Correlation of risk factors with systemic inflammatory response syndrome in burn patients at the Burn Center of Dr Soetomo General Hospital, Surabaya, Indonesia

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ABSTRACT

Introduction: Systemic inflammatory response syndrome (SIRS) is the main cause of death in burns and is associated with high burn mortality rates. SIRS occurs when burns are in the subacute phase and is affected by several factors, such as host, trauma and management. The research was conducted at the Burn Center of Dr Soetomo General Hospital, Surabaya, Indonesia, using retrospective observational analytic research design. The aim of the study was to assess the correlation of risk factors which include age, extent of burns, cause of burns, inhalation trauma, history of hyperglycaemia, anaemia, hypoalbuminemia and ESBL infection with the incidence of SIRS.

Materials and Methods: The study is observational analytic research using a retrospective design and secondary data of all burn patients treated at the Burn Center of Dr Soetomo General Hospital, Surabaya, Indonesia from January 2018 to December 2019.

Results: A total of 163 burn patients were included. Among comorbidities found were inhalation trauma (39.3%), diabetes mellitus (2.5%), anaemia (14.7%), hypoalbuminemia (40.5%) and ESBL infection (1.2%). A total of 11 patients (6.7%) suffered from SIRS. The statistical analysis showed that anaemia (p=0.012), hypoalbuminemia (p=0.030) and the percentage of burns (p=0.001) were significantly correlated to the incidence of SIRS while age, sex, cause of burn injury, inhalation trauma, diabetes mellitus and ESBL infection have no significant correlation with SIRS.

Conclusion: Burn surface area is the most influencing factor of SIRS incident. It is important to meticulously monitor patients with extensive burn areas for indications of SIRS. However, the sample size of this study was relatively small, and it used a retrospective approach, so a larger sample size and a prospective or cohort design method were recommended for further study.

KEYWORDS:
Risk factors, systemic inflammatory response syndrome, burn, Indonesia, preventable deaths

INTRODUCTION

Burn injuries represent one of the most severe forms of trauma, inflicting enduring physical and psychological distress. They cause immense suffering and can lead to significant disabilities, often resulting in societal stigma.[1] The impact of a severe burn injury extends beyond the immediate physical damage. It initiates a systemic chain reaction within the body, triggering a systemic inflammatory response syndrome (SIRS) and profound metabolic disturbances. These disturbances can present in various forms, including cardiac dysfunction, acute respiratory distress syndrome, acute renal failure and increased intestinal permeability, which can potentially lead to bacterial translocation.[2-4] Furthermore, the body's homeostatic balance is significantly disrupted, leading to conditions such as hypermetabolism, hypercatabolism and sepsis. These severe disruptions can escalate to multiple organ failure and, in extreme cases, result in death. Therefore, the repercussions of burn injuries are far-reaching, causing a cascade of complications that can have enduring consequences.

According to the World Health Organization (WHO), burns account for more than 300,000 deaths worldwide each year.(1) In Indonesia, the mortality rate from burns is particularly high, around 40%, with severe burns being the primary cause.6 This high mortality rate is closely associated with SIRS, which is the leading cause of death in burn cases, accounting for 47.05% of fatalities.[7,8] Specifically, at Dr. Soetomo General Hospital, the mortality rate for patients with burn injuries was 10.3% based on data from 2007 to 2011. Meanwhile, the Burn Center of Cipto Mangunkusumo Hospital reported a higher mortality rate of 24% between January 2013 and December 2015.[9,10]

SIRS is an exaggerate, complex and non-specific inflammatory response of immune system to condition that is harmful to the body.[11] SIRS is a problem that arises in the subacute phase of burns and is influenced by several factors, including host, trauma and management factors.[7] Until now in Indonesia, there has been no research correlating these factors with SIRS. This is the basis for conducting this study to know the correlation of risk factors which include age, the extent of burns, cause of burns, inhalation trauma, history of hyperglycaemia, anaemia, hypoalbuminemia and extended spectrum beta lactamase (ESBL) bacterial infection with the

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Table I: Characteristic of study participants

Characteristics	n	%	Mean	SD
Age (years)			34.48	21.00
Less than 1	11	6.7		
1-20	30	18.4		
21-60	101	62		
>60	21	12.9		
Sex				
Male	111	68.1		
Female	52	31.9		
Cause				
Fire	98	60.1		
Hot water	35	21.5		
Electricity	21	12.9		
Chemicals	4	2.5		
Hot oil	2	1.2		
Thermal contact	3	1.8		
SIRS incidence				
Occurred	11	6.7		
Not occurred	152	93.3		
Inhalation trauma				
Occurred	64	39.3		
Not occurred	99	60.7		
Diabetes mellitus				
Occurred	4	2.5		
Not occurred	159	97.5		
Anaemia				
Occurred	24	14.7		
Not occurred	139	85.3		
Hipoalbuminemia				
Occurred	66	40.5		
Not occurred	97	59.5		
ESBL infection				
Occurred	2	1.2		
Not occurred	161	98.8		
Burn surface area percentage				
Less than 50%	125	76.7		
50% or more	38	23.3		

SIRS = Systemic inflammatory response syndrome; ESBL = Extended spectrum beta-lactamase

Table II: Statistical comparison analysis of risk factors for Systemic Inflammatory Response Syndrome in burn patients admitted to the Burn Center of Dr Soetomo General Hospital

Variables	OR	95%CI	p-value
Age	-	-	0.412
Sex -	-	0.733	
Cause	-	-	0.725
Inhalation trauma	-	-	0.112
Diabetes mellitus	-	-	1.000
Anaemia	0.213	0.05, 0.81	0.012*
Hipoalbuminemia	0.231	0.06, 0.91	0.030*
ESBL infection	-	-	0.131
Burn surface area percentage	5.835	1.55, 21.95	0.001*

OR = Odds Ratio, 95%CI = 95% Confidence Intervals, ESBL = Extended spectrum beta-lactamase, *Statistically significant

incidence of SIRS in burn patients and the mortality rate at the Burn Center of Dr Soetomo General Hospital, Surabaya, Indonesia.

MATERIALS AND METHODS

The study is observational analytic research using a retrospective design based on secondary data. The research sampling method used the total sampling method including data from all burn patients treated at the Burn Center of Dr Soetomo General Hospital, Surabaya, Indonesia. The following criteria was used as inclusion criteria: patients diagnosed with burn injury and admitted from 2018 to 2019. The data were extracted from medical records of the patients. The independent variables were age, extent and depth of burns, causes of burns, hyperglycaemia, anaemia, hypoalbuminemia and ESBL. The dependent variable (bound) is the occurrence of SIRS.

STATISTICAL ANALYSIS

The data is presented descriptively in the form of graphs and tables. The comparison of each variable was analysed using the chi-square statistical test or Fisher's exact test. All data were analysed using the Statistical Package for the Social Sciences (SPSS) software with a significance of 0.05.

RESULTS

The study included 163 burn patients at the Burn Center of Dr Soetomo General Hospital, Surabaya, Indonesia from January 2018 to December 2019. Table I displays the results of the descriptive analysis. The table shows that the study population was mostly from productive age (2060 year) with 101 patients (62.0%) and the mean age of sample in this study was 34.48±21.00 year. The most common cause of burn injury was fire (60.1%). The mean of burn surface area was 30.93±23.39%, where 125 patients had less than 50% of burn surface area. Sixty-four patients (39.3%) suffered from inhalation trauma, four patients (2.5%) had diabetes mellitus, 24 patients (14.7%) suffered from anaemia, 66 patients (40.5%) suffered from hypoalbuminemia and two patients (1.2%) suffered from EBL infection. Among them, 11 patients (6.7%) suffered from SIRS.

The result of the statistical analysis showed that anaemia, hypoalbuminemia and burn body surface percentage were significantly correlated to the incidence of SIRS while age, sex, cause of burn injury, inhalation trauma, diabetes mellitus and ESBL infection has no significant correlation with SIRS. The detail are shown in Table II.

The data processed consequently were analysed using logistic regression analysis resulting in burned body surface area percentage as the most influencing factor of SIRS incident (Odds Ratio, OR: 5.835; 95% Confidence Intervals, 95%CI: 1.55, 21.95), followed with anaemia (OR: 0.213; 95%CI: 0.05, 0.81).

DISCUSSION

SIRS is a form of systemic clinical response to various severe clinical stimuli such as infection and non-infection such as trauma, burns, autoimmune reactions, cirrhosis and pancreatitis. The inflammatory response following an injury is physiological. However, when this response is systemic, it cannot be considered physiological anymore.[12]

In burns patient, the predisposing factors for the emergence of SIRS are grouped into two factors: internal and external. Internal factors include the general state of the patient, such as age and nutritional status as well as other co-morbid conditions, including pregnancy, existing disease, or disorder such as heart disease, and kidney, vascular and other metabolic disorders. External factors include the type of trauma and its management. The types of trauma that play a role in the course of the disease and prognosis include inhalation injuries, shock, the extent and depth of burns, and other accompanying injuries. Meanwhile, management that affects the incidence of SIRS includes first aid given, resuscitation measures and further management, including wound care management.[12]

The previous study was conducted by Burman Hedi in 2017 with different samples and populations through correlation analytic research using observational methods and cross-sectional approaches to look at factors related to SIRS events including age, infection cases, cases non-infectious, surgical cases and non-surgical cases. The study population was patients treated in the intensive care unit (ICU) of Lahat Hospital, South Sumatra. The results showed that there was a significant relationship between age (p=0.009) gender (p=0.007), cases of infection (p=0.010) and surgical cases (p=0.014) and the incidence of SIRS.[13]

The findings of this study have significant implications for the clinical management of burn patients. The identification of burn area and anaemia as key risk factors for the incidence of SIRS provides clinicians with valuable information for early detection and intervention.

Given that the extent of a burn has been recognised as the most influential risk factor, it is imperative for healthcare professionals to meticulously monitor patients with extensive burn areas for indications of SIRS. This could necessitate more regular assessments and the utilisation of predictive instruments to evaluate the probability of SIRS occurrence.

Routine physical examinations and laboratory investigations can be employed to more effectively monitor these patients. Physical examinations can aid in the early detection of SIRS signs, such as alterations in body temperature, heart rate, and respiratory rate.[14,15] Persistent tachycardia, tachypnoea, leucocytosis and a resetting of normal temperature to approximately 38°C have been documented as indicators of SIRS in burns encompassing more than 15-20% of the total body surface area (TBSA).[16] Laboratory tests can also provide a more detailed insight into the patient's condition. For instance, blood tests can reveal abnormalities in the levels of certain biomarkers associated with inflammation and infection, such as C-reactive protein (CRP), procalcitonin (PCT) and interleukins (ILs). Therefore, a comprehensive approach to patient monitoring can significantly improve the management and outcomes of severe burn injuries.[17]

The TBSA implicated in a burn has been previously recognised as a determinant of fatality in patients suffering from severe burns. Research indicates that for each one percent escalation in TBSA burned, there is a corresponding six percent augmentation in the risk of mortality.[18] Patients with extensive burn areas are susceptible to hypovolemic shock, a condition precipitated by increased systemic capillary permeability and consequent protein leakage. However, the ramifications of a larger burn area are not confined to hypovolemic shock; it can also precipitate the onset of SIRS. Investigations have established that both SIRS and TBSA are substantial contributors to fatality in patients with severe burns.[19] Consequently, the magnitude of the burn area assumes a pivotal role, not merely in the immediate repercussions of the injury, but also in the genesis of systemic complications that can markedly influence the patient's prognosis.

Anaemia was identified as the second most influential factor. This suggests that maintaining optimal haemoglobin levels could potentially reduce the risk of SIRS in burn patients.[21] Clinicians could consider implementing strategies to manage anaemia, such as transfusion of whole blood, in patients with significant burns.[21] Although other studies suggest that anaemia in SIRS patients is the result of bone marrow blunting as a response to erythropoietin, mediated by inflammatory cytokines such as interleukin-1 and tumour necrosis factor. Thus, the anaemia is precedented by inflammatory processes, and not the contrary.[22] Capillary leak from increased endothelial permeability in severe burn injury led to transendothelial loss of albumin. Besides its oncotic effect, albumin has anti-inflammatory and antioxidant activities beneficial to burn patient and to reduce the severity of SIRS. On the other hand, the release of cytokines induced by SIRS (e.g. interleukin-1 and tumour necrosis factor-α) may cause an acute reduction of albumin during the first 24-48 h through increased capillary permeability and subsequently through depressive effect on interleukin-1 to mRNA involved in albumin production.[23,24] By managing these risk factors effectively, it is hoped that the incidence of SIRS in burn patients can be reduced, thereby improving patient outcomes. Future research could focus on developing specific protocols for the management of these risk factors in the clinical setting.

However, this study has some limitations. The sample size was small, and it used a retrospective approach. To enhance the study's reliability and generalisability, future research should consider increasing the number of participants. A larger and more diverse sample would provide more robust results. Instead of data from 2 years, data from a longer period of time is recommended.

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