (Table 26.8). A score of 0 indicates severe injury or absence of the parameter, and a score of 2 signifies no deficit.[2] A value of 0 on the CRAMS scale indicates the worst prognosis or death, and a value of 10 indicates the best prognosis or lack of injury.[1] A CRAMS score ≤8 indicates a major trauma,[1] and a score ≥9 signifies a minor trauma.[2] CRAMS is cumbersome for field use and is limited by its reliance on subjective prehospital clinical components, such as capillary refill and respiratory effort. It is also often difficult to examine patients with thoracic and abdominal trauma in the field.[1]

The Apache Scale

The Acute Physiology and Chronic Health Evaluation scale is a more complex physiologic scoring system used predominantly later in the course of care to predict morbidity and mortality. The APACHE I was introduced in 1981 and had 34 physiological elements. This was revised in 1985, resulting in the APACHE II, which retained only 12 of the 34 physiological elements. The APACHE scale will not be discussed here. Readers interested in this scoring system should refer to the appropriate literature.

Combined Anatomic and Physiologic Injury Scoring Systems

Combined systems use anatomic and physiologic scoring to estimate morbidity and mortality risk for an individual patient as well as for trauma populations. These systems have an improved accuracy of both anatomic injuries caused by trauma and physiologic derangements caused by the patient's underlying chronic health state. As such, they are better predictors of survival than those systems based on anatomic or physiologic criteria alone.[2] However, they can be cumbersome. They are most often used in inpatient settings after the patient has been initially stabilised. Examples of this model are the Paediatric Trauma Score (PTS), Trauma and Injury Severity Score (TRISS), and A Severity Characterisation Of Trauma (ASCOT).[2] These are also known as outcome analysis systems.[1]

Paediatric Trauma Score

The PTS was devised specifically for the triage of paediatric trauma patients.[3] The PTS is calculated as the sum of individual scores from six clinical variables (Table 26.9). The variables include weight, airway, SBP, central nervous system (CNS) status (level of consciousness), presence of an open wound, and skeletal injuries.[1,3] Two of the clinical parameters, airway and CNS status, are somewhat subjective measures. Each of the six clinical parameters is assigned a score ranging from no injury to a major or life-threatening injury.[3] The PTS is calculated as the sum of individual scores, and its total values range from –6 to +12. A PTS ≤ 8 is recommended as an indication for prehospital triage of a patient to a trauma centre.[2] There are conflicting reports on the effectiveness of the PTS as a tool for assessing prognosis and in identifying those who will need a transfer to a paediatric trauma centre.[1,3,5,15,16]

Further refinements of the PTS include the Age-Specific PTS and the triage Age-Specific PTS. These scoring systems, however, have not yet been validated and are rarely used.

Trauma and ISS

The TRISS is a combination of the physiologic data in the RTS (and, less commonly, the TS) and anatomic data in the ISS to estimate the probability of survival for a given trauma patient.[2,3] The probability of survival [$P(s)$] for any one patient is determined by the formula.[1,2,3]

$$P(s) = 1/(1 + e^{-b}),$$

where $b = b_0 + b_1$(TS or RTS) + b_2(ISS) + b_3(age factor). The b coefficients (b_0, b_1, b_2, and b_3) are derived from logistic regression analysis of patients in the Major Trauma Outcome Study (MTOS) data base. These coefficients are different for blunt and penetrating trauma. The age factor (or age index, as used by other authors) is zero for all patients aged <55 years and 1 for all patients aged ≥55 years.[1] If the patient is younger than 15 years of age, the blunt index for b_3 is used regardless of mechanism. Values for $P(s)$ range from 0, for no survival expectation, to 1.00 for 100% survival expectation.[1] Generally, survivors have a $P(s) \geq 0.5$, and nonsurvivors have a $P(s) < 0.5$. Trauma fatalities with a $P(s) < 0.5$, by convention, are defined as expected outcomes, and fatalities with a $P(s) \geq 0.5$ are unexpected outcomes. This terminology is important for quality evaluation of trauma care. There is also the Paediatric Age-Adjusted TRISS, which simply uses the paediatric Age Specific PTS instead of the RTS, but this is not yet in wide use by investigators.[3]

The drawbacks of the TRISS are primarily related to the component scoring systems that form its basis: the RTS (or TS or PTS) and the ISS. It is also not easy to compute due to a complex logistic regression formula used to calculate $P(s)$.[2] Despite all these limitations, TRISS is the most validated and commonly used trauma mortality prediction model to date, and its methodology has been shown to perform reasonably well for both adult and paediatric trauma patients.[1]

ASCOT

The developers of ASCOT designed it as a mortality prediction model to improve on the limitations of the TRISS. ASCOT uses the AP instead of the ISS for the description of an anatomic injury.[1] It also uses separate algorithms for blunt and penetrating trauma. ASCOT takes into account each injury within a given body region by using the AP and, as such, better represents the increased mortality risk associated with multiple injuries.[1] The AP, as used in ASCOT, divides serious injuries (AIS > 2) into three categories—head, brain or spinal cord injuries; thorax or neck injuries; and all other serious injuries. Note that nonserious injuries (AIS of 1 or 2) are not significantly associated with mortality and are therefore dropped from ASCOT calculations.

Like the TRISS, ASCOT relies on the RTS to provide physiologic data but advocates the use of the individual components of the RTS rather than the total RTS score. It derives a measure of the probability of survival by combining values of the GCS, SBP, and RR as coded by the RTS, patient age (0 for all paediatric patients) and the AP.[3] $P(s)$ using ASCOT is calculated similarly to the TRISS by employing the following formula:[1,2]

$$P(s) = 1/(1 + e^{-k}),$$

where $k = k_1 + k_2$(RTS GCS value) + k_3(RTS SBP value) + k_4(RTS RR value) + k_5(AP head region value) + k_6(AP thorax region value) + k_7(AP other serious injury value) + k_8(age factor).

The k coefficients for blunt and penetrating injuries are all derived from the MTOS data base and can be found in the literature. ASCOT is more cumbersome to compute than the TRISS but appears to be more accurate at predicting trauma mortality, especially for penetrating injuries.[1]

Table 26.10 demonstrates example calculations of some of the trauma scores by using a single hypothetical case scenario: A 13-year-old boy, weighing 35 kilograms, was standing by the side of the road and was struck by a moving vehicle, hitting his head against the edge of a gutter. On arrival at the Accident and Emergency (A&E) department

Table 26.8: CRAMS scale.

Clinical parameter	Parameter category	Coded value
Circulation	Normal capillary refill, SBP >100 mm Hg	2
	Delayed capillary refill, SBP 85–100 mm Hg	1
	No capillary refill or SBP <85 mm Hg	0
Respiration	Normal	2
	Abnormal (laboured or shallow)	1
	Absent	0
Abdomen/thorax	Abdomen and thorax nontender	2
	Abdomen and thorax tender	1
	Abdomen and thorax rigid, flail chest, or penetrating trauma	0
Motor	Normal	2
	Responds only to pain (other than decerebrate)	1
	No response (or decerebrate)	0
Speech	Normal	2
	Confused	1
	No intelligible words	0

Table 26.9: Paediatric Trauma Score.

Clinical parameter	Severity category	Score value
Weight	≥ 20 kg	+2
	10–19 kg	+1
	<10 kg	-1
Airway	Normal	+2
	Maintainable	+1
	Unmaintainable	-1
Systolic blood pressure*	>90 mm Hg	+2
	50–90 mm Hg	+1
	<50 mm Hg	-1
Central nervous system	Awake	+2
	Obtunded/loss of consciousness	+1
	Coma/decerebrate	-1
Open wound	None	+2
	Minor	+1
	Major or penetrating	-1
Skeletal injury	None	+2
	Closed fracture	+1
	Open or multiple fractures	-1

*In the absence of a proper-sized blood pressure cuff, BP can be assessed by assigning the following values:[3] presence of palpable pulse at the wrist = +2; presence of a palpable pulse at the groin = +1; absence of pulse = –1.

Table 26.10: Examples of how to calculate some trauma scores for hypothetical scenarios.

Abbreviated Injury Score (AIS)		
Head/Neck	Subdural haematoma	AIS score = 4
Face	Abrasions	AIS score = 1
Chest	Fracture of four ribs	AIS score = 4
Abdomen	Splenic laceration (Grade IV)	AIS score = 4
Extremity	Fracture right femur	AIS score = 3
Skin	Abrasions	AIS score = 1
Injury Severity Score (ISS)		
ISS = $4^2 + 4^2 + 4^2 = 48$. This is a severe injury.		
Paediatric Trauma Score (PTS)		
Weight	35 kg	+2
Airway	Maintainable	+1
SBP	78 mm Hg	+1
CNS	Obtunded	+1
Open Wound	None	+2
Skeletal Fracture	Closed fracture	+1
PTS = 8. Such a patient should be triaged immediately to a paediatric trauma centre, where available.		
Revised Trauma Score (RTS)		
GCS = 10	Coded value = 3	Weight = 0.9368
SBP = 78	Coded value = 3	Weight = 0.7326
RR = 28	Coded value = 4	Weight = 0.2908
RTS = (0.9368 x 3) + (0.7326 x 3) + (0.2908) = 2.8104 + 2.1978 + 1.1632 = 6.1714		

of the hospital, his GCS was found to be 10, with an RR of 28 cycles per minute and a SBP of 78 mm Hg. His airway was maintainable. A computed tomography (CT) scan revealed a right-sided parietal subdural haematoma. It was also revealed by CT scan that he had a grade IV laceration of the spleen. Radiography of the chest and right femur showed fractures of four ribs on the right and a femoral shaft fracture.

Paediatric trauma care has improved a great deal in the developed and industrialised countries as a result of standardisation of patient assessment and reporting. The various scoring systems, especially those combining anatomic and physiologic parameters, have helped to improve the care of trauma patients. A search of the African literature, especially by using African Journals Online (AJOL), did not reveal much activity in the use of these scoring systems. This deficiency needs to be rectified because some of these injury scoring systems are easily implemented without extra funding, yet may improve patient outcomes.

Trauma Registry

A trauma registry (TR) is an accurate and comprehensive collection of data on patients who receive hospital management for specified types of injuries. A TR provides an important and ongoing analytical tool to assess the management of patient care. The purposes[18–20] of any TR are many and include the provision of data for injury surveillance, analysis, and prevention programmes; monitoring and evaluation of the outcome of care of trauma patients; support of quality assurance evaluation activities; provision of information for resource planning, system design, and management; provision of resources for research and education; and validation and evolution of scoring systems for improved management of trauma patients. The successful implementation of trauma care systems, including their quality assurance through trauma registries, has contributed to the decline in death and disability resulting from injuries. This is evidenced by a decline in projected road traffic deaths in high-income countries, whereas those in middle- to low-income countries continue to rise.[21,22] Improvement in trauma care in Africa will rely on further development of functioning prehospital and trauma care systems, as well as establishing local, regional, and national trauma registries. Conglomeration of multicentre data can then be used to further examine and improve trauma care in African countries.

A TR typically includes detailed information about injured patients, including prehospital data, resuscitation efforts, and outcome data. The actual data points may vary between registries, but it is important that they be detailed and consistently collected among patients.[23] Too few data points will lead to incomplete and ineffective data, and too many data points will be cumbersome and impossible to maintain.[24]

Unfortunately, a number of resources are needed to implement and maintain a TR. This begins with a well-defined patient population. Some registries record data only on the severely injured and those who arrive at the hospital alive. Some registries record data dependent on length of stay of the patient. Most registries derive some score of injury severity for all registered patients. Careful consideration must be given when defining the patient population because exclusion of certain patients may skew the data, altering the apparent severity of injury and affecting later conclusions based on the data.[25] Personnel must be adequately trained to collect and enter ongoing data. In the United States, a nationally recognised certification process has been initiated to ensure appropriately trained staff. The data must be collected by using reasonable and dependable software, with the ability to grow and expand as more patients are registered as well as the ability to protect patient privacy. Of course, ultimately, all of these resources require funding. Possible sources of funding to establish trauma registries throughout Africa include the ministry of health of each participating country, nongovernmental organisations (NGOs), and international development partners.

Barriers to the creation of trauma registries throughout Africa are many. The most prominent roadblock is that those tools that have been established and validated in other systems may not be applicable to the African population.[26-31] Also, the lack of a continuous power supply may limit the ability to record and maintain data. This may be surmounted by backing up data daily. Further barriers to the establishment of efficient TRs in developing countries are the following:[23]

- little or no prehospital care;
- nonavailability of (or inefficient) evacuation and transportation system;
- limited interhospital communication in the case of transfers;
- lack of standardised and uniform hospital data formats;
- limited availability of electronic data storage and retrieval facilities;
- inadequate funding;
- unfavourable government health policies;
- inadequate census and population data; and
- lack of awareness in the communities.

Despite these obstacles, existing trauma registries in developed countries can be used as initial guides to create a system that is applicable in resource-poor areas.

The implementation of the Kampala Trauma Score (KTS), a simplified system first introduced in Uganda, has fueled the hope that these barriers can be overcome. The KTS is a simplified conglomerate of the RTS and the ISS, resembling the TRISS.[32] Its validity and reliability have been demonstrated in both urban and rural settings in Uganda.[33–35] This hospital-based registry was initiated as the first step in an injury surveillance system.[34] Data were collected regarding demographics, injury causation, and outcomes by using a single-page form. The project was subsequently expanded to include five large hospitals in Kampala as well as Addis Ababa in Ethiopia.[35,36]

The organisation of a continent-wide paediatric trauma registry in Africa will require the participation of many hospitals in all countries. Ideally, it would begin with the establishment of regional and state registries, followed by national registries. These can then be grouped into subregional registries, including North, East, South, and West African registries, which will eventually combine to form the African Trauma Registry Database (ATRD).

Evidence-Based Research

Table 26.11 presents a literature review of scoring systems for paediatric trauma, and Table 26.12 presents a report on the establishment of the first national Italian trauma registry.

Table 26.11: Evidence-based research.

Title	ABCs of scoring systems for pediatric trauma
Authors	Furnival RA, Schunk JE
Institution	Department of Pediatrics, Primary Children's Medical Center, University of Utah School of Medicine, Salt Lake City, Utah, USA
Reference	Pediatr Emerg Care 1999; 15(3):215–223
Problem	An overview of frequently used trauma scoring systems.
Intervention	Literature review.
Comparison/ control (quality of evidence)	This literature review does not compare patients, per se, but compares the effectiveness of various trauma scoring systems in the paediatric age group with or without modifications. The many existing trauma scoring systems are divided into triage scoring systems, injury scoring systems, and trauma outcome analysis systems, each with its advantages and limitations when used in children.
Outcome/ effect	The scoring systems are designed to enhance effective prehospital triage of trauma patients, organise and improve trauma system resource planning, allow accurate comparison of different trauma populations, and serve as quality assurance filters in trauma patient care.
Historical significance/ comments	This well-written article takes the reader through the historical development of some trauma scoring systems and provides a very good overview of frequently used systems. The authors even inform readers about an ideal scoring system: it should correlate well with the desired outcome (e.g., death, disability, costs, etc.); it should be reasonable to clinicians and correlate with their judgement; it should use available data; it should be reliable among different users; and it should be simple. This is, in fact, what all scoring systems should be.

Table 26.12: Evidence-based research.

Title	The first Italian trauma registry of national relevance: methodology and initial results
Authors	Bartolomeo SD, Nardi G, Sanson G, et al.
Institution	Unit of Hygiene and Epidemiology, DPMSC School of Medicine, University of Udine, Udine, Italy
Reference	Eur J Emerg Med 2006; 13:197–203
Problem	Endeavour to establish a multiregional trauma registry in Italy.
Comparison/ control (quality of evidence)	The evidence of success in Italy so far is good, and the goals of the project have been achieved.
Outcome/ effect	The possibility of using the data collected for future quality improvement and research appear great, and there are steps to link this registry to other European trauma registries. It is also envisaged that, considering its success, other hospitals in Italy will offer to participate in such a registry.
Historical significance/ comments	This is a beginning worth emulating in the African subregion if we want to build a recognisable trauma registry for Africa. Not all African countries have to start at the same time; the end result will be the same eventually, if we follow other people's examples.

Key Summary Points

1. Trauma scoring systems are grouped into three sections: anatomic, physiologic, and combined scoring systems.
2. Each system has its place of use and must be used appropriately.
3. Each system has its advantages and disadvantages, and these must be weighed carefully before a particular system is chosen for use in a clinical setting.
4. The system chosen must be reproducible, or at least should be reliable and simple.
5. The most widely used systems include the Revised Trauma Score (RTS), Paediatric Trauma Score (PTS), Abbreviated Injury Scale (AIS), Injury Severity Score (ISS) and its modifications, and the Trauma and Injury Severity Score (TRISS).
6. A trauma registry collects and maintains data on patients who have had injuries and is used for planning to develop newer methods of trauma care as well as quality assurance.
7. Trauma registry data are confidential and must be treated as such.

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