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Probability of Survival Scores in Different Trauma Registries: A Systematic Review

Bogdan Stoica[1], Sorin Paun[1,2], Ioan Tanase[1], Ionut Negoi[1,2], Alexandru Chiotoroiu[1], Mircea Beuran[1,2]

[1]Emergency Hospital of Bucharest, Romania
[2]Carol Davila University of Medicine and Pharmacy Bucharest, Romania

Rezumat

Scoruri de probabilitate a supraviețuirii în diferite registre de traumă: review sistematic

Introducere: Scorul mixt pentru a prezice probabilitatea supraviețuirii are un rol cheie în sistemele de traumă moderne. Scopul studiului actual este de a rezuma cunoștințele actuale cu privire la estimarea supraviețuirii pacienților sever lezionați în diferite registre de traumă.
Metoda: Review sistematic al literaturii folosind căutarea computerizată în baza de date PubMed/Medline, Web of Science, și EBSCO. Am folosit ca și cuvinte cheie de căutare ("trauma", "probability of survival", and "mixed scores"). Strategia de căutare în PubMed a fost: ((((trauma(MeSH Major Topic)) OR injury(Title/Abstract)) AND score(Title/Abstract)) AND survival) AND registry (Title/Abstract)))). Am folosit ca sursă doar literatura de limbă engleză.
Rezultate: Nu există un consens între principalele registre de traumă, în ceea ce privește probabilitatea estimării supraviețuirii la pacienții cu traume majore. Scorurile registrului de traumă german (RISC II) și englez (PS model 14), se bazează pe cea mai mare populație, cu datele demografice actualizate la modelul lezional European. Scorul TRISS revizuit rezultat din USA National Trauma Database, pare a fi inexact pentru sistemele de traumă care îngrijesc predominant leziuni penetrante.
Concluzii: Probabilitatea de supraviețuire ar trebui să fie evaluată la toți pacienții cu traumatisme majore, cu un scor derivat dintr-o populație care reproduce datele demografice actuale. Numai un audit atent al deceselor neașteptate poate îmbunătăți continuu îngrijirea pacienților grav răniți.

Cuvinte cheie: scoruri traumatice, probabilitatea supraviețuirii, registrul de traumă

Abstract
Introduction: A mixed score to predict the probability of survival has a key role in the modern trauma systems. The aim of the current studies is to summarize the current knowledge about estimation of survival in major trauma patients, in different trauma registries.
Method: Systematic review of the literature using electronic search in the PubMed/Medline, Web of Science Core Collection and EBSCO databases. We have used as a MeSH or truncated words a combination of "trauma", "probability of survival", and "mixed scores". The search strategy in PubMed was: "((((trauma(MeSH Major Topic)) OR injury(Title/Abstract)) AND score (Title/Abstract)) AND survival) AND registry (Title/Abstract))))". We used as a language selection only English language literature.
Results: There is no consensus between the major trauma registries, regarding probability of survival estimation in major trauma patients. The German (RISC II), United Kingdom (PS Model 14) trauma registries scores are based of the largest population, with demographics updated to the nowadays European injury pattern. The revised TRISS, resulting from the USA National Trauma Database, seems to be inaccurate for trauma systems managing predominantly blunt injuries.

Corresponding author: Bogdan Stoica, MD
General Surgery Department
Emergency Hospital of Bucharest, Romania
No 8 Floreasca Street, Sect 1, 014461
E-mail: stoicabogdan85@yahoo.com

Conclusions: The probability of survival should be evaluated in all major trauma patients, with a score derived from a population which reproduce the current demographics.Only a careful audit of the unpredicted deaths may continuously improve our care for severely injured patients.

Key words: trauma scores, probability of survival, trauma registry

Introduction

Polytrauma is a term used frequently in the European trauma literature and typically, it defines a situation of simultaneous injuries involving a threat to life (1). In opposite, in the Anglo-American literature the term is rarely used. In the Anglo-American concept, the polytrauma it is generally defined by a nominated injury severity score and the terms used are "major trauma" and "multiple trauma" (2).

The management of a polytrauma is highly resource consuming, often involving massive resuscitation efforts, extensive imaging, multiple operations, extended intensive care unit (ICU) stay and complex rehabilitation programmes (3).

Moreover, wherever a severe trauma happens, it has serious consequences for the victims. The statistics show a high mortality rate, or in case of survivors, long lasting physical and mental problems. Many of the trauma victims are young people, and the accident affects their role in society, work, and families, therefore, severe trauma was turned into a serious public health problem. Decreasing the mortality and morbidity in severe trauma cases by improving the quality of care, has become an objective for health care providers.

Method

Systematic review of the literature using electronic search in the PubMed/Medline, Web of Science Core Collection and EBSCO databases. We have used as a MeSH or tuncated words a combination of "trauma", "probability of survival", and "mixed scores". The search strategy in PubMed was: "((((trauma [MeSH Major Topic]) OR injury (Title/Abstract) AND score (Title/Abstract) AND survival) AND registry (Title/Abstract))))". We used as a language selection only English language literature.

Results

Between hospitals from different part of the world, the benchmarking process and monitoring of traumatic injury outcome over time are possible, by routinely using of trauma scoring systems. The severity of injury is converted into a number based on a trauma-scoring system. In this way, worldwide clinicians can speak a common language in terms of quality-assurance and quality-control programmes (4-6). All scores have one purpose in common: the reduction of a complex clinical situation into a one-dimensional value by an impartial evaluation and combination of different clinical aspects (7). The overabundance of available scoring systems for trauma (8, 9)indicatethat an universally applicable system should be developed, but this objective may be difficult to reach. In addition, the scoring system must be able to predict various outcomes in different populations, therefore the development of a system that summarise the severity of different injuries in one patient using a single number, becomes a complex task.

Trauma registries have an important contribution to improve the quality of taking care of traumas and also in scientific research where classical randomized trials are difficult to perform. For achieving these objectives it is absolutely necessary to be able to accurately describe injury severity, or the risk of death, on an individual basis. Susan Baker, who published the Injury Severity Score (ISS) which is a cornerstone of injury in epidemiology says: 'If you have never felt the need for any type of severity scoring system, then you probably have never had to explain how it is that survival rate of 85% in your trauma center is actually better than the survival rate of 97% in some other hospital where the patients are much less seriously injured (10). For developing countries, the improvements concerning the treatment of multi-traumatized people, depend on performant trauma systems, trauma registries being part of the systems infrastructure. (11).

For physicians and also for researchers, scaling the severity of injury predicting the clinical outcome in a victim, are extremely important findings. Many risk scoring systems have been developed and validated to estimate risk in trauma patients, over the past 30 years (12, 13). Many of the scoring systems, involve the injury severity score (ISS), which is strictly based on anatomic injury (14), the revised trauma score (RTS), which is based on physiological variables (15), and a combination of ISS and RTS with patient age – trauma and injury severity score (TRISS) (16). In the field of trauma, between these systems, TRISS is known as the worldwide standard for prediction of outcomes (17).

Trauma scores are not used only for prediction, but also for triage. For example, the Revised Trauma Score has two versions: a triage version that is used for prehospital stage and a prediction version used during hospitalization which predicts the mortality (18, 19). Mortality related to trauma is determined by factors as injury severity, age, sex, mechanism of injury, quality of health care provided, but also co-morbidities (20, 21). Evaluation of injured patients is made using several trauma scores. Scoring systems are classified into physiologic, anatomic, and combined anatomic with physiologic. (19). Several developed systems exist, but there is no agreement on which is the best for mortality prediction. An evaluation of the epidemiology of trauma death, was made by Sauaia, who concluded that injuries to central nervous system (CNS) represent the most frequent cause of death (42%), succeeded by exsanguination (39%) (22).

The Injury Severity Score (ISS) is an anatomical score, derived from the Abbreviated Injury Scale (AIS). In 1974, Susan Baker described for the first time, the 6 body areas to which it concerns: head and neck, face, chest, abdomen, pelvis and extremities, skin. Each injury receives an AIS of 0-

5, with the following signification: 0 for being uninjured, 1 for trivial/minor, until 5 which is extremely severe The ISS is converted from AIS, as the sum of the square of the three highest-scoring injuries, from three highest-scoring body regions (i.e. it is included only one injury per body region). In consequence, the ISS has values from 0 to a maximum of 75. In common use, a "major trauma" has an ISS of 16, while a "massive trauma" has an ISS higher than 40.

NISS was developed by Osler et al., in order to overcome the limitations of the ISS (23). NISS is defined as the sum of squares of the highest three AIS scores, but regardless of the body region in which the injuries occur.

According to most of the studies, NISS is superior to ISS for evaluating injured patients (21, 24-26), but some studies have shown that they have similar accuracy (27). In any case, the most widely worldwide used score is ISS(26).

Searching in different trauma systems we found that not all of these are using the same probability of survival scores.

The TraumaRegister from Germany, named DGU (TR-DGU), includes patients from about 108 trauma units, being a prospective multicenter database. Patients with severe trauma, who need intensive care, are manage based on standardized documentation, leading to a detailed registry with demographical, clinical and laboratory data.

In order to estimate patients prognosis, the TraumaRegister DGU® uses since 2003 RISC (Revised Injury Severity Classification). In 2013, it was developed a new version, RISC II using data from 2010 and 2011, from more than 30,000 patients. In the beginning, TR-DGU used the TRISS score to adjust the results, which was based on data from the Major Trauma Outcome Study (MTOS), but at this moment they use RISC II. This score was validated in 2012 (28). Revised Injury Severity Classification (RISC) was the first score, that included values from the initial laboratory tests (base deficit, hemoglobin, partial thromboplastin time) and also it included interventions (cardiopulmonary resuscitation (CPR) (29). The final pattern of RISC II included the following variables: worst injury, second-worst injury, head injury, sex, age, ASA score, pupil size, pupil reactivity, motor function, mechanism of injury, blood pressure, coagulation - INR level, haemoglobin level, acidosis - base deficit and CPR (*Table 1*). It was demonstrated that RISC II it is better than the other scores, in a study made by Lefering and colab, ROC curve showing a significant improvement. (28).

American Trauma Society used TRISS, formulated originally in 1983. The scores variables are a weighted combination of patient age, Injury Severity Score (ISS), Revised Trauma Score (RTS - derived from GCS score, systolic blood pressure and respiratory rate) and injury mechanism. The score is used to estimate a patient's probability of survival following traumatic injury (*Table 2*).

In 1987, logistic regression models were used to estimate TRISS coefficients (16). In 1995, it was revised with the help of the American College of Surgeons Committee on Trauma coordinated Major Trauma Outcome Study (MTOS) database (30). TRISS coefficients were further revised using data obtained from the American College of Surgeons Committee on Trauma National Trauma Data Bank (NTDB) and the NTDB National Sample Project (NSP), in 2010(31).

TRISS has become the international standard and the method for evaluation of the quality of treatment in traumatology most widely used, but even so, it has several imperfections (32). An argument is that patient groups can be very heterogeneous, even with the same ISS (a variable of TRISS), since ISS considers only one injury from every injured region, therefore undervalue patients with multiple injuries in the same body area. Cayten et al. (33)demonstrated that in patients with low-energy injuries, the RTS, a measure of physiological state (and another variable of TRISS), is completely unsuccessful. More than this, TRISS underestimates

Table 1. *Variables included in RISC II*

Variable	Explication
Worst injury, second-worst injury	AIS injury severity level; if the first injury is labeled, the second injury is noted 0
Head injury	AIS injury severity level of the body region ‘head' as defined for the ISS score
Age	Age in years
Sex	Males/females
ASA	Pre-trauma ASA (American Society of Anesthesiologists) score
Pupil reactivity	Brisk, sluggish, and none. The first pre-hospital assessment is used; if missing assessment on admission is used (41)
Pupil size	Normal, anisocoria, and bilateral dilated. The first pre-hospital assessment was used; if missing assessment on admission is used (41)
Motor function	The motor function was derived from the Glasgow Coma Store (GCS) motor score; The first pre-hospital assessment is used if available; if missing assessment on admission was used in non-intubated cases
Mechanism	Blunt or penetrating mechanism of injury
Blood pressure	Systolic blood pressure (mmHg), first measurement after admission; in case of missing values the first pre-hospital measurement was used
Coagulation: INR	International normalized ratio (INR); first measurement after admission
Acidosis: base deficit	Base deficit, or base excess (mEq/l); first measurement after admission
Blood: haemoglobin	Haemoglobin (g/dl); first measurement after admission
CPR	Cardiopulmonary resuscitation (CPR), performed pre-hospitally in case of cardiac arrest (not in the emergency room)

Table 2. *TRISS variables*

1	ISS (Injury Severity Score)
2	Age
3	Injury mechanism (blunt/penetrating)
4	RTS (Revised Trauma Score)

the effects of age and head injuries and it does not take into consideration conditions previous to injury (34). TRISS can fail to determine a correct classification, in 15-30% of such patients (35).

Different from TRISS, RISC uses more detailed variables regarding age (> 55, > 65 or > 75 years) and takes into consideration the severity of the injury, measured by the anatomical New Injury Severity Score. In addition, it considers more serious head and pelvic injuries with bleeding, laboratory investigations (base excess and activated partial thromboplastin time), reanimation before arrival at hospital and indirect signs of bleeding (low haemoglobin values, low systolic blood pressure and massive transfusion)(36).

RISC has demonstrated its efficacy, during evaluation, offering correct results, in imperfections attributed to TRISS. This goal was achieved by considering all major injuries (not just the single most severe injury in a region), taking in consideration severe head injuries and having a more objective appreciation of the physiological state of the patient (37).

In 1989, it was created TARN score, first declined from the US major trauma outcome study, becoming after that the UK major trauma outcome study, developed with funds from a central government grant. In 2014, it was applied by 100% of trauma receiving hospitals in NHS England and 100% in Wales, almost all Republic of Ireland and some hospitals in continental Europe (38).

In 2006, based on data from the UK Trauma Audit and Research Network (TARN), it was published a new survival prediction pattern, by Bouamra and colleagues (39). TARN used TRISS as a score to predict outcome, since 1989, in the beginning with the MTOS 1990 coefficients and later with UK TARN derived from TRISS. Anyway, with the TRISS method, a large amount of data was lost. In the PS09 model, the prediction-model coefficients have been reconsidered on recent data: the model still includes all those subsets by using age, a transformation of ISS, GCS, gender and Gender × Age interaction as predictors (40).

For each injured patient, it is calculated a probability of survival (PS), which is saved in TARN database. In 1984 the Probability of Survival (PS) of each patient was determined based on Revised Trauma Score, Injury Severity Score, age and method of injury (blunt or penetrating). This was known as the TRISS model. In 2004, TARN launches a new PS logistic regression model, calculated from age, gender, Injury Severity Score (ISS) and Glasgow Coma Score (GCS). Wherever GCS is missing, it means that intubation was used instead. Each component of the model, produced a weighting derived from retrospective analysis of the TARN database. During 2014, there were recalculated the coefficients once more and the model was updated, by adding comorbidities of patients, resulting PS model 14. (*Table 3*)

Table 3. *PS Model 14 variables*

1	ISS (Injury Severity Score)
2	GCS (Glasgow Coma Score)
3	Intubation
4	Gender (Male/Female)
5	Age
6	Charlson comorbidity index for pre-existing medical conditions

Conclusions

There is no consensus between the major trauma registries, regarding probability of survival estimation in major trauma patients. The German, United Kingdom trauma registries scores are based of the largest population, with demographics updated to the nowadays European injury pattern. The revised TRISS, resulting from the USA National Trauma Database, seems to be inaccurate for trauma systems managing predominantly blunt injuries.

Conflict of interest: none

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