A Review Paper on Trauma Scoring Systems including Artificial Intelligence Techniques

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Abstract

The main purpose of the review paper in this study is to demonstrate a brief overview of existing trauma scoring systems that can be used by emergency physicians. In this paper, the trauma scoring systems have been divided into four categories; Anatomical Indices, Physiological Indices, Combined Anatomical/Physiological Score, and Artificial Intelligence based on Trauma Scoring Systems. However, the majority of review papers have been not mentioned Artificial Intelligence methods which we believe are effective ways to predict trauma outcomes nowadays. Therefore, in this article, the fourth part was added which explains Artificial Intelligence techniques that have been used in Trauma Scoring Systems.

Introduction

Recently, Trauma is the most serious issue of health care problems for modern society. Despite of the great rates of mortality and morbidity correlated to trauma, it is still not observed as a foremost disease. Documentation of trauma facilitates to compare between patient care and outcomes from diverse medical centres. Triage of trauma is used to assess trauma level for prioritising of injured people for treatment or transport that depend on their severity of injury. Primary triage is done at the act of an accident and less important triage at the casualty clearing station at the site of a main incident. Triage is reiterated prior to passage away from the scene and again at the receiving hospital (Patient 2015).

Trauma scores are also as audit and research tools used to study the outcomes of trauma and trauma care, rather than predicting the outcome for individual patients. Many different scoring systems have been developed; some are based on physiological scores (eg, Glasgow Coma Scale (GCS)) and other systems rely on anatomical description (eg, Abbreviated Injury Scale (AIS)). There is, however, no universally accepted scoring system and each system has its own limitations. Scoring systems were initially introduced as a requirement for triage part, along with being effective and accessible for pre-hospital people. Scoring systems ought to precisely assess severity of injury both anatomically and physiologically (Maslanka 1993). Therefore, trauma scores can assess the severity and level of an injury and consequently help forecast the possibility of survival and subsequent morbidity. Emergency department currently has an opportunity to collect that data in a simply retrievable form by the e-code system. Emergency department could make a significant influence to trauma avoidance by building capture of the mechanism of injury predictable, ‘e-coding’ the data and submitting it to existing trauma databases ((Fani-Salek 1999; Senkowski et al ,.1999; Yates et al ,.1990; Mark 2015)**)**. Table1 shows four categories; Anatomical Indices, Physiological Indices, Combined Anatomical/Physiological Score and Artificial Intelligence base on Trauma Scoring Systems.

Table 1: Anatomical Indices, Physiological Indices, Combined Anatomical/Physiological Score and Artificial Intelligence base on Trauma Scoring Systems

Anatomical Indices	**Physiological Indices**	**Combined Anatomical/ Physiological Score**	**Artificial Intelligence base on Trauma Scoring Systems**
• Abbreviated Injury Scale (AIS) and (MAIS) • Injury severity score (ISS) and (NISS) • Anatomic Profile (AP) • Trauma mortality prediction model (TMPM) • International Classification of Diseases-based ISS (ICISS) • Organ Injury Scales(OIS) • Abdominal Trauma Index (ATI)	• Glasgow coma scale(GCS) • Paediatric Glasgow Coma Scale (PGCS) • Trauma Score(TS) • Revised Trauma Score(RTS) • Acute Physiology and Chronic Health Evaluation(APACHE) • Rapid Acute Physiology score(RAMS) • Rapid Emergency Medicine Score (REMS) • Prognostic Index(PI) • Emergency Severity Index(ESI) • Sequential Organ Failure(SOF) • Assessment Score (SOFA) • Multiple Organ Dysfunction syndrome (MODS) • Systemic Inflammatory Response Syndrome Score (SIRSS) • MULTIPLE ORGAN FAILURE (MOF) • Circulation, Respiratory, Abdominal/Thoracic, Motor and Speech Scale(CRAMS) • Glasgow Coma Scale, Age, and Systolic Blood Pressure (GAP) • Logistic Organ Dysfunction Score(LODS) • Simplified Acute Physiology Score(SAPS)	• Trauma Score-Injury Severity Score Methodology (TRISS) • Drug-Rock Injury Severity Score(DRISS) • Trauma Index (TI) • Harborview assessment for risk of mortality (HARM) • A Severity Characterization of Trauma (ASCOT) • Paediatric Trauma Score (PTS) • Triage Index(TI) • Admission base deficit, International Normalized Ratio and GCS (BIG)	• Artificial Neural Network(ANN) • Fuzzy Logic(FL) • Genetic Algorithm(GA) • Iterative Random Comparison Classification (IRCC)

1- Anatomical Indices.

1.1- Abbreviated Injury Scale (AIS) and (MAIS)

In 1971 the American Medical Association (AMA) Committee on Medical Aspects of Automotive Safety which has introduced the abbreviated injury scale (AIS) to help medical field with a method for assessment the severity of traumatic categories. In spite of many changes were applied in the 1998 update of the abbreviated injury scale (AIS 98) contrasted with the preceding AIS 90, both are still common in the all over world for coding of anatomic injury in trauma (Skaga et al., 2007). AIS-90 is used to classify more than 2000 injury description in nine body parts (head, neck, face, thorax, spine, abdomen, upper limbs, lower limps, and external) (Kim 2012). In an ordinal scale between 1 (minor injury) and 6 (maximum injury, possibly mortal) range, is allocated to each injury. For patients by several injuries, the main AIS is distinct as the maximum AIS (MAIS). MAIS is used to express total severity; MAIS is not linearly increase and decrease by varying likelihood of mortal. To provide solution for these limitations and then the injury severity score (ISS) was presented (Stevenson et al. 2001).

1.2- Injury severity score (ISS) and (NISS)

Three years later from improving of the AIS, in 1974, the ISS was introduced to progress the AIS. The ISS is an ordinal scale and anatomically constructed that could be in a collection between 1 and 75 (Champion 2002). The nine AIS regions have divided by The ISS into six groups: head or neck, face, chest, abdominal or pelvic contents, extremities or pelvic girdle, and external. ISS has ability to engage anatomic parts of injury in formulating an expectation of outcomes (Chawda et al., 2004) .However, it has some limitations that it could expect less accurate in the case of multi-injuries in the same body region .Therefor, the ISS is just used one of the these injuries even if other injuries in this body region are more severe than injuries in other regions. Another drawback of the ISS is that all injuries are measured an equal AIS score irrespective of body region where is injured. The last revision of the ISS has known is the New Injury Severity Score (NISS). The NISS is computed as the sum of squares of the three most significant (severe) AIS (1990 revision) injuries and it has improved the forecast of survival and enhanced routine, statistically, than the ISS (Stevenson et al. 2001). NISS has more ability to forecast mortality comparing to ISS values for the same patients in individually of the two data sets. This means that NISS provides a better fit throughout its entire range of prediction survival as well (Osler et al., 1997).

1.3-Anatomic Profile (AP)

Anatomic Profile trauma scoring system has some similarities to ISS, however it has own features. However, ISS has limitations, multidimensional properties which cover the number, region, and severity of anatomic injuries and create a result which is followed. Therefore, Anatomic Profile routines four factors to calculate injured patient: A, B, and C for severe injuries (AIS >= 3) which are head and neck, thorax, and other defined body parts separately, and D defines any region of body which is not serious injury .It uses to combine an Euclidean Distance Model viz. The square root is sum of the squares (Champion 2002).

$$\mathbf{AP} = \sqrt{A^2 + B^2 + C^2 + D^2}$$

(Champion 2002) Equation1.1

1.4-Trauma mortality prediction model (TMPM-ICD9)

TMPM-ICD9 is the one of modern injury-severity assessment which is depends on empirical valuation from ICD-9-CM codes. It is candidate to change expert-based AIS measures global in order to make easier accessibility and enhanced analytical performances. International Classification of diseases ninth Edition Injury Severity Score (ICISS) TMPM-ICD9 is very useful method for risk-adjustment model once injuries are verified using ICD-9-CM coding, and probably to be used to risk-adjust result assessment for trauma report cards at hospital. It is also result that it expresses a likelihood of death depends on the most five severe ICD-9-CM-coded injuries. Empiric scales of injury severity for each of the trauma ICD-9-CM codes were assessed using a regression-based method, and then used as the source for a new Trauma Mortality Prediction Model (TMPM-ICD9). In this article, it was compared with ICISS model. Findings ,TMPM-ICD9 was demonstrate greater model performance. (Glance el at,. 2009).

1.5 International Classification of Diseases-based ISS (ICISS)

ICISS is one of anatomical injury systems that it uses ICD-9 codes. This method is also called the ICD-9 Injury Severity Score (ICISS) and for each ICD-9 discharge diagnosis that it uses survival risk ratios (SRRs). SRRs use to divide the number of survivors in each ICD-9 code by the overall number of ill people with the equal ICD-9 code. The ICISS is estimated as the simple produce of the SRRs for each of the injured people. The ICISS has more power than ISS. It lets all the patients to contribute to the forecast, and individual injuries are more correctly modelled. Moreover, it is also use information about all the injuries, composes with the patient's three severe injuries. Nevertheless, it is hardly to compare the performance of clinics. (Chawda et al.,2004).

1.6- Organ Injury Scaling (OIS)

In 1987 OIS was introduced by Committee of the American Association for the Surgery of Trauma (A.A.S.T.) (Moore el at .,1989). In this study emphasizes that it devises injury severity scores for separate organs to enable clinical research. The subsequent classification system is basically an anatomic Indices, measured from 1 to 5, expressing the minimum to the greatest severe injury. There are great number of comparable scales has been improved in the past, but no one of system scores has done for separate organs. OIS uses for spleen, liver, and kidney. It is earlier scales applied for these organs. The enclosed OIS characterises an initial classification system that necessity experience continued improvement as newer trauma scoring system to become accessible for medical centres.

1.7-Penetrating Abdominal Trauma Index (PATI)

The Penetrating Abdominal Trauma Index (PATI) was developed in 1981 (Chappuis et al., 1991).This method is used to detect trauma patients at risk of postoperative difficulties. It also provides an effective way to examine and help as tool in the decision-making procedure once dealing penetrating abdominal trauma. For instance, in this study there are 56 patients and 28 of them were randomised into individually group. Data were composed concurrently and difficulties and outcome recorded. Most cases in each group were young men. The typical age for the primary repair group was 26 years (range, 17 to 58 years). There were 27 males and 1 Female in the primary repair group and 25 males and 3 Female in the diversion group and for the diversion group, 23 years (range, 14 to 61 years). Consequently to score trauma, injury severity instruments (ISI) are used in the unlike stages of trauma management for injury assessment. Totally associated abdominal organs injured were assessed and treated consequently. The small bowel was the additional organ injured most routinely (Table2). Injury number, involving colon injury, was similar in both groups (Table 3).

Table 2: Associated Intra-abdominal Injuries

Organs	Primary Repair	Diversion
Small bowel	15	21
Duodenum	7	4
Stomach	6	4
Liver	6	4
Major vascular	5	4
Kidney	4	3
Pancreas	2	2
Ureter	1	3
Diaphragm	2	-
Gallbladder	1	-
Spleen	1	-

Table 3: Total Number Organs Injured

Number	Primary Repair	Diversion
1	2	3
2-3	19	19
>4	6	7

2- Physiological Scale.

2-1 The Glasgow Coma Scale (GCS)

The Glasgow Coma Scale (GCS) was introduced in 1974. It was developed to standardise assessment of a patient's level of consciousness (LOC). It is relatively simple to apply and is used in a variety of medical assessment cases such as determining urgency of care and for neurological examinations. Its scale is 3 to 15 obtained by evaluating eye opening, verbal and motor behaviours as shown in (Table 3). It can assess the depth of coma and predict its duration; however it has limited predictive power of mortality (Fani-Salek et al., 1999). There is The Paediatric Glasgow Coma Scale (PGCS) is the modified version of GCS for use for preverbal children. It uses different verbal response variables to GCS.

2.2- The Paediatric Glasgow Coma Scale (PGCS)

The main difference between GCS and PGCS is that GCS is effective method for patients who are older than 2 years as (Table 4) shows for calculation using the typical adult GCS score, as is regularly used for verbal children. However, The PGCS score is used for those patients 2 years and younger and the calculation which use a scale previously obtained from preverbal children the parameters as shown in(Table 5) (Holmes et al., 2005).

Table 4: The Glasgow Coma Scale (GCS)

Eye Opening (E)	Best Verbal Response (V)	Best Motor Response (M)
4 = spontaneous	5 = normal conversation	6 = normal
3 = to voice	4 = disoriented	5 = localises to pain
2 = to pain	3 = incoherent words	4 = withdraws to pain
1 = none	2 = incomprehensible	3 = decorticate (flexion)
	1 = none	2 = decerebrate (extension)
		1 = none

Table 5: Paediatric Glasgow Coma Scale

Eye Opening (E)	Best Verbal Response (V)	Best Motor Response (M)
4 = Spontaneous	5 = Coos, babbles	6 = Normal spontaneous movement
3 = To speech	4 = disoriented	5 = Withdraws to touch
2 = to pain	3 = Irritable, cries	4 = withdraws to pain
1 = none	2 = Cries to pain	3 = Abnormal flexion
	1 = none	2 = Abnormal extension
		1 = none

2.3- Trauma Score (TS)

The Trauma Score is introduced to alter the Triage Index in order to use systolic blood pressure and respiratory rate and the Glasgow Coma Scale (GCS) to calculate the degree of coma. The Trauma Score is between 1 (worst prognosis) and 16 (best prognosis) and can be calculated by sum scores which are given to component variables (Champion 2002).

2.4- Revised Trauma Score (RTS)

Trauma Score and Revised Trauma Score are used to be responsible for trauma clinicians with a quick and reliable instrument using weighted baseline physiological records to sum a total score that increasing forecast severity of injury and the probability of death. In the Revised Trauma Score, respiratory expansion and capillary filling were dropped due to difficulties in making a valid assessment in the field and there are 4 variables which express as 0 (worst prognosis) to 4 (best prognosis) (Champion, 1989). The result of his method is combining scores of three groups which are i) Glasgow coma scale, ii) systolic blood pressure and iii) respiratory rate (Injury Severity Scores). For case of triage, systolic blood pressure, coded values of Glasgow Coma Scale and respiratory rate are used in the triage version which is T-RTS, of the RTS that uses integer number between 0 and 12 (Champion 2002). The T-RTS also triages about 97.2 per cent to trauma centres.

2.5- Acute Physiology and Chronic Health Evaluation (APACHE)

APACHE was implemented to prediction hospital mortality between critical adult patients (Zimmerman et al., 2006). In this study, it is uses discrimination "(area under the receiver operating characteristic curve _ 0.88) and calibration (Hosmer- Lemeshow C statistic _ 16.9, p _ .08). But for 90% of 116 ICU admission diagnoses, the ratio of observed to predicted mortality was not significantly different from 1.0".

2.6 - The Rapid Acute Physiology Score (RAPS)

The Rapid Acute Physiology Score (RAPS) was developed for practice as a severity scale in serious care transports. RAPS is also an abbreviated version of the Acute Physiology and Chronic Health Evaluation (APACHE-II) via only variables regularly available on all patients who are transported. Therefore, it uses four parameters which are (respiratory rate, blood pressure, pulse, and Glasgow Coma Scale).In terms of range, it starts from 0 (normal) to 16(worst) (Rhee et al., 1987).

2.7- Rapid Emergency Medicine Score (REMS)

The Rapid Emergency Medicine Score can likelihood mortality over 4.7 years in the department of non-surgical emergency (ED) (Olsson et al., 2004). In this study, 12,006 non-surgical patients consecutively presenting to an adult ED at a 1,200-bed university hospital during a period of one year were enrolled ". However , REMS uses (respiratory rate, pulse rate, blood pressure, peripheral oxygen saturation, Glasgow Coma Scale score, and patient age) .It was also evaluated for all patients who admitted to the ED. Moreover, the statistical associations between REMS and long-term mortality were surveyed. Findings: REMS could forecast mortality over 4.7 years (hazard ratio, 1.26; p< 0.0001). Related to results were found in the foremost patient groups (stroke, coma, chest pain, dyspnea, and diabetes). It also had been tested a forecaster of mortality at one week, one month , three months , one year, and 4.7 years in the non-surgical ED. They found that REMS can be individually expecting long-term mortality even with age as a parameter. Additional, it is logical to undertake that a disorder of the physiologic parameters in REMS which could have an influence on short-term mortality as previously described, but how this a score can forecast long-term result seems less clear.

2.8- Prognostic Index (PI)

The prognostic index was established in 1980 and it was derived to enable complete separation of fatal and nonfatal cases and when consequently used in a nine index cases and properly forecasted the outcome. In this method can reflect the ability of the prognostic index to distinguish among patients at low and high risk of death. It is also regularly defined in terms of the part under the ROC curve (ROC part), which is connected to close probability. In this way, all possible pairs of patients in which one patient survives and the other non-survives, a real danger was allocated to the patient who died than to the one did not (Walter et al .,2001).

2.9- Emergency Severity Index (ESI)

The Emergency Severity Index (ESI) uses to simplify reliable severity evaluation and likely prediction patient disposition (Tanabe et al .,2001). It has five-level ESI algorithm which was presented to triage nurses at two university hospital EDs, and executed into training with reinforcement and adaptation management plans. This method has it owns component which can enable it to forecast the resource consumption. the algorithm of ESI uses RR = respiratory rate; HR = heart rate; SpO2 = pulse oximetry; T = temperature; PEFR = peak expiratory flow rate (Wuerz et al .,2001) . It is also provide clinically related stratification of patients into five groups according to a range of urgency. This means that it depends on patient case severity and supply that needs. It also can deal thru plus a new unit on using the ESI algorithm with paediatric kind (Gilboy el al 2011).

2.10- Sequential Organ Failure Assessment(SOFA)

(SOFA) was introduced by European Society of Intensive Care and Emergency Medicine during a consensus conference (Cabré et al .,2005). According to this conference, initially called the “sepsis-related” organ failure assessment, SOFA could be useful equally to all ICU patients. Moreover, SOFA score is collected of scores from six organ systems, classified from 0 to 4 according to the degree of dysfunction/failure. Organ systems also measured in the SOFA score are: respiratory (PO22/FIO2), cardiovascular (vasoactive drugs, blood pressure), hematological (platelet count), renal (diuresis and creatinine), liver (bilirubin) and neurological (Glasgow Coma Score).But some of medical persons are not familiar with SOFA score while decisions on limiting life support were made(Cabré et al .,2005).

2.11- Multiple Organ Dysfunction syndromes (MODS)

MODS uses to develop clinical syndrome triggered by several motivations that it is the main reason of mortality and morbidity in patients who admitted to intensive care units (ICU). This technique uses for cardiovascular assessment which bases on the so-called “pressure-adjusted heart rate”

(PAR), defined as the product of the heart rate (HR) multiplied by the ratio of the right atrial pressure (RAP) to the mean arterial pressure (MAP) (Cabré et al .,2005).

2.12- Systemic Inflammatory Response Syndrome Score (SIRSS)

SIRSS is also one of the clinical expressions which deal with the action of difficult intrinsic mediators of the severe stage reaction (Nyström 1998). This method is triggered by measurement of pancreatitis, trauma, infection, and surgery. Moreover, it could also come to terms of the function of several organ systems subsequent in Multiple Organ Dysfunction Syndrome (MODS). Therefore, the MODS and SIRSS are classified expressions of the inflammation related to serious patient (Nyström et al., 1998).In this study the SIRSS was expressed by two or more of the following conditions: "temperature 38°C or 36°C; heart rate 90 beats/min; respiratory rate 20 breaths/min or PaCO2 32 torr (4.3 kPa); WBC 12,000 cells/mm3, 4000 cells/mm3 or 10% immature (band) forms". But in finding, the SIRSS for other signs as an example, the appearance of C-reactive protein are better designated as the severe stage reaction. In addition, several patients with SIRSS show different degrees of organ dysfunction whereas some developments to progress multiple organ failure.

2.13- MULTIPLE ORGAN FAILURE (MOF)

Multiple organ failure (MOF) is influenced epidemic parts in several intensive care units. It uses to predict dead case in the surgical intensive care unit (Deitch et.,at 1992). MOF score is deals with four organs (lungs, kidneys, liver, and heart) were measured regularly for dysfunction and scored from 0 (no dysfunction) to 3 (severe dysfunction)(Zallen et al .,1999). This technique was examined in sepsis and the severity of bacterial sepsis was assessed reflectively in 37 intra-abdominal-sepsis and 55 trauma patients with MOF. Finally, The severity of MOF was graded, and an analysis was made of day of onset, incidence, sequence, severity, and mortality of organ failures as well as there is no difference was initiated between groups in severity, sequence, or mortality of organ failures(Goris et.,at 1985).

2.14-Circulation, Respiratory ,Abdominal-Thoracic, Motor and Speech Scale (CRAMS)

CRAMS is commonly appropriate physiological trauma scoring (Gormican 1992).CRAMS works based on five parameters (respiration, circulation, trauma to the trunk, speech and motor) on a 0–2 scale. A score of 0 shows severe injury or absence of the factor; a score of it > 2 signify no deficit. Therefore, the overall likely score ranges from 0 which for a corpse to 10 for an uninjured patient. Including zero as the score for death which makes this method is more effective than the GCS. Where even a corpse could take more than 3 scales and when CRAMS score is <=8 that it means critical trauma, while a score of 9 or 10 designates mild trauma. The CRAMS discriminates between mild and critical trauma levels and it can be useful to avoid over-triage to trauma middles and even though dependable for triage part. Nevertheless, it may not be constantly validated on repeating scrutiny. It also has a disadvantage in its capability to predict the essential for operation (Ornato el at., 1985).

2.15- Glasgow Coma Scale, Age, and Systolic Blood Pressure (GAP)

GAP is one of scoring systems which could be perfectly expectative way in-hospital mortality and it's also more practical than many other trauma scores which are used in the emergency department. For example, GAP was used to measure records of 13,463 trauma cases in a derivation data set defined by using via logistic regression. Some scoring systems that are Triage Revised Trauma Score, Revised Trauma Score, Trauma and Injury Severity Score were compared with GAP. The calculation of GAP scores included GCS score that was from 3 to 50 points, patients age were less than 60 years (three points) and SBP (> 120 mmHg, six points; 60 to 120 mmHg, four points). The c-statistics for the GAP scores (0.965 for short-term mortality and 0.933 for long-term mortality) were more superior than c other trauma systems. Moreover, GAP scoring was practical for determining the incidence of death (Kondo et al., 2011).

2.16- Logistic Organ Dysfunction Score.

The LOD has developed to support an impartial tool for measuring severity classifications for organ dysfunction in the ICU and likelihood of mortality (Le Gall et al ., 1996). In this study, LOD scores classifies from 1 to 3 points of organ dysfunction for 6 organ measures: hepatic, hematologic, renal, cardiovascular, neurologic and pulmonary. This is initially from 1 to 5 LOD points were allocated to the stages of severity. (Timsit et al., 2002) .It score was also affected way in measuring severity during the first day in ICU .

2.17- Simplified Acute Physiology Score (SAPS).

SAPS is one of trauma scoring systems which is widely seen in many hospitals nowadays. This technique uses for universal severity of disease and outcome prediction .It assesses acute age, pathophysiology, pre- and comorbidity, state at admission, and underlying disease. The underlying disease classification has a self-determining role for outcome of hospital dealing with severe patients (Schuster et al,. 1997). This technique is initially point for future assessment of the productivity of intensive care units (Le Gall et al., 1993).

3- Combined Anatomical and Physiological Score.

3.1 - Trauma Score-Injury Severity Score Methodology (TRISS)

Trauma and Injury Severity Score (TRISS) is a combination of anatomical and physiological scoring systems. It provides the probability of trauma survival base on a logarithmic regression as

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

where $$b = b_0 + b_1(RTS) + b_2(ISS) + b_3(AgeScore)$$
$$RTS = (0.9368\,GCS) + (0.7326\,BP_{sys}) + (0.2908\;RR)$$

The value of ISS is calculated as described previously and parameter AgeScore =0 if age <55 years and 1 if age > 55 years. The coefficients b0-b3 depend on the type of trauma as indicated in Table 6 (Siritongtaworn et al., 2009).

Table 6: The TRISS coefficients' values

Coefficient	Blunt trauma or age < 15 years	Penetrating trauma
b0	-1.247	-0.6029
b1	0.9544	1.1430
b2	-0.0768	-0.1516
b3	-1.9052	-2.6676

TRISS has been criticised as

• Its ability to predict moderately survival.

• It incorporates the problems associated with ISS.

• It cannot include tubed patients as respiration rate and verbal responses are not obtainable.

• It does not account for patients mix and thus making comparisons between trauma centres difficult (Siritongtaworn et al., 2009).

3.2- Drug-Rock Injury Severity Score (DRISS)

The Drug-Rock Injury Severity Score (DRISS) was introduced by emergency physicians and illustrates exactly how trauma severity scores can be advanced or adapted for new, specific situations. The DRISS is also one of a new combined trauma scoring system which was developed particularly to more accurately and powerfully triage injured patients at rock concerts. This Method is efficiently to compare medical resource which use at unlike measures. It uses values for intoxicants as a result of the high rate of drug/alcohol practise at rock concerts. While not yet validated, DRISS can be beneficial for categorising who are injured into the groups of those need more care , those who are carefully cured and released (Fani-Salek et al., 1999).

3.3- The Trauma Index (IT)

IT method usually uses to rapidly assess patients with severe trauma. It has assignment for injury severity which are (minimal injury= 1, moderate injury= 3 or 4 and severe injury= 6) and Parameters base on (regions, type of injury, cardiovascular status, central nervous system status and respiratory status). trauma index = (points for region + points for type of injury + points for cardiovascular status+ points for CNS status + points for respiratory status). Interpretation minimum score with trauma: 2, maximum score: 30 and scores >7 need admission to the hospital. But it has limitation of trauma index is not intended for burn patients (Medal Military Medicine 2010).

3.4- Harborview assessment for risk of mortality (HARM).

The HARM score is an effective tool for a predictive likelihood of in-hospital mortality for trauma patients (Al West et al ., 2000). This technique has consistently outperformed both ICD- 9-CM Injury Severity Score (ICISS) and the TRISS methods .Moreover, it esteems to both calibration and discrimination, using information that is readily accessible from hospital discharge coding, and without requiring ED physiologic records . In this study, The HARM was a superior appropriation of the authentication data (HL statistics = 21.37; p = 0.0315) than ICISS (HL = 712.4; p = 0.0005) and TRISS (HL = 59.54; p = <0.005). But HARM is to forecast survival on bases of factors established at time of injury itself.

3.5- A Severity Characterisation of Trauma (ASCOT).

In 1990 was introduced A Severity Characterisation of Trauma (ASCOT) (Champion et al .,1996). ASCOT was the following system improvement to evaluate the accuracy and minimizes the number of faults of TRISS. ASCOT is one of combined methods of injury severity relating emergency department admission parameters of Glasgow Coma Scale, systolic blood pressure, respiratory rate, age of patient, and AIS-85 anatomic injury scores by means of obviating ISS limitations. It is also more sensitivity than TRISS (69.3 vs. 64.3) and recognises the criterion for model standardisation (H-L statistic < 15.5) required for precise z and W scores .However, the TRISS does not encounter the calibration criterion (H-L = 30.7). In terms of adults with penetrating injury, ASCOT has a considerably lower H-L parameter than TRISS (20.3 vs. 138.4), but neither encounters the measurement.

3.6-Peadairic Trauma Score (PTS)

A Paediatric Trauma Score (PTS) is introduced as a combined method of a triage means and PTS was developed as a way of helping rapid precise assessment of the children who is injured in a routine that it can protect inclusive initial assessment. It is also a scoring system that it assesses base on six common determinants of clinical condition in the injured child. Each of the six determinants is assigned a scoring containment that -1 (major or immediate life-threatening injury), + 1 (minor or potentially major injury) or finally +2 (minimal or no injury). The arrangement of this method uses manner well-matched with typical advanced trauma life support procedure. Suitable diagnoses of the multiply injured child mandate is not only precise initial assessment, however also a gratefulness of those variances in pediatric physiology affecting potential morbidity (Tepas et al .,1987).

3.8 Triage Index (TI)

Trauma Score is familiarized as an index of injury severity for both alone and in combination with the Injury Severity Score (ISS), an anatomic index of injury severity and age of patient (Champion el at,. 1981). It uses tools for triage part and assessment of care of the trauma victim is proposed. TI is improved by state-of-the-art multivariate statistical techniques which enable it to deal with interval ranking scale and has been both assessed and validated for interuser reliability. TI is also expected as a validated mothed of early, rapid, non-invasive, precise patient assessment authorising suitable corresponding of trauma victims with accessible therapeutic resources in order to reduce morbidity and mortality (Champion el at,. 1980).

3.9 Admission base deficit, International Normalized Ratio and GCS (BIG).

BIG was developed by Borgman et al. in 2011. They retrospectively analyzed data from 2002 to 2009 and showed that base deficit, international normalized ratio (INR), and GCS (Glasgow Coma Scale) were correlated to mortality. These variables were formulated as [(base deficit + (INRx2.5) + (15-GCS)] in the BIG scale. This equation was then adapted to a formula predicting mortality (Sultanoğlu el at,. 2019). The pediatric trauma BIG score is a simple way that could be performed rapidly on admission to evaluate the severity of illness and predict mortality in children with traumatic injuries. The result of this study was acceptable in both penetrating-injury and blunt-injury populations and might have significant utility in comparing the severity of injury in future pediatric trauma research and quality-assurance studies. (Borgman el at,. 2011) In addition, this technique was useful to determine inclusion criteria on admission for prospective studies when accurately estimating the mortality for sample size calculation is required.

4- Artificial Intelligence base on Trauma Scoring Systems.

4.1- Artificial Neural Networks (ANN)

The brain is complex, nonlinear and parallel computer and Neural Networks has been introduced to lead computers to work like brain's computation which is different from digital computer's computation. Each Neural Network consists of small part that called neurons and connection between neurons. Each neuron has an action with regard to its input values and can be active or de-active. Therefore having a vast number of neurons in different layers helps neural networks to approximate any linear and nonlinear problem (Haykin 2009). Artificial Neural Network has multilayer perceptron (MLPs) by this way it can create ANN model systems (Pearl et al., 2008). ANN process has two phases; the forward pass, where calculations outputs corresponding to assumed inputs are measured, and the backward pass, where some derivatives are disseminated back through the network. To prognostic models to remove GCS scores from calculations in mortality forecast. By using ANNs the result of prediction has become progressively widespread in physiological indices. Mathematical models constructed on the base of organic neural structures, these ANNs are supple systems which are gradually used in prognostic part which can give the ability of the ANN to learn and increase the chain instruction of variation gives very similar computational instructions for the backward pass as the ones in the forward pass. The model was developed according to the last constructed for analysis of SMC data for eight input parameters which are systolic blood pressure, respiratory rate and mGCS components as verified at Scene. Age parameters were encoded. Pulse was lost from the USA National Trauma Data Bank (NTDB) dataset, consequently only seven input variables were used for this model. ANN Analysis of model design was by contrast of the performance in mortality and survival prediction. The factors considered by the ANN were used to compute the likelihood of survival base on the following equation.

$$Psurvival = 1-1/ (1 + e^{b})$$

Where b is computed from:

b= b1(lowRR)+b2(RR)+b3(SBP)+b4(lowsbp)+b5

(OCmd)+b6(3rdAge)+b7(PedAge)

To determine the possibility of survival (mortality forecast) the parameters, recognised as PDT, were at that time plotted in an ROC graph for contrast by model and with typical scores of trauma outcome measurement. Original design started by 5 neurons in the hidden layer. The best performing models were identified by their Gini co-efficient and ability to correctly predict mortality. The training sets were compared in each design case to their test set, and found to be identical in Gini co-efficient and performance. Further studies might need to be conducted to classify if population cohort size affects the capability of NN to forecast mortality, and that designs of systems on minor as well as huge a population dataset cover significant trends (Pearl et al., 2008).

4.2- Fuzzy Logic (FL)

Fuzzy logic is a computational model that makes available a mathematical tool for representing and manipulating information in way that it is similar to human communication and intellectual processes (Allen and Smith 2001 ; Güler and Barisci 2002 ; Elkfafi et al ., 1997). This method is a useful way to define and forecast the type of cardiac diseases and depth of anaesthesia .FL was used in a new diagnostic system for classifying the severity of traumatic brain injuries by using fuzzy logic technology. With 26 traumatic brain injuries in unlike gender and age that they were taken in the case study. Trauma, Glasgow coma scores and Electroencephalography were used for assessing the system. They found a reasonable agreement between the results of neurologists and systems outputs for normal, serious and maximum electroencephalogram tracing data (EEG TD).Therefore, obtaining this system in routine may be simplifying to make a fast and positive decision to classifying the severity of trauma in these groups (Güler et al ., 2008).

4.3- Genetic Algorithm(GA)

Genetic algorithm is more useful technique than several common search algorithms (Kentala et al., 1999). It has also extensibility, conceptual simplicity, broad applicability, robustness and the possible to hybridize with other means. In medicinal field, GA also has been used in many parts such as perfecting the immune system and identifying one at risk of coronary artery disease. The genetic algorithm maintains a population of candidate rules from which it chooses the best to create the new generation. The fitness of a rule is that it computes from the negative regularity and positive completeness which covers of the rule in a learning set and by the difficulty of the rule. The highest fitness is given to a rule that covers all positive and none of the negative samples with a smallest number of conditions. A minor number of cases (traditionally 30%) is shut out from the learning set and located in a testing set to create the evaluation of the outcomes objective. Precision detects how fits the undetected cases with the disease in request are selected by the rule and how many untrue positives (patients without the disease) are categorised into the disease group. This facility makes it probable to discover the rule and validate its strength. But it is sometimes problematic for an expert to examine rules due to the large number of conditions (Kentala et al., 1999).

4.3 Iterative Random Comparison Classification (IRCC)

IRCC method was used for determining the probability of survival (Ps) in trauma injury. It was implemented as a novel technique to examine in trauma brain damage (TBI) for people who (survivors and non-survivors) to predict the probability of survival. The result of IRCC in determining Ps in TBI was compared to two existing techniques. The first was Ps14 technique and the second was predictive statistical diagnosis PSD, which relied on Bayesian statistics. The number of cases is 4124 adult cases in the TBI database (mean age 67.9 years, standard deviation 21.6), with 3553 (86.2%) survivors and 571 (13.8%) non-survivors. Ps was determined with an accuracy of 79.0 and 71.4 present for survivors and not survivors, respectively, whereas Ps14 was 97.4 percent (survivors) and 40.2 percent (not survivors) and PSD was 90.8 percent (survivors) and 50 percent (not survivors) (not survivors). With a sufficient database, IRCC could be useful for determining Ps in TBI and other traumas.

Conclusion

Several injury severity scores have been established over the past 30 years. It is clear that currently there is no commonly satisfactory and appropriate scoring system that taking into account all the issues of trauma requirements. However, with improved injury description using some severity scores such as GCS or AIS .They are now a more reliable and available, which has made our ability to predict outcome more systematic. Moreover, these techniques are suitable to work in conjunction as a beginning for probabilistic models for a diversity of scientific requests. In this article we discussed fourth types of trauma scoring systems and explains Artificial Intelligence base on Trauma Scoring Systems as a new technique. Until such a system is constructed,
one should be aware of use of the existing trauma-scoring systems.

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