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ORIGINAL

Prediction of massive bleeding. Shock index and modified shock index☆

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KEYWORDS
Massive bleeding;
Massive transfusion;
Shock index;
Modified shock index;
Injury severity score;
Revised trauma score

Abstract
Objective: To determine the predictive value of the shock index and modified shock index in patients with massive bleeding due to severe trauma.
Design: Retrospective cohort.
Setting: Severe trauma patient's initial attention at the intensive care unit of a tertiary hospital.
Subjects: Patients older than 14 years that were admitted to the hospital with severe trauma (injury severity score >15) form January 2014 to December 2015.
Variables: We studied the sensitivity (Se), specificity (Sp), positive and negative predictive value (PV+ and PV−), positive and negative likelihood ratio (LR+ and LR−), ROC curves (receiver operating characteristics) and the area under the same (AUROC) for prediction of massive hemorrhage.
Results: 287 patients were included, 76.31% (219) were male, mean age was 43.36 (±17.71) years and ISS was 26 (interquartile range [IQR]: 21–34). The overall frequency of massive bleeding was 8.71% (25). For shock index: AUROC was 0.89 (95% confidence intervals [CI] 0.84–0.94), with an optimal cutoff at 1.11, Se was 91.3% (95% CI: 73.2–97.58) and Sp was 79.69% (95% CI: 74.34–84.16). For the modified shock index: AUROC was 0.90 (95% CI: 0.86–0.95), with an optimal cutoff at 1.46, Se was 95.65% (95% CI: 79.01–99.23) and Sp was 75.78% (95% CI: 70.18–80.62).
Conclusion: Shock index and modified shock index are good predictors of massive bleeding and could be easily incorporated to the initial workup of patients with severe trauma.

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PALABRAS CLAVE
Hemorragia masiva;
Transfusión masiva;
Índice de shock;
Índice de shock modificado;
Escala de severidad del trauma;
Escala de trauma revisado

Predicción de hemorragia masiva. Índice de shock e índice de shock modificado

Resumen
Objetivo: Determinar la capacidad de predicción del índice de shock y del índice de shock modificado para hemorragia masiva tras sufrir un trauma grave.
Diseño: Cohorte retrospectiva.
Ámbito: Atención inicial hospitalaria al paciente con enfermedad traumática grave en una unidad de cuidados intensivos de trauma de un hospital terciario.
Sujetos: Pacientes mayores de 14 años con trauma grave (*injury severity score* [ISS] > 15), admitidos de forma consecutiva desde enero de 2014 hasta diciembre de 2015.
Variables: Se estudiaron sensibilidad (Se), especificidad (Sp), valores predictivos positivo y negativo (VP+ y VP−), razones de verosimilitud positiva y negativa (RV+ y RV−), curvas ROC *(receiver operating characteristics)* y el área bajo las mismas (AUROC) para predicción de hemorragia masiva.
Resultados: Se incluyeron 287 pacientes, el 76,31% (219) fueron varones, con una edad media de 43,36 (± 17,71) e ISS de 26 (rango intercuartil [RIC]: 21-34). La frecuencia global de hemorragia masiva fue de 8,71% (25). Para el índice de shock se obtuvo: AUROC de 0,89 (intervalo de confianza [IC] 95%: 0,84-0,94), con un punto de corte óptimo en 1,11, Se del 91,3% (IC 95%: 73,2-97,58) y Sp del 79,69% (IC 95%: 74,34-84,16). Para el índice de shock modificado se obtuvo: AUROC de 0,90 (IC 95%: 0,86-0,95), con un punto de corte óptimo en 1,46, Se del 95,65% (IC 95%: 79,01-99,23) y Sp del 75,78% (IC 95%: 70,18-80,62).
Conclusiones: El índice de shock y el índice de shock modificado son buenos predictores de hemorragia masiva y de fácil aplicación durante la atención inicial del trauma grave.

Introduction

Hemorrhagic shock is the leading cause of avoidable mortality following severe trauma. Its early identification remains a challenge both out and in hospital—a fact that results in deficient diagnosis and inappropriate patient transfer.[1,2]

The early diagnosis of hemorrhagic shock is essential to improve the outcomes after trauma and control bleeding. Early and precise prediction of hemorrhagic shock makes it possible to adequately prepare the initial patient management team, with prompt activation of the massive bleeding protocol (MBP).[3–5]

Retrospective studies analyze different predictive indices, assessing their capacity to diagnose massive bleeding (MB). These indices are difficult to implement, however: their determination requires laboratory test results and imaging data that are very time consuming and difficult to perform at out-hospital level.[6]

On the other hand, simple clinical parameters such as heart rate or arterial pressure have been shown to be inexact in predicting MB.[7–9]

The shock index (SI), defined as heart rate divided by systolic blood pressure, and the modified shock index (MSI), defined as heart rate divided by mean blood pressure, are simple and easy to apply, and have therefore been studied by a number of authors.

Different studies have shown that a high SI after severe trauma is associated to high mortality[10–12] and to the severity of injury.[13] The SI has also been used as a predictor of days on mechanical ventilation and of hospital stay,[14] as well as of the probability of admission to critical care.[15] Lastly, some authors have related SI to the need for blood transfusion and hemostatic intervention.[16] Less is known of its capacity to predict MB, however.

The present study was carried out to determine the capacity of SI and MSI to define the optimum cutoff point in patients who have suffered severe trauma.

Design and methods

A retrospective cohort study involving the consecutive inclusion of all patients was carried out in the trauma and emergencies intensive care unit (ICU) of a tertiary hospital. We included patients over 14 years of age with severe trauma (injury severity score [ISS] >15) in which initial management took place upon arrival in hospital. The study patients were admitted between January 2014 and December 2015 (excluding individuals with cardiorespiratory arrest in out-hospital care, spinal cord injury, the use of heart rate-regulating drugs, and initial resuscitation performed in another center). Initial trauma care is provided by a specialized team composed of two intensivists (staff physician and resident), two nurses, a clinical assistant and two hospital attendants. The team can also consult different specialists related to trauma care. Management is carried out following the Advanced Trauma Life Support (ATLS) guidelines. The hospital has a MBP that has been approved by the transfusions commission and by hospital management.

The data were collected with masking of the observer: demographic variables (age and gender), physiological parameters (first recorded heart rate, systolic and diastolic blood pressure after arrival in hospital—initial resuscitation area of the ICU); laboratory test parameters (arterial blood gases—pH, base excess [BE], lactic acid) and prognostic