Original Paper

The Predictive Value of Scores Used in Intensive Care Unit for Burn Patients Prognostic

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ABSTRACT: *Purpose:* Statistical evaluation of the prognosis of burned patients based on the analysis of prognostic scores as quickly and easily obtainable that track the evolution of burned patient in ICU. *Material / Methods*: The prospective study included 92 patients were performed with severe burns on 35-67% body surface large area, aiming to establish a cut-off score for each studied and statistically significant prognostic parameter for assessing the risk of mortality. The control group was represented by 20 patients with burns on the body surface of <10%. *Results:* The death rate was not statistically significant on burned (p> 0.05) sex (male / female), but we had p <0.001 when we referred to the total body surface area, and p <0.05 when we took into account the degree burns, acute respiratory distress syndrome and age. For each index / prognostic score studied by making ROC curve when they take different values, we set a cut-off. Quantification of variables by calculating the area under the ROC curve (AUC), sensitivity and sensitivity, positive predictive value (PPV) and negative predictive value (NPV), allowed a better appreciation of these prognostic scores. *Conclusions*: These systems applicable to the burned patient scores, making a cut-off of each index / mortality probability score, he can manifest usefulness in medical decision making process and strategy to reduce the risk of death in patients with severe burns.

KEYWORDS: *burns, mortality prediction, ICU prognosis scores*

Introduction

Burns remain an important cause of morbidity and mortality worldwide and ranks among the most expensive traumatic injuries because of the long duration of hospitalization and rehabilitation [1].

Technical progress around the world have greatly improved the qualitative aspect of life, but also multiplied dangers of producing thermal injuries. WHO found that thermal trauma ranks 2-3 all types of trauma, giving primacy only road trauma, and the number of aggressors and victims grows continuously.

Although the chance of survival after burning has increased steadily over the past three decades, predicting mortality in burned patients is still a topic of interest for physicians.

A good predictive model offers clinicians a basis for clinical decisions and helps to understand the relative contributions of different prognostic criteria. But, it is important to recognize that for patients individually marking systems can not be a substitute for clinical decision making and predicting the evolution of a patient is the first and most pressing question facing family doctor before a patient seriously.

Material and method

In a prospective study we followed 92 patients with severe burns in the Intensive Care Unit (ICU) and Plastic Surgery Clinic and Recuperation in the Emergency County Hospital of Craiova, we statistically analyzed a number of prognostic scores in these patients. I watched, depending on the progress of each patient, setting a cut-off scores for each prognostic study.

Patients were selected who had severe burns on 35-67% body surface large area, where less than 35% body surface area over 70% body surface area being excluded because I felt a burning percentage below 35% is less threatening and recovery is satisfactory, and at a rate of burning over 70%, the risk is very vital, and local and systemic evolution is encumbered by multiple complications.

It was first established protocol of investigation and a set of measurable parameters. Evaluation of burned surface was obtained using the method of Wallace (Rule of 9) and Lund and Browder estimate, after which we set and the depth of the burn, according to the classification Wilson (superficial burns, 2nd degree burns, A and B, and 3rd degree burns) .

Statistical analysis of data was performed using statistical indicators, applied to the studied cases and in accordance with the indices and scores of burned patients.

In order to ensure appropriate development severity burned and objective assessment of prognosis, we used prognostic scores based on clinical and laboratory data targets as quickly and easy.

For this purpose we used prognostic scores as prognostic index (PI) Baux score, score ABSI(Abbreviated Burn Severity Index) - TOBIASEN, score Blot, MODS score (Multiple Organ Scores dysfunctional), APACHE II (Acute Physiology and Chronic Health Evaluation II) MPM (Mortality Probability Model). Note that for a rigorous statistical analysis, we took into account the control group, statistical analysis is performed on the entire group of 112 patients in number.

Some of these scores are used in ICU, to calculate a prognostic score of mortality in all patients, not just characteristic of burn patients. We used to study these prognostic scores as general developments in the early hours of burned injured patient in ICU is similar to that of other trauma patients.

Results

We examined deaths from acute (≤ 3 days), and deaths in the first, second and third week of admission. The mean age of the patient's was 43 years with a minimum age of 17 years and a maximum age of 76 years.

To find different characteristics of patients with burns, we divided the group of 92 subjects into 3 groups:

- Lot 1: burned surface of <45% but> 35%
- Lot 2: burned surface of ≥45% but <55%
- Lot 3: burned surface of ≥55% but <65%

Also, we used a control group, called Lot 0 patients with burns on the body surface of <10%, which included 20 cases.

Table 1. Statistical analysis of death rates depending on a number of clinical parameters

Parameter	Category	Deaths	Total	%	p chi-square value
Sex	Females	9	48	18.75%	0.830809 >0.05 (NS)
	Males	11	64	17.19%	
Age	<20	0	7	0.00%	0.001028 <0.05 (S)
	20-29	0	11	0.00%	
	30-39	2	17	11.76%	
	40-49	3	23	13.04%	
	50-59	1	21	4.76%	
	60-69	8	22	36.36%	
	>70	6	11	54.55%	
Burned surface	<10	0	20	0.00%	0.0000107 <0.001 (HS)
	35-45	2	27	7.41%	
	45-55	4	36	11.11%	
	>55	14	29	48.28%	
Burned degree	1	0	14	0.00%	0.008352 <0.05 (S)
	2a	6	55	10.91%	
	2b	10	28	35.71%	
	3	4	15	26.67%	
ARDS	without ARDS	13	97	13.40%	0.001745 <0.05 (S)
	with ARDS	7	15	46.67%	

The death rate was not statistically significant in terms of gender (male / female) p = 0.830, p>0.05, but highly significant if we refer to the total body surface area (TBSA) p <0.001. Parameters as age and degree of burns are statistically significant death rate, as well as Acute respiratory distress syndrome (ARDS), p <0.05.

Statistical analysis included specifically for evolutionary analysis of prognostic indices correlated with a number of clinical parameters in order to determine which of them is more reliable and can give us more information about the prognosis of burn patients.

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Table 2. Statistical analysis of prognostic indices studied

Parameter	Value	Sn	Sp	PPV	NPV	OR (95% CI)	RR (95% CI)
PI	120	90.00%	65.22%	36.00%	96.77%	12.31 (3.34 - 45.34)	8.13 (2.21 - 29.95)
Baux score	100	90.00%	71.74%	40.91%	97.06%	22.85 (4.95 - 105.48)	13.91 (3.01 - 64.22)
ABSI	9	90.00%	69.57%	39.13%	96.97%	22.85 (4.95 - 105.48)	13.91 (3.01 - 64.22)
MODS	9	95.00%	85.87%	59.38%	98.75%	115.46 (14.21 - 937.93)	47.50 (5.85 - 385.86)
BLOT	3	80.00%	85.87%	55.17%	95.18%	24.31 (7.01 - 84.24)	11.45 (3.30 - 39.67)
APACHE II	26	100.00%	97.80%	86.96%	100.00%		
MPM 0	55	95.00%	95.65%	82.61%	98.88%	418.00 (44.20 - 3952.97)	73.52 (7.77 - 695.29)
MPM 24	40	100.00%	94.57%	80.00%	100.00%		
MPM 48	43	95.00%	97.83%	90.48%	98.90%	563.67 (55.57 - 5717.27)	77.73 (7.66 - 788.39)
MPM OT	53	95.00%	97.83%	90.48%	98.90%	563.67 (55.57 - 5717.27)	77.73 (7.66 - 788.39)

For all parameters analyzed by performing ROC curve showed an area under the curve (AUC) statistically significantly different from the value of 50% (p <0.001). Therefore, for any of these parameters can identify a cut-off value to discriminate between cases that do may have a fatal outcome and those with favorable prognosis.

In calculating the *Prognostic Index (PI)* has formed a scale of severity that can provide evolutionary and prognostic information. The diagnostic performance of these variables was quantified by calculating the area under the ROC curve (AUC), sensitivity and sensibility, positive predictive value (PPV) and negative predictive value (NPV). Achieving the ROC curve when PI has different values, stands out a cut-off of 120 for PI.

At 65.22% specificity, 90% PI is sensitive to predict death. In practical use, the positive predictive value of 36% means that, in the case where the PI> 120, there is a probability of more than 35% to have a death, while the negative predictive value shows that if we do not identify an PI> 120, the probability of survival is 96.77% - in other words, the probability of death is only 3.23%. Statistical analysis shows a statistically significant difference in the distribution of deaths by prognostic index value.

Table 3. The incidence of death in the studied group (PI> 120)

PI	Deceased	Survivors	Total
>120	36	64	100.00
<=120	3.23	96.77	100.00
Total	17.86	82.14	100.00

It can be said that there is a statistically significant difference in the distribution of deaths by prognostic index value (OR 12.31, RR 8.13, 95% CI, p <0.05) and we can say that the value of PI> 120 shows a higher statistically significant possibility of death.

The Baux Score continues to provide an indication of the risk of mortality. ROC curve gave us relationships and values concerning Baux score value to the probability of death from large burned, and had an AUC value of 0.879. When we used Baux score as test subjects for probable death, values over 100 were cut-off value of the test. In statistical analysis Baux score, we noted a sensitivity of 90% and a specificity of 71.74%, with 40.91% PPV and NPV of 97.06%, which shows that if we have a Baux score <100, the probability of death is only 2.94%.

Table 4. The incidence of death in the studied group (Baux score> 100)

Baux score	Deceased	Survivors	Total
>100	40.91	59.09	100.00
<=100	2.94	97.06	100.00
Total	17.86	82.14	100.00

We can say that there is a statistically significant difference in the distribution of deaths by Baux score value (OR 22.85, RR 13.91, 95% CI, p <0.05) and we can say that the value of Baux score> 100 shows a higher statistically significant probability of death.

Noting that the indices used in intensive care were less reliable in some burned, have been looking and achieved a number of other indices that reflect more clearly the burned patient situation. In this way we can use *ABSI index (abbreviated Burn Severity Index)* which takes into account sex, age, burned area and depth, inhalation injuries and other comorbidities.

Realizing the ROC curve with AUC of 0.891, when ABSI take different values, stands out a cut-off of 9 for ABSI. Statistical analysis revealed a sensitivity of 90% and a specificity of 69.57%, with 39.13% PPV and NPV of 96.97%, in which case a cut-off ABSI < 9, the probability of death may be 3.03%.

Table 5. The incidence of death in the studied group (ABSI> 9)

ABSI	Deceased	Survivors	Total
>9	39.13	60.87	100.00
<=9	3.03	96.97	100.00
Total	17.86	82.14	100.00

We noticed that there is a statistically significant difference in the distribution of deaths by Baux score value (OR 22.85, RR 13.91, 95% CI, p <0.05) and we can say that the value ABSI> 9 shows a higher statistically significant possibility of death.

MODS (Multiple Organ Dysfunction Score) is a score that most studies did not include in burned patients prognosis this score representing a prediction score in intensive care for patients with multiple trauma. However, in our study calculated values of area under the ROC curve (AUC) were over 0.972, proving the special value of this prognostic score, making a cut-off of 9 for MODS. With a sensitivity of 95% and a specificity of 85.87%, MODS score can be used to predict death in patients with major burns. Also on PPV values of 59.38% and 98.75% of the NPV of the probability of death in a cut-off MODS <9 is only 1.25%.

Table 6. The incidence of death in the studied group (MODS> 9)

MODS score	Deceased	Survivors	Total
>9	59.38	40.63	100.00
<=9	1.25	98.75	100.00
Total	17.86	82.14	100.00

In the distribution of deaths by value of MODS score (OR 115.46, RR 47.50, 95% CI, p <0.05) there is a statistically significant difference, and the cut-off value MODS> 9 shows a statistically significant higher risk of death.

Blot mortality score showed us that this score can be a predictive model for deaths at major burned patients on the basis of clinical endpoints. Making ROC curve showed us a sensitivity of 80% and a specificity of 85.87% of the mortality prediction score with a cut-off score of 3, this limit being useful prognostic value using probability score Blot death.

Blot mortality score showed us that this score can be a predictive model for deaths at major probability burned on the basis of clinical objective criteria.

Table 7. The incidence of death in the studied group (Blot> 3)

BLOT score	Deceased	Survivors	Total
>3	55.17	44.83	100.00
<=3	4.82	95.18	100.00
Total	17.86	82.14	100.00

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The PPV values of 55.17% and 95.18% of the NPV, the probability of death to a cut-off of Blot <3 is only 4.82%. We found a statistically significant difference in the distribution of deaths by Blot score value (OR 24.31, RR 11.45, 95% CI, p <0.05), and the cut-off value Blot score> 3 show a significantly higher risk of death .

APACHE II score was not validated for burned patients, it is used in intensive care both for critically ill patients and for burned patients. By making the ROC curve and area under the ROC curve of 0.999 value, we determined the sensitivity and specificity when APACHE II score takes various values. There is a high specificity of 97.80% and a sensitivity of 100%. Because we were interested primarily chosen threshold APACHE II score to give us a better sensitivity as we proposed, according to the statistical analysis, a cut-off of 25 for APACHE II score.

Table 8. The incidence of death in the studied group (APACHE II> 25)

Apache II	Deceased	Survivors	Total
>25	86.96	9.09	100.00
<=25	0.00	100.00	100.00
Total	17.86	82.14	100.00

86.96% PPV shows that, in the case when the APACHE II> 25, it is likely to have a 85% death, and when the NPV is 100%, it indicates that, with APACHE II score < 25, the probability of survival is 100 %. We can say that there is a statistically significant difference in the distribution of deaths by APACHE II score value because the Chi square test we obtained the value of 99,605, which exceeds the 95% threshold for 2x2 tables of incidence (3.840, corresponding to a p <0.05) as well as the 99% confidence 2x2 tables of incidence (6.630, corresponding to p <0.01).

MPM score (Mortality Prediction Models) has not been validated for burned patients, but we've used, considering that we can give a more accurate longer term prediction burned patients. Practical it is not considered a score, but also a possibility for calculating survival.

MPM0-admission. Calculating the ROC curve showed us a sensitivity and specificity of 95.00% and 95.65% respectively, as useful limits of using prognostic cut-off value of MPM0> 55 for the probability of death.

Table 9. The incidence of death in the studied group (MPM 0> 55)

MPM admission	Deceased	Survivors	Total
>=55	82.61	17.39	100.00
<55	1.12	98.88	100.00
Total	17.86	82.14	

PPV values of 82.61% and the NPV of 98.88%, indicate a probability of death at a cut-off MPM 0 <55 at a rate of 1.12%. Depending on the value MPM0 we found a statistically significant difference in the distribution of deaths (OR 418, RR 73.52, 95% CI, p <0.05), and the cut-off value MPM0> 55, show a significantly higher risk of death.

MPM24 and MPM48 score were used to calculate the prognosis for patients remaining in the ICU for more than 24 hours. ROC curve when the MPM 24 and MPM48 take different values, noticed a sensitivity of 100% for MPM24 and 95% for MPM48. To use prognostic value of MPM24 and MPM48 score for the probability of death, statistical analysis revealed a cut-off of 40 and 43 respectively.

In the case of MPM24, with values of 80% for PPV and 100% for NPV, we can say that a cut-off of <40, we do not have estimated deaths in the first 24 hours.

At a cut-off for MPM48 determined at 43, with values of 90.48% PPV and NPV values of 98.90% we can say that for MPM48 <43, we have estimated a rate of deaths of 0.89% in the first 48 hours.

Table 10. The incidence of death in the studied group (MPM24>40)

MPM 24 h	Deceased	Survivors	Total
>=40	82.15	17.85	100
<40	0.00	100.00	100
Total	17.86	82.14	

Table 11. The incidence of death in the studied group (MPM48>43)

MPM 48 h	Deceased	Survivors	Total
>=43	83.04	16.96	100
<43	0.89	99.11	100
Total	17.86	82.14	

Statistical analysis showed that there was a statistically significant difference in estimated deaths by MPM48 score (OR 563.67, RR 77.73, 95% CI, p <0.05) at a cut-off> 43.

Given that the Department of ATI burned, was burned patients required hospitalization and more than 48 hours, we calculated the MPM score over time (MPMOT), to estimate the long-term prediction of patients. The sensitivity and specificity for this parameter, calculated by performing the ROC curve, we showed values of 95.00% and 97.83% respectively for the two parameters remember. When we used MPMOT value> 53 as the cut-off for the probably death of the subjects, incidence table data from our group, giving us a good sensitivity.

Table 12. The incidence of death in the studied group (MPMOT> 53)

MPM OT	Deceased	Survivors	Total
>=53	86.36	13.64	100.00
<53	1.11	98.89	100.00
Total	17.86	82.14	

With values of 90.48% PPV and NPV values of 98.90%, we could estimate in the studied group, as a cut-off of <53, there is a risk of death just from 1.11%.

Discussions

Although the chances of survival in burned patients increased due to the new techniques and methodologies improvement in intensive care in the last 20 years, the development of predictive scores mortality in these patients is still a matter of debate for specialists in this area [2]. These estimations would be useful for both patient and family as well as for practitioners in medical and financial decisions [3].

Although were established various scoring systems for predicting mortality risk of burned patients, there is not yet an accepted standard system, even if they were developed several models of prognosis [4]. The causes that have been reported as affecting mortality are represented by sex, age, burned area, presence of inhalation injury, co-existing trauma, comorbidities and pneumonia, which are included in estimating the prognosis of burned patients and to determine the appropriate development of burn severity and prognosis evaluation [5].

The death rate was not statistically significant in terms of gender (male / female) p = 0.830, p>0.05. The issue of gender as a risk factor for death among burn patients is controversial. George et al [6] found that women are more at risk. The current study found no gender differences among risk factor, such as seen in other studies [7].

Age, degree burns, were accepted as risk factors for death among burned patients and is confirmed by our study, as in other studies [8,9]. These parameters are statistically significant for death rate, as well Acute respiratory distress syndrome (ARDS) with p <0.05, and highly statistically significant if we refer to the total body surface area (TBSA) p <0.001.

Some existing models for predicting the risk of death in burned patients are exceeded and do not take into account advances in clinical care or are complex and difficult to use [10].

The scores can generally be divided into scores that addresses a specific pathology (sepsis, trauma, burns) scores used in all ICU patients and general mortality prediction scores adjusted (APACHE, SAPS, MPM).

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In this study we used as predictive model, scores used both for burned patients and mortality prognostic scores, which are used in ICU. To establish the evolution burn severity and prognosis objective evaluation, we used prognostic scores based on clinical and laboratory data targets as quickly and easy.

Statistical analysis of the results obtained by calculating the scores used by us to assess the prognosis mortality from major burns, was made to establish a cut-off value in our case, from which it can determine whether there is a death probability.

Because we were interested that the threshold chosen for Prognostic Indices to give us a better sensitivity, we have suggested that the cut-off value of 120 for PI, and at 65.22% specificity, 90% sensitivity, PI is sensitive to predict death.

Baux Score is an index which is calculated quickly and can give some clues on burned patient prognosis. With a sensitivity of 90% and a specificity of 71.74% at a cut-off> 100, Baux score showed an increased risk of death in the statistical analysis of the our study. Although in recent years has developed a new system of Baux score by including this inhalational injury [11,12], we used the old Baux Score because we felt that this score continues to provide a good indication of mortality risk .

ABSI (Abbreviated Burn Severity Index) is a better predictor of mortality than Baux score, although it has been proposed to improve and this score. In our study we had a sensitivity of 90% and a specificity of 69.57% for this index, remarking that there is a statistically significant difference in the distribution of deaths by Baux score value (OR 22.85, RR 13.91, 95% CI, p <0.05). We observed that the value Absi> 9 shows a significantly higher risk of death. Other studies show that at a score over 11, rate of survival is ≤ 10% [13]. In our study, at a score over 11, the survival rate was low, the percentage of deaths at a score of 12, it was even 100%. Multiple Organ Dysfunction concept that leads to the death of patients with major burns is relatively new. A full description of dysfunction or organ failure in patients with burn trauma is quite complex. In literature and computer tables for calculating the MODS score value> 9 shows a mortality rate of 25%. In the study published by Khwannimit in 2007 [14] refers to a statistically significant value to death with MODS score over 10. But most studies about MODS score prognosis does not include burned patients, it represents a predictive score in intensive care at patients with multiple trauma. By making the ROC curve, we determined the sensitivity (95.00%) and specificity (85.87%) when MODS score takes various values, as useful limits prognostic value using MODS score> 9 for the probability of death.

In the recent years, the Belgian Burn Injury Outcome Study Group headed by Blot [15] tried to establish a model of death following an acute thermal injury, considering the area burned, age and presence of inhalation injury.

Blot mortality score was 0.899 AUC (95% CI, p <0.05). Sensitivity and specificity values were 80.00% and 85.87%, achieving a score cut-off of mortality Blot = 3, which we can use as a test for the probability of death.

Despite the apparent specialization scoring system, mortality prediction systems, as APACHE II score (Acute Physiology and Chronic Health Evaluation), became the most popular and used scores in intensive care. Although APACHE II score was not validated for burned patients, it is used in ICU both to critically ill patients and for burned patients and is used in many studies to weather condition such patients. In 2014 in Gilani's study [16], APACHE II had a more appropriate than APACHE III calibration or SAPS II, APACHE II so only correctly predicted mortality risk in their ICU, on all patients with various traumas.

The score of 25 showed better sensitivity (100%) and specificity (97.80%) for mortality in our study, with area under the curve of year 0.999 (P <0.05, 95% CI), emphasizes the hypothesis that APACHE II score is really a variable closely related to the severity of the case and strongly associated with mortality.

MPM score (Mortality Prediction Models) uses data present in the first hours after ICU admission (MPM0) at 24h (MPM24) hours at 48 hours (MPM48) and 72 hours (over time - MPMOT). Neither this score has not been validated for burned patients or children, but we've used, considering that we can give a more accurate prediction longer term in burned patients. It is considered not practical score, but rather an opportunity for calculating survival. It is easy to calculate, there is a computerized method, each variable is calculated as absent or present, being allocated a coefficient. In the literature there are studies that places MPM score a better position than APACHE score [17], and studies APACHE and SAPS score believes that most corresponding calibration have to MPM [18]. Area under the receiver operating curve characteristics was nearly the same for all 4 scores MPM. The highest sensitivity, 100.00%, had a MPM24 with 94.57% specificity.

This study has some limitations being conducted in a single center, on a relatively small number of patients, it reflects the results of burned patients in department of ICU and may not be generalizable to all hospitals. However, the study provides an idea about this problem, showing a model for the evaluation of burn patients.

Conclusions

This risk score system can play a useful role in developing decision making, implementing risk reduction strategies and guidance for efforts to improve the quality of care. Scoring systems aim to use the predictive factors for injury to obtain a probability of death for an individual patient. Age, burn surface area and inhalational injury remain the main factors of prognosis in burned patients, but their relative proportion varies between scoring systems, and biochemical markers remain extremely important for predicting the prognosis. Using general scoring systems such as those used in the Intensive Care Unit may be relevant in burned patients.

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