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PROGNOSIS OF INHALATION INJURY MORTALITY RATE WITH REVISED BAUX SCORE AT DR SOETOMO GENERAL ACADEMIC HOSPITAL, SURABAYA, INDONESIA (2019-2021)

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ABSTRACT

Introduction: Burn trauma has quite a high mortality rate in Indonesia. One of the scoring systems that is straightforward to apply is the revised Baux score. However, there is no standardised scoring system that is currently in use in our institution. Therefore, the purpose is to determine the feasibility of using this scoring system in our population's features.
Methods: This research is a retrospective study with research design case control design using secondary data in the form of medical record data from patients with acute burn trauma that were admitted to Burn Unit of Dr. Soetomo General Academic Hospital in Surabaya between January 2019 and December 2021. All the data will be divided by their group and analysed with SPSS software.
Results: The study found significant relationships between several factors and mortality rates among burn patients. Age, total burn surface area percentage, presence of inhalation injury, and the revised Baux Score all showed significant correlations with mortality rate ($p < 0.005$). Specifically, among burn patients with inhalation injury, the correlation between mortality rate and revised Baux score remained significant ($p=0.002$).
Conclusions: The study revealed that age, the percentage of total burn surface area, and the presence of inhalation injury are significantly associated with mortality rate among burn patients. Additionally, the revised Baux Score was identified as a useful tool for predicting the prognosis of burn patients with inhalation injury. These findings emphasize the importance of these factors in assessing and managing outcomes for burn patients, particularly those with inhalation injury.

Highlights:

1. Fire is the most frequent cause of burns, while thermal contact is the least common.
2. Mortality rate with revised Baux score in burn patients with inhalation injury showed a significant relationship.

INTRODUCTION

Burn trauma is still an important issue, particularly in low- and middle-income countries. Although specific updated statistics for Indonesia's burn patient mortality rates in 2024 are not readily available, global trends suggest ongoing challenges in addressing burn injuries.[1] In 2012, Indonesia's burn patient mortality rate remained high, with rates of

27.6% in RSCM and 26.41% in Dr. Soetomo General Academic Hospital.[2] Based on World Health Organization (WHO) data in 2008, the mortality rate and crude death rate of Southeast Asian countries were the highest in the world compared to other countries. The mortality rate has risen to 184.000 per year, with a crude death rate of 11.6 per 100.000 inhabitants and a global death percentage of 59%.[1] In that situation, Indonesia, as a member of Southeast Asia, should devote more attention to burn injuries.[3,4] Clinicians should adopt a strategic approach based on demographic and specific characteristics to reduce death rates on Indonesian islands.

There are researches conducted to establish predictive values for burn mortality. The concept of stratification via a scoring system is widely established in clinical practice worldwide.[5] A good prognosis score should satisfy several criteria, including high accuracy, simplicity, and ease of application. Among the proposed scoring systems in the burns sector, one that is straightforward to apply is the revised Baux (abbreviated as rBaux) score.[6]

Professor Serge Baux developed a formula in 1961 to predict mortality in burn patients. The Baux score is calculated by adding the Total Burn Surface Area (TBSA) percentage and patient age to get a mortality score. Osler then proposed the revised Baux (rBaux) score in 2010, and it has since been evaluated and widely applied in developed countries. Osler adds inhalation injury since inhalation injury has been recognized as an important contributor to mortality after burn injury.[7] The rBaux score is calculated by adding together the percentage of Total Burn Surface Area (TBSA) and the patient's age. This score provides crucial predictive information for determining the prognosis of burn patients, where higher scores indicate a higher risk of mortality. One of the main advantages of the rBaux score is its simplicity in application. By considering only these two factors, the score can be calculated quickly and easily in various clinical settings. This simplicity makes it a valuable tool for clinicians in assessing burn patients and guiding treatment decisions based on prognostic factors.[1] Such a score has been investigated and applied in numerous centres worldwide, but no standardised scoring system is currently in use in our institution.

This study aimed to prove that the revised Baux score can determine the mortality rate prognosis of inhalation injury in burn trauma and determine the feasibility of using this scoring system in our population's features.

METHODS

This research is a retrospective case-control study conducted in February 2022, utilizing data collected from medical records of patients with acute burn trauma admitted to the Burn Unit of Dr. Soetomo General Academic Hospital in Surabaya. The study included all subjects admitted due to acute burns between January 2019 and December 2021. Exclusion criteria encompassed chronic burns, inhalation trauma accompanied by other trauma or comorbidities, missing data on variables, and loss to follow-up. A total of 214 patients admitted during the specified period were reviewed based on age, total burn surface area (TBSA), and presence of inhalation injury.

The data were categorized into groups and analyzed using SPSS software. The case group comprised patients with acute burn trauma treated at the Burn Unit of Dr. Soetomo Hospital in Surabaya during the study period. These individuals had specific conditions or diseases relevant to the research focus. The control group consisted of patients without a history of burn trauma and not subjects of burn trauma-related research. They served as a comparison group to assess the relationship between studied factors, such as age, total burned body surface area, and inhalation injury,

and clinical outcomes, including mortality among patients with burn trauma.

The researchers implemented a systematic and well-documented data collection process to ensure comprehensive acquisition of all necessary information for analysis. This data collection process allowed researchers to identify relevant patterns and trends regarding the studied risk factors.

Subsequently, the collected data underwent statistical analysis using software like SPSS to uncover patterns, relationships, and trends associated with the studied risk factors. The analysis was retrospective, utilizing historical data from patients' medical records to explore the relationships between specific risk factors, such as age, burned body surface area, and inhalation injury, with clinical outcomes, such as mortality among patients with burn trauma.

Inferential statistical techniques were applied to assess the statistical significance of the relationships between these variables. Depending on the research questions, Spearman correlation tests or logistic regression analysis may have been employed. The results of the analysis were thoroughly evaluated and interpreted to determine the existence and significance of relationships between the studied risk factors and clinical outcomes, particularly mortality among burn trauma patients. The result of this research will be presented with tables and graphics.

RESULTS

The dataset consists of 214 medical records from patients with acute burn injuries who were admitted to the Burn Unit of Dr. Soetomo General Academic Hospital Surabaya from January 2019 to December 2021.

Figure 1. Medical Record Data from Patients with Acute Burn Trauma Admitted to the Burn Unit of Dr. Soetomo General Academic Hospital Surabaya in the Period January 2019 - December 2021

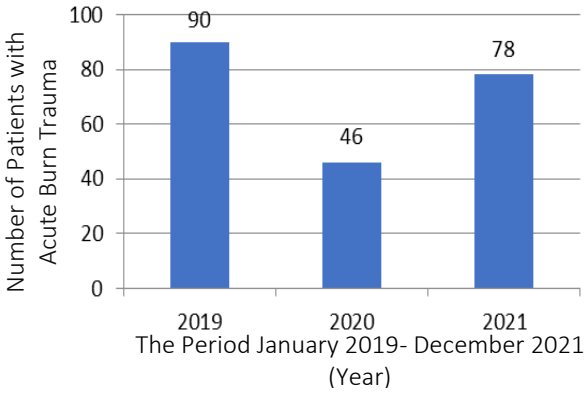


Table 1. Demographic Data of Burn Patients Dr. Soetomo General Academic Hospital Surabaya in the Period January 2019 - December 2021

Characteristics	n	%
Total Data	214	100
Gender		
Male	146	68.22
Female	68	31.78
Cause of burn		
Scald	61	28.5
Fire	113	52.8
Electric Injury	35	16.36
Chemical	4	1.87
Contact Thermal	1	0.47
Age		
0-10	47	21.96
11-20	25	11.68
21-30	28	13.08
31-40	37	17.29
41-50	42	19.63
51-60	19	8.88
61-70	12	5.61
71-80	4	1.87
81-90	0	0
91-100	0	0
Total Burn Surface Area (%)		
0-10	41	25.23
11-20	38	22.90
21-30	30	16.82
31-40	23	13.08
41-50	16	10.28
51-60	11	6.54
61-70	4	2.80
71-80	4	1.87
81-90	1	0.47

91-100	0	0
Inhalation Trauma Presence		
Yes	50	23.36
No	164	76.61

Comparison of sex from medical record data collected obtained 146 (68.22%) male and 68 (31.78%) female patients. This indicates that there were more male patients than female patients among those treated for burns during the study period. While the most common cause of burns is fire (52.8%), and the least common is thermal contact (0.47%). This suggests that fire-related incidents are the predominant cause of burns among the patients studied. The largest age group was 0-10 years, namely 47 patients (21.96%). This highlights the vulnerability of children to burn injuries. The group with the highest Total Burn Surface Area percentage was 0-10%, namely 41 patients (25.23%). This indicates that a significant proportion of patients had relatively minor burn injuries in terms of TBSA percentage. The number of inhalation injuries obtained from the data was 50 incidents (23.36%). This underscores the importance of considering inhalation injuries as a significant factor in burn cases, as they can have serious implications for patient outcomes and treatment strategies.

Table 2. Correlation Between Clinical Variables and Mortality Rate in Burn Patients

Clinical Variable	Correlation Coefficient	p-value
Age vs. Mortality Rate	0.213	0.002
TBSA vs. Mortality Rate	0.475	0.000
Inhalation vs. Mortality Rate	0.369	0.000

The table provides statistical outcomes from Spearman correlation tests conducted among various variables (age, Total Burn Surface Area (TBSA), Inhalation) and Mortality Rate in burn patients. Each correlation coefficient is accompanied by its respective p-value. Emphasizing statistically significant findings is crucial, typically those with p-values lower than a chosen significance level, commonly denoted as α (e.g., <0.05 or <0.001).

The Spearman correlation test results presented in Table 2 demonstrate significant associations between various variables and the Mortality Rate among burn trauma patients. Firstly, there exists a noteworthy positive correlation between age and Mortality Rate ($r=0.213$, $p=0.002$), indicating that older age is linked to increased mortality likelihood. Similarly, the Total Burn Surface Area (TBSA) exhibits a substantial positive correlation with Mortality Rate ($r = 0.475$, $p < 0.001$), suggesting that larger TBSA percentages are associated with higher mortality rates. Moreover, Inhalation injury shows a significant positive correlation with Mortality Rate ($r=0.369$, $p<0.001$), highlighting the heightened mortality risk among patients with inhalation injuries. These findings emphasize the critical role of age, TBSA, and Inhalation injury in predicting mortality and guiding clinical management strategies for burn trauma patients.

Table 3. Outcome Data of Burn Patients with Inhalation Trauma and without Inhalation Trauma at Dr. Soetomo General Academic Hospital Surabaya in the Period January 2019 - December 2021

Outcome	Inhalation Trauma	Without Inhalation Trauma
Alive	28	147
Dead	22	17

The data in the table presents a comparison of outcomes between patients with inhalation trauma and those without at Dr. Soetomo General Academic Hospital in Surabaya during the period from January

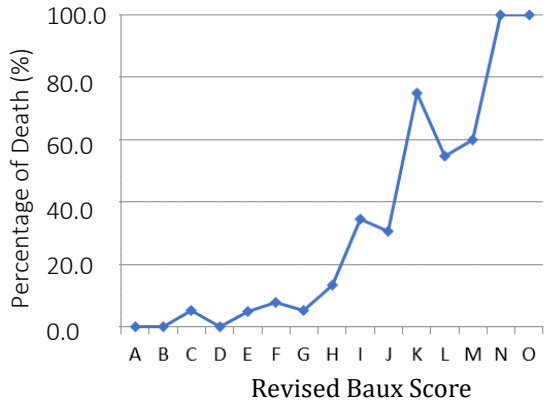
2019 to December 2021. The table indicates a significant difference in mortality rates between the two groups. Patients with inhalation trauma had a higher mortality rate (22 patients) compared to those without inhalation trauma (17 patients). However, the number of survivors among patients without inhalation trauma (147 patients) was substantially higher than among those with inhalation trauma (28 patients). These findings suggest an elevated risk of mortality associated with inhalation trauma.

The data above was analysed using SPSS to find the Odds Ratio and obtained an OR value of 6.79 ($p < 0.005$). This result follows previous research conducted by Osler, Glance and Hosmer (2010)[8], which said that inhalation trauma contributed to adding 17 years or 17% of the total burn surface area to the calculation of Baux Score.

Revised Baux Score data obtained from the calculation of age, Total Burn Surface Area percentage, and inhalation injury presence in all burn patients in this study then processed with actual mortality data that occurred, as shown in the following tables and figure bellow.

Table 4. Revised Baux Score Data with Actual Mortality of Burn Patients at Dr. Soetomo General Academic Hospital Surabaya in the Period January 2019 - December 2021

R-Baux Score	Alive		Dead	
	n	%	n	%
0-10	11	100.0	0	0.0
11- 20	17	100.0	0	0.0
21-30	18	94.7	1	5.3
31-40	20	100.0	0	0.0
41-50	20	95.2	1	4.8
51-60	23	92.0	2	8.0
61-70	18	94.7	1	5.3
71-80	13	86.7	2	13.3
81-90	17	65.4	9	34.6
91-100	9	69.2	4	30.8
101-110	2	25.0	6	75.0
111-120	5	45.5	6	54.5
121-130	2	40.0	3	60.0
131-140	0	0.0	2	100.0
>140	0	0.0	2	100.0



A : 0-10 F : 51-60 K : 101-110
B : 11- 20 G : 61-70 L : 111-120
C : 21-30 H : 71-80 M : 121-130
D : 31-40 I : 81-90 N : 131-140
E : 41-50 J : 91-100 O : >140

Figure 2. Plotting Percentage of Death with Revised Baux Score in Burn Patients

The data above found that the increase in the revised Baux Score value was in line with the actual mortality rate of burn patients and vice versa. In the lower Baux score categories (0-30), the mortality rate is relatively low or even non-existent. However, in higher ranges of the Revised Baux Score, especially above 80, there is a significant increase in the percentage of patients who die. For instance, in the range of 81-90, only 65.4% of patients survive, while 34.6% die. In the range of 131-140 and above 140, all patients succumb to mortality.

In this study, researchers also conduct Spearman correlation test to prove the magnitude of the relationship between the revised Baux Score and survival outcome of burn patients both with inhalation trauma and without inhalation trauma, with the following results shows a correlation coefficient of 0.495, which indicates a sufficient relationship between the revised Baux Score and the survival outcome of burn patients. The research also obtained a

significance value of 0.000, indicating a correlation between the Revised Baux Score and the mortality rate of burn patients.

Table 5. Revised Baux Score Data with Actual Mortality of Burn Patients with Inhalation Injury at Dr. Soetomo General Academic Hospital Surabaya in the Period January 2019 - December 2021

R-Baux Score	Alive		Dead	
	n	%	n	%
0-10	0	0.0	0	0.0
11- 20	0	0.0	0	0.0
21-30	0	0.0	1	100.0
31-40	0	0.0	0	0.0
41-50	1	100.0	0	0.0
51-60	2	100.0	0	0.0
61-70	5	100.0	0	0.0
71-80	1	100.0	0	0.0
81-90	5	62.5	3	37.5
91-100	5	71.4	2	28.6
101-110	2	33.3	4	66.7
111-120	5	50.0	5	50.0
121-130	2	40.0	3	60.0
131-140	0	0.0	2	100.0
>140	0	0.0	2	100.0

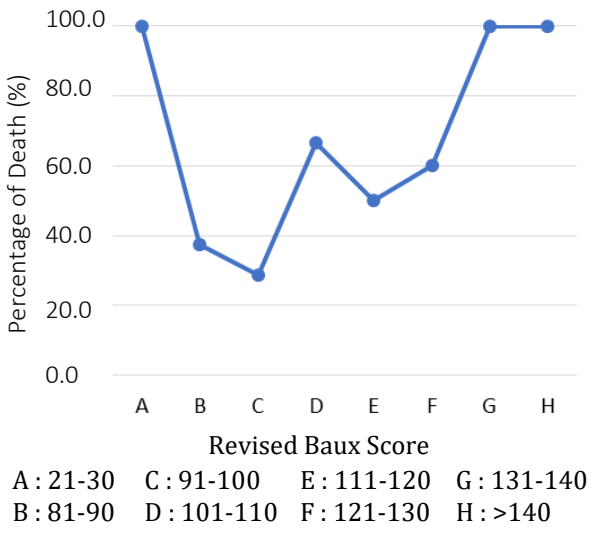


Figure 3. Plotting Percentage of Death with Revised Baux Score in Burn Patients with Inhalation Injury

Table 5 and Figure 3 found that the increase in the revised Baux Score value of burn patients with inhalation injury was in line with the actual mortality rate and vice versa.

In this study, researchers also conduct Spearman correlation test to prove the magnitude of the relationship between the revised Baux Score and survival outcome of burn patients with inhalation injury, with the following results shows a correlation coefficient of 0.423, which indicates a sufficient relationship between the revised Baux Score and the survival outcome of burn patients with inhalation injury. The research also obtained a significance value of 0.002, indicating a correlation between the Revised Baux Score of burn patients with inhalation injury and the mortality rate.

DISCUSSION

Burn injuries pose a significant challenge, particularly in Indonesia, a developing country in Southeast Asia, where the mortality rate from burns is increasing and has reached 27.6%.[3] The role of healthcare professionals in effective burn management is crucial. One strategy to enhance treatment outcomes involves using predictive models to evaluate mortality rates associated with burn injuries. Scoring systems for categorizing burn severity have become widely adopted in many countries. Among these systems, the revised Baux score (rBaux) stands out as a promising tool due to its simplicity and ease of use.[9,10]

The revised Baux score (rBaux) is a scoring system used in the assessment of burn injuries to predict mortality risk. It is an adaptation of the original Baux score, which was developed to estimate the likelihood of death in burn patients based on various clinical parameters. The rBaux score incorporates factors such as age, percentage of total body surface area (TBSA) burned, and inhalation injury to calculate a numerical score. This scoring system enables clinicians to categorize patients into different risk groups and make informed treatment decisions accordingly.

Healthcare professionals use the rBaux score to guide resource allocation and prioritize care, particularly in urgent situations requiring immediate triage. By accurately evaluating burn injury severity and forecasting patient outcomes, the rBaux score contributes to enhanced patient management and improved clinical results.[7,10-12]

In this study, an analysis was conducted to examine the relationship between age, total burn surface area percentage, inhalation injury presence, and the mortality rate among burn patients. These three variables significantly impact the mortality rate percentages observed in burn patients as determined by the revised Baux Score.

The Spearman correlation analysis between age and mortality rate revealed a statistically significant but weak relationship (p=0.002), suggesting that patients at extreme ages face a higher risk of mortality. These findings align with prior research, where older age (p=0.004) remained a significant risk factor for burn mortality after accounting for other variables. This increased risk in older individuals is attributed to a higher prevalence of pre-existing medical conditions, compromised immune responses against post-burn infections, and skin thinning leading to more severe burn injuries.[13]

According to previous studies, advancing age was a notable risk factor for seniors and adults but not for children (p=0.355).[14] In contrast, children's mortality rates decrease with age, likely due to the development of organs and immune systems.

The Spearman correlation test between total burn surface area percentage and mortality rate showed a significant relationship (p=0.000). This result shows that the wider the % total burn surface area, the higher the risk of mortality. These results follow previous research, namely that an increase in the percent burn area increases the risk of mortality (p<0.001) associated with wound infection, sepsis, and organ failure.[15]

The Spearman correlation test between inhalation injury presence and mortality rate showed a significant relationship (p=0.000). This result indicates that inhalation injury can increase the risk of mortality. This finding is also reinforced by data analysis using the Odd Ratio, where there is a 6-fold increase in mortality in burn patients with inhalation injuries. Additionally, one study demonstrated that inhalation trauma contributes significantly to the calculation of the Baux Score, potentially adding 17 years or 17% of the total burn surface area.[16] Another study highlighted that combining cutaneous burns with inhalation injury leads to increased fluid requirements for resuscitation, higher incidence of pulmonary complications, and elevated mortality rates.[17]

After establishing the significant relationship between the three variables in the revised Baux Score and the mortality rate of burn patients, the study proceeded to analyze the correlation between the revised Baux Score obtained from patient data and the actual mortality rate. The researchers plotted the percentage of survival and mortality against the revised Baux Score and conducted a Spearman correlation test. The findings revealed that higher values of the revised Baux Score corresponded to higher percentages of mortality. The Spearman correlation test confirmed a significant relationship between the revised Baux Score and mortality rate (p=0.000), indicating that higher revised Baux Scores were associated with increased mortality rates. Furthermore, the researchers specifically analyzed the correlation between the revised Baux Score and mortality rate in burn patients with inhalation trauma, uncovering a significant relationship (p=0.002). This suggests that inhalation trauma in burn patients can elevate

mortality risk. The study's data also highlighted that burn patients with inhalation trauma, coupled with extensive burns (mean TBSA 40.84%) and advanced age (mean age 40.2 years), exhibited a high mortality rate.

The results of this study align with previous research conducted at Dr. M. Djamil Padang Hospital, where logistic regression analysis demonstrated an interrelation between age, TBSA, and inhalation trauma in predicting mortality using the revised Baux score ($p < 0.001$).[17] Similarly, research at Dr. Cipto Mangunkusumo General Hospital indicated significant predictive discrimination of the r-Baux score for burn patient mortality ($p < 0.001$).[18] Additionally, a study at Chelsea and Westminster Hospital also found a significant relationship between the revised Baux Score and mortality rate ($p < 0.001$).[19]

These findings support the use of the revised Baux score in predicting prognosis for burn patients with inhalation injuries. Implementing effective prognostic scoring systems like the rBaux score can aid clinicians in accurately assessing burn injury severity and predicting patient outcomes. By integrating these tools into clinical practice, healthcare providers can make informed decisions and allocate resources more efficiently, potentially improving survival rates and enhancing burn trauma management in Indonesia.

The limitation of the study is that it cannot calculate the mortality rate of burn patients who do not meet the criteria for hospitalization, even though even the smallest burn carries a risk of morbidity and mortality.[20] However, the strengths and novelty of this study lie in its comprehensive data collection from medical records of burn trauma patients admitted to the Burn Unit of Dr. Soetomo General Academic Hospital Surabaya, spanning from January 2019 to December 2021. This extensive data collection enhances the robustness of the study's findings. The research considers various factors such as age, Total Burn Surface Area (TBSA), and inhalation injury in assessing their correlation with mortality rates among burn trauma patients. This comprehensive approach allows for a thorough examination of potential risk factors. The study employs Spearman correlation tests to analyze the relationship between different variables (age, TBSA, inhalation) and mortality rate, ensuring rigorous data analysis. The findings of the study have direct implications for clinical practice, particularly in burn management. By identifying significant correlations between age, TBSA, inhalation, and mortality rate, clinicians can better understand and manage burn trauma cases, potentially improving patient outcomes. Additionally, the study contributes to the existing body of knowledge on burn trauma management by specifically examining the predictive value of the revised Baux score in the study population. This novel aspect of the research adds valuable insights to the field of burn care.

CONCLUSION

The revised Baux Score is effective for predicting mortality prognosis in burn trauma cases involving inhalation injury. Age, percentage of Total Burn Surface Area, and the presence of inhalation injury significantly impact mortality prognosis in burn trauma. To enhance understanding of the revised Baux Score's predictive accuracy for mortality in burn patients, future studies could compare it with other prognostic scoring systems like BOBI and ABSI.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in this study.

FUNDING DISCLOSURE

The authors declare that there is no financial interest in this study.

AUTHOR CONTRIBUTION

DHS contributed to the conception and study design, collection and assembly of data, analysis and interpretation of the data, RM contributed to the methodology, drafting of the article and project administration, ASB and DMI contributed to the critical revision of the article for important intellectual content. All authors participated in the final proofreading.

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