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## Shock index as a mortality predictor in patients with acute polytrauma

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## ABSTRACT

**Objective:** To evaluate whether the shock index (SI), given by the formula  $SI = \text{heart rate}/\text{systolic blood pressure}$  (HR/SBP), is useful for predicting mortality at 24 h in trauma patients admitted to the emergency department of a university hospital in Colombia.

**Methods:** A database of trauma patients admitted between January 2013 and December 2013 was constructed; the result according to the shock index was determined, generating a dichotomous variable with two groups: Group A ( $SI < 0.9$ ) and Group B ( $SI > 0.9$ ). Univariate analysis was performed.

**Results:** A total of 666 patients were analyzed, 83.3% (555) had  $SI < 0.9$ , and 16.7% (111)  $SI > 0.9$ . The mean age for Groups A and B was 32.4 and 35.4 respectively. The average injury severity score for both groups was 9.6 and 17.6 respectively. Mortality at 24 h after injury for both groups was 3.1% ( $P = 0.032$ ) and 59.5% ( $P = 0.027$ ) respectively.

**Conclusions:** An initial shock index greater than 0.9 implies a worse prognosis 24 h after injury. The shock index predicts mortality in multiple trauma patients in the emergency department, and is also a quick and applicable in all hospital.

## 1. Introduction

Trauma is a global health problem, causing around 5 million deaths per year<sup>[1,2]</sup>. A study published by the World Health Organization about trauma, defines it as an important cause of DALY's, more pronounced in Latin American countries as Colombia<sup>[3,4]</sup>, where young, economically active man are the most affected<sup>[4]</sup>.

Vital signs such as heart rate, blood pressure and respiratory rate have been used by different groups of trauma to detect the early abnormalities (different trauma groups, for the early detection of abnormalities), and according to these findings follow some predestinated (predestined, predetermined) conducts<sup>[5–7]</sup>.

The shock index (SI) is obtained from the ratio between heart rate and systolic blood pressure (HR/SBP). It's a physiological score that can guide in the prehospital and initial emergency care

to determine the severity of the trauma, and also to detect an early hemorrhagic shock<sup>[8,9]</sup>.

The aim of this study is to evaluate whether or not the shock index is useful to predict mortality at 24 h of trauma in patients admitted to the emergency department, in a Colombian university hospital.

## 2. Materials and methods

## 2.1. Design

This is an observational, retrospective cohort study of trauma patients admitted to the emergency room of the University Neiva Hospital (NUH) from January 2013 to December 2013 in which we applied the index of shock on each patient in the admission.

The variables were evaluated, and the result according to the rate of shock was determined by generating two groups: Group A ( $SI < 0.9$ ) and Group B ( $SI > 0.9$ ).

## 2.2. Patient population

NUH is a level 1 hospital that counts with 504 beds and an important trauma center of reference for the region. NUH admits

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approximately 2000 adult trauma patients per year and has 30 adult intensive care unit beds. The hospital is the primary trauma center for 3.2 million inhabitants living in an area extending over 60000 square miles. Its radius of care extends far into the Amazonian region, where the most intense fighting between rebel groups, cocaine traffickers and government forces has taken place for over 40 years.

### 2.3. Inclusion and exclusion criteria

We have included in the study those trauma patients admitted to the institution with shock index taken during admission. We excluded from the study patients younger than 18 years, patients with history of hypertension, metabolic syndrome, and patients older than 50 years.

### 2.4. Data collection and statistical analysis

The method used for data collection was direct observational non-participatory. We performed a review of medical records, and then filled a form with epidemiological, clinical and social data. The results obtained in the study were stored and analyzed by a statistical software version 2.15.2 R online; Measures of central tendency and dispersion for continuous variables were calculated. A student *t*-test was used to compare continuous variables, and Pearson *Chi*-square was used to compare categorical variables. Statistical significance was defined with a  $P \leq 0.05$ .

## 3. Results

In total 666 patients were analyzed. From those patients we observed 83.3% of them (555) with  $SI < 0.9$ , and 16.7% of them (111) with  $SI > 0.9$ ; according this difference we created two groups, Group A with  $SI < 0.9$ , and Group B with  $SI > 0.9$ . The mean ages for both groups were 32.4 years and 35.4 respectively, and around 73% and 86% of the patients of Groups A and B were man, the other 27% and 14% were woman (Table 1).

The ISS of the Group A had a median 9.6, and 17.6 for the Group B (Table 1). Lactate instead was 3.49 mg/dL for group B and 1.79 mg/dL for Group A (Table 2). Penetrating trauma was founded in 59% of patients in Group B, and 15% in Group A. Closed trauma was observed in 84% of patients in Group A, and

**Table 1**

Clinical and sociodemographic characteristics of trauma patients admitted to the HUN.

Variable	Group A (n = 555)	Group B (n = 111)	P < 0.05
Sex			
Male	405 (72.9%)	96 (86.4%)	0.023 4
Female	150 (27.1%)	15 (13.6%)	
Age (Years)			
Media (mean ± SD)	32.40 ± 14.20	35.40 ± 16.05	NS
Range	(18–50)	(18–50)	
ISS			
Median (mean ± SD)	9.60 ± 3.96	17.60 ± 11.10	0.0029

Source: Database of patients from HUN; ISS: Injury severity score; NS: Not significant.

**Table 2**

Mechanism of trauma and correlation of lactate trauma patients admitted to the HUN.

Variable	Group A (n = 555)	Group B (n = 111)	P < 0.05
Mechanism of trauma			
Closed	470 (84.7%)	52 (46.8%)	0.032
Open (penetrating)	85 (15.3%)	59 (53.2%)	
Lactate			
Media	1.79	3.49	0.037 8
Range	(0.7–2.3)	(0.9–5.0)	

Source: Database of patients from the HUN.

**Table 3**

Diagnosis and outcome of trauma patients admitted to the HUN.

Variable	Group A (n = 555)	Group B (n = 111)	P < 0.05
Result			
Alive	538 (96.9%)	45 (40.5%)	
Death	17 (3.1%)	66 (59.5%)	0.032
Diagnosis			
Polytrauma	200 (36.0%)	69 (62.2%)	0.045
Thorax trauma	166 (30.0%)	28 (25.2%)	NS
Abdominal trauma	28 (5.0%)	2 (1.8%)	NS
Cranioencephalic trauma	111 (20.0%)	10 (9.0%)	NS
Orthopedic trauma	50 (9.0%)	2 (1.8%)	NS

Source: Database of patients from the HUN; NS: Not significant.

46% in Group B (Table 3). Two diagnoses were found to be higher in both groups, but with differences in prevalence. In Group A polytrauma had a prevalence of 36%, and in Group B a prevalence of 62%; thorax trauma had a prevalence of 30% in Group A, and 25% in Group B. As an end result we found a prevalence of mortality of 59% in Group B, and 3% in Group A (Table 3).

## 4. Discussion

The trauma is still and will continue to be a public health problem for the world population in the foreseeable future. According to international protocols in the management of trauma such as the ATLS, there is little to no research investment regarding promotion and prevention (just 4 cents for every dollar invested)<sup>[8–10]</sup>.

This situation in developing countries like ours, where pre-hospital care is just beginning to professionalize and management guidelines are beginning to spread, simple scores as the SI are easy to use and apply in both pre-hospital and hospital setting<sup>[11–13]</sup>. At the University Hospital of Neiva, located in Southwestern Colombia, we receive on average 200 patients a month with some kind of trauma, of which 40% suffers severe trauma<sup>[14,15]</sup>.

Evaluating the results of our study and compared with international results, we see that being a male is a risk factor to suffer some sort of trauma. This was already described by World Health Organization in its different newsletters, in which confounding factors such as being older than fifty, and the presence of comorbidities such as hypertension or metabolic syndrome were removed<sup>[15,16]</sup>. Another correlation that we found is between SI greater than 0.9 with ISS greater than 16, and the presence of

multiple trauma and elevated lactate, mortality, and we compared with the available literature.

Patients with ISS higher than 16 tend to have an SI greater than 0.9 ( $P = 0.029$ ). This was also noted with the presence of multiple trauma and an SI greater than 0.9. In the literature, McNab *et al.* have already described that the ISS has a correlation with the level of SI, like we found in our study, explaining this correlation as a severity indicator<sup>[17]</sup>. Lactate was found to be correlated with SI greater than 0.9 ( $P = 0.037$  8). In the various citations we reviewed, we found no relationship between these two variables<sup>[17–19]</sup>.

In our institution, mortality also showed correlation with an SI greater than 0.9; it appears as a mortality predictor at 24 h from trauma ( $P = 0.032$ ). Choi *et al.*, Berger *et al.*, and Bruijns *et al.*<sup>[19–21]</sup> showed in different series with larger populations that the use of indices, as the SI, is very useful to do a better triage, ending in better outcomes for the patients<sup>[22]</sup>.

We consider the limitations of our study as a retrospective observational study, whose sample compared with the various international series seems to be small, but significant for our Colombian population, and have allowed us to draw interesting conclusions to apply in our own casuistry.

SI is an easy, fast, inexpensive, and secure tool that can be used in the prehospital and hospital stages to determine severity and predict mortality at 24 h of trauma in patients.

### Conflict of interest statement

The authors report no conflict of interest.

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