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Prognostic and Predictive Factors of Mortality in Burn Patients at dr Cipto Mangunkusumo General Hospital, Indonesia

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Abstract

Introduction. Some prognostic– and predictive factors in burn have never been investigated in Indonesian specific characteristics, which is delayed treatment. A study was conducted to determine prognostic and predictive factors in this specific characteristic.

Method. A retrospective cohort focused on burn mortality in extensive burns managed in CMGH from 1998–2010. Some known prognostic– and predictive factors and unknown ones were the variables of interest. Bivariate and multivariate using logistic regression analysis proceeded to find out these factors.

Results. Out of all factors investigated, the variables that showed a significant correlation were: TBSA, inhalation injury, Baux score, revised Baux score, serum albumin, blood urea, serum creatinine, haemoconcentration, base excess, serum lactate, international normalized ratio, and random blood glucose.

Conclusion. In the study, Baux score, revised Baux score, serum creatinine, haemoconcentration, base excess, and INR as predictive factors for mortality in the extensive burn.

Keywords: Baux score, revised Baux score, serum creatinine, haemoconcentration, base excess, international normalized ratio, predictive factor, mortality, extensive burn

Introduction

Burn mortality remains the major problem encountered in Indonesia, in contrast to decreasing mortality rate significantly in the well-developed country as in the United States.¹ Studies focused on burn mortality showed the associated factors that play a role as the prognostic and predictors. To these studies, the factors such as age, burned surface area, inhalation injury, Baux or modified Baux score, and the period between injury time to treatment were significant prognostic factors. In addition, the known predictive factors were: acute kidney injury, serum albumin, deteriorated haemostasis, including thrombocytopenia, base excess, serum lactate, hyperglycemia, and inflammatory markers such as procalcitonin C reactive proteins.^{2–11}

Delay in the management, particularly in the prehospital setting, is the main problem encountered in Indonesia as a developing country with limited resources. In dr. Cipto Mangunkusumo General hospital (CMGH) admitted burned patients were dominated with those categorized as complicated with delay in the early management. Despite prehospital management, these cases were characterized by massive edema and minimal response to fluid treatment during the presentation. Thus, having a high risk of mortality.¹² Some studies focused on predictive and predicting factors of Indonesian characteristic, which was Baux score, serum lactate, and some markers. Unfortunately, some of those investigated in well-developed countries were not suited for Indonesian. Thus, prognostic and predictive factors relatable to these

Indonesian-specific characteristics were needed to improve the quality of management and the outcome.

This study aimed to determine prognostic and predictive factors for mortality in burn patients managed in CMGH.

Method

A retrospective cohort enrolled all subjects with extensive burn injury (i.e., total burned surface area, TBSA >25%) managed in CMGH from 1998 to 2010. Electric–, chemical–, blast injury and multi–traumatized patients were excluded. Subjects' characteristics, including age, TBSA, inhalation injury, the period between onset to treatment, and Baux (revised Baux score), were independent variables of interest for prognostic factors. Whereas serum albumin, blood urea, and creatinine serum, red blood cells counts, haemoconcentration, serum lactate, base excess, random blood glucose, and international normalized ratio (INR) were independent variables of interest for predictors factors. The study focused on the values of the first 48 hours.

Mortality was the dependent variable of interest, in addition to the length of hospital stays that expressed descriptively. Data was collected from the burn registry in the burn unit and medical record and subjected to analysis. A bivariate analysis proceeded, using a comparative analysis of a nonparametric one. The analysis continued with logistic regression multivariate analysis. Further, the analysis proceeded with the ROC curve to determine the cut-off point, sensitivity, and specificity.

The Committee of Ethics, Faculty of Medicine, Universitas Indonesia, approved the study.

Results

There were 1708 burn injured patients managed from 1998 to 2010, 247 subjects who met the criteria were enrolled in the study. The characteristics of these subjects are expressed in median (min-max) and percent, as shown in table 1.

Table 1. Subject Characteristics

Variable	Values
Age	26 (1-91) years
Total burned surface area (TBSA)	46% (26%-97%)
Inhalation injury	30 + 12.1
Onset to treatment	8 hours (3–48 hours)
Baux score	79 (36.5-180)
Revised Baux score	82 (36.5-234)
Serum albumin	2.5 g/dL (1.1-3.2 g/dL)
Blood urea	78 (28–544)
Serum creatinine	1.7 g/dL (0.8-7)
Erythrocyte reduction	3 cells/mm ³ (-0.89-8.1 cells/mm ³)
Hemoconcentration	14 % (0-32 %)
Base excess	-11 mEq/L (-23-21 mEq/L)
Serum lactate	5.1 mmol/L (-9-12.3 mmol/L)
International normalized ratio (INR)	1.7 (1.1-2.5)
Random blood glucose (RBG)	196 mg/dL (40-617 mg/dL)
Length of hospital stays	14 days (1-42 days)
Mortality	117 (47.4%)

In bivariate analysis, the variables that showed a significant correlation were: TBSA, inhalation injury, Baux score, revised Baux score, serum albumin, blood urea, serum creatinine, hemoconcentration, base excess, serum lactate, INR, and RBG.

Table 2. Comparative analysis of predictive factors on mortality

Variable	Deceased	Survivor	p-value	Odds ratio (95%CI)
Total sample	117	130		
Age	24 (1-91)	28.5 (1-71)	0.561	-
Burn surface area	65 (28-97)	43 (26-67)	<0.001	-
Inhalation injury	23 (19.7)	7+5.4	0,001	4.29 (1.7-10.4)
Onset to treatment	8 (3-48)	9 (3-48)	0.486	-
Baux score	90 (36.5-180)	69 (38-137)	<0.001	-
Revised Baux score	91.5 (36.5-234)	69.5 (38-137)	<0.001	-
Serum albumin	2.1 (1.1-2.9)	2,6 (1.1-3.2)	<0.001	-
Blood urea	119 (28-455)	61 (29-544)	<0.001	-
Serum creatinine	2.2 (0.9-7)	1.2 (0.8-5,6)	<0.001	-
Erythrocyte decrease	2.9 (-0,-8,1)	3 (0.1-8)	0.005	-
Hemoconcentration	6 (0-30)	19 (0-32)	<0.001	-
Base excess	-12.4 (-23-0.2)	-9 (-21-21)	<0.001	-
Serum lactate	7.3 (-9-12)	3.65 (2.1-9.7)	<0.001	-
International normalized ratio	2.1 (1.1-2.5)	1.4 (1.1-2,5)	<0.001	-
Blood glucose	214 (49-617)	178.5 (40-617)	<0.001	-

On further analysis, namely logistic regression of the multivariate, a variable of Baux score was excluded as it may lead to collinearity and statistical bias with the revised Baux score. The results are presented in Table 3.

Table 3. Multivariate analysis

Variable	B	SE	p value	OR	95%CI
Revised Baux score	0.020	0.009	0.029	1.020	1.00-1.03
Serum creatinine	0.616	0.231	0.008	1.852	1.17-2.91
Hemoconcentration	-0.150	0.029	0.000	0.861	0.81-0.91
Base excess	-0.115	0.051	0.025	0.891	0.80-0.98
INR	2.118	0.602	0.000	8.318	2.55-27.08
Constants	-6.082	1.113	0.000	0.002	

These results were then converted to the ROC model to find the area under the curve, cut-off value, sensitivity, and specificity, as presented in Table 4.

Table 4. The area under curve and cut-off value of the significant factors.

Variable	AUC	Cut-off	Sensitivity	Specificity
Revised Baux score	0.733	76.00	0.718	0.615
Serum creatinine	0.762	1.80	0.718	0.746
Hemoconcentration	0.746	9.50	0.831	0.735
Base excess	0.750	-10.05	0.631	0.778
INR	0.851	1.65	0.812	0.769

Discussion

This study found a significant correlation between total burned surface area, Baux score, revised Baux score, serum creatinine, and hemoconcentration with mortality in extensive burn injury. The increase of total burned surface area, revised Baux score, and serum creatinine showed increased mortality. The previous study has shown similar results with a large burn surface area.¹³ Increase burn surface area was associated with wound infection, sepsis, organ failure in the previous study, the most common cause of death in burn injury.¹³ Increased exposure to the environment with extensive burn surface area may lead to wound and systemic infection.¹⁴ Significantly increased risks of infection found in a burned surface area more than 40% in the adults and 60% in pediatric.¹³

Previous studies have shown both Baux score and revised Baux score as a prognostic factor for mortality. Both consist of total burned surface area and age, for revised Baux score added inhalation injury. Revised Baux score was showed superior to Baux score as inhalation injury is a significant issue leading to high mortality in burn injury.^{15,16} Previous study has shown that revised Baux score a high predictive measure of according to ROC curve with 92% of accuracy for burn mortality.¹⁶

Organ dysfunction is one of the main complications in the major burn that leads to mortality.¹⁷ Extensive tissue damage led to an exaggerative systemic inflammatory response and resulted in organ dysfunction.¹⁷ Renal dysfunction is the most issue following this systemic inflammatory response, denoted with increased blood urea and serum creatinine.¹⁷ We found that serum creatinine showed a higher predictive value for burn mortality compared to blood urea. Serum creatinine has shown the predictive value for mortality in other scoring systems such as the acute physiology score (APS) and APACHE II scoring system.¹³ Thus, the reliability of serum creatinine in predicting organ dysfunction translates to the ability to predict mortality, as shown in this study.

Extensive burn injury leads to significant water loss following increased transdermal evaporation in a damaged epidermal barrier. Hypovolemia occurs with increased hematocrit levels, reduced urine output production, and lower systolic blood pressure.¹⁸ Intravenous fluid administration as the initial fluid resuscitation may correct intravascular volume. However, a corrected volume may be followed by decreased hemoglobin content and hematocrit values. The previous study has

shown a significant decrease in hemoglobin content and hematocrit following fluid resuscitation, found in the third and fifth post burned days.¹⁹ In this study, we found a significant correlation between improved hematocrit value 24 hours after fluid resuscitation and mortality. We found significantly higher mortality in subjects with low hematocrit improvement than those showing a more remarkable hematocrit improvement. A significant hematocrit improvement reflects the success of initial fluid resuscitation. The hematocrit improvement is denoting as the indicator of fluid resuscitation failure in burn during the first 24 hours, also shown in this study.²² The importance of initial fluid resuscitation in extensive burn has been shown directly associated with survival.²¹

The association between INR and burn injury mortality has significantly increased mortality in subjects with higher INR values. Studies showed that coagulopathy in burns with the altered of anticoagulant and antifibrinolytic interaction. Coagulopathy has been associated with significant morbidity and mortality in burn patients with a thromboembolic event and multiple organ failure.²³ One should note that coagulopathy may be caused by hemodilution following fluid resuscitation (dilutional effects). A condition found as a cascade of the systemic inflammatory response, followed by disseminated intravascular coagulation. These conditions were reflected with the increase of INR and aPTT, thus correlated with mortality in burn victims.²⁴

Further analysis with the ROC curve and cut-off measures was carried out on the significant variables. In the study, INR showed the highest area under the curve (AUC) with 85% accuracy. The cut-off point for INR in this study is 1.65, with high sensitivity and specificity. The previous study has described an INR value higher than 1.5 as the indicator of early-onset burn-induced coagulopathy that significantly increased mortality risks. The study is also shown such an issue.²³ Revised Baux score was also showed a significant predictive value with the AUC of 71%. The cut-off point for the revised Baux score is significantly lower than in the previous study, which reflected the higher severity of burn injury in this study.²⁴ ROC curve of serum creatinine has shown an AUC of 76% with a high cut-off point. This study found that the serum creatinine cut-off point was considered an acute kidney injury, higher than the previous study.²⁵ The high serum creatinine cut-off value also reflected the burn severity in this study.

The limitation of this study includes limited variability of laboratory examination in burn patients that leads to a high exclusion. The variability of initial treatment in a prehospital setting may also affect this study's outcome and rolled as a confounding factor. The retrospective nature of this study with ten years gap may also be a risk of bias in this study.

Conclusions

We concluded Baux score, revised Baux score, serum creatinine, hemoconcentration, base excess, and INR as a predictive factors for mortality in the extensive burn.

Conflict of Interest

The author declares no conflicts of interest.

Funding Statement

The authors declare no external funding

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