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PROGNOSIS OF INHALATION INJURY IN SEVERE BURN PATIENTS ON EMERGENCY PHASE

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ABSTRACT

***Background**: Inhalation injury in severe burns is a serious problem cause mortality and morbidity. Survival prognosis of severe burn is most important for patients and family in the emergency phase. The purpose of this study is to analyze the impact of inhalation injury in severe burn patient during emergency phase in Sanglah Hospital, Bali, Indonesia.*
***Methods**: This study was a cohort retrospective design of the 78 samples of medical records at Sanglah Hospital in a period of 2 years, from March 2014 until March 2016.*
***Results**: The results of logistic regressions with mediation show that inhalation injury is a predictor factor of patient's survival (p = 0.000) that mediated by respiratory rate. The equation obtained y" = -6.608 + (5.589) (Inhalation Injury) + (1.942) (RR). The probability for patient with severe burn to die in the first 48 hours if the patient has an inhalation injury and has a respiratory rate in the first 8 hours after fluid resuscitation of more than 24 x/m is 71.4%.*
***Conclusions**: Patient with inhalation injury on severe burn has better prognosis if respiratory rate on first 8 hours is less than 24 cycles per minute.*

***Keywords**: Prognosis of burn, inhalation injury, severe burn, emergency phase*

INTRODUCTION

Burn injuries are critical clinical issues with high morbidity and mortality. The incidence of inhalation injury in burn patients who require hospitalization ranges from 20% to 30%, and at least 30% of patients with inhalation injury die [1, 2, 3]. Mortality of patients with an inhalation injury was expected to increase by a maximum of 20%, and by 60% with both inhalation injury and pneumonia [4]. Treatment of patients with severe burn injuries remains a significant challenge, even with advances in burn care during recent decades [5]. Exposure to heat can cause significant injury and rapidly developing edema to the upper airways in up to one-third of burn patients with inhalation injury [1].

Inhalation injury is defined as pulmonary trauma caused by a direct thermal injury of the upper airway or chemical injury of the lower airway [6,7]. Inhalation injury can develop to airway swelling, irritation of chemicals from the lower respiratory tract and produce inflammation of the lungs due to the toxic gases such as carbon monoxide and cyanide for several hours [7]. Therefore inhalation injury became a serious problem during the emergency phase.

Prognosis of survival on burn patient is most often asked even since new patients enter the emergency room. Sanglah Hospital is a referral center and the only one hospital facilitated by the burn unit in Bali. Therefore, this study was conducted to analyzed prognostic implications of inhalation injury to the survival of patients with a severe burn on the emergency phase in Sanglah Hospital.

METHODS

This retrospective observational study was conducted to analyze the relationships between inhalation injury, hemodynamic status, and survival rate. Between March 2014 and March 2016, 98 patients with severe burn admitted to a burn unit in Sanglah Hospital. Based on inclusion criteria such as an adult patient with severe thermal burn and patient with missing data were excluded, so the final dataset included 78 respondents. This study passed from ethical clearance by the Ethics Committee of the Medical Faculty, Udayana University on April 4th, 2016.

The instrument uses a data collection sheet by noting the presence or absence of inhalation injury in patients with severe burns and hemodynamic status. Inhalation injury, respiratory rate, heart rate, and systolic blood pressure were measured in the first eight hours as the variables of interest in this study.

The correlation between the independent variable and survival rate were first examined using correlation for bivariate analysis. Between respiratory rate, heart rate, systolic blood pressure, and survival rate were examined using Spearman with a confidence level of 95% because data were not normally distributed, while the correlation between inhalation injury and survival rate were examined by Lambda test with a confidence level of 95%. The multivariate test used logistic regression with mediation. To simplify the model, the variables were reduced by backward selection based on significance. The model performance was evaluated using measures of the area under the receiver operating characteristic (ROC) curve. The Hosmer-Lemeshow goodness-of-fit test was used to assess calibration.

RESULTS

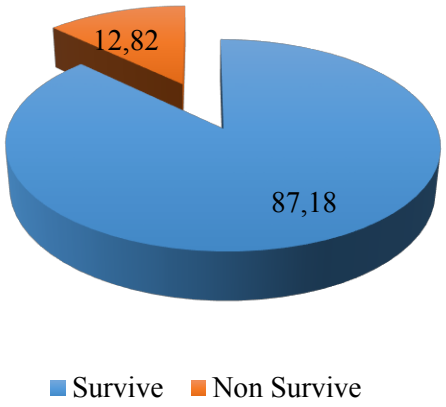

Figure 1. Survival Rate of Severe Burn Patient in Sanglah Hospital

Figure 1 shows that from 78 samples survival rate patients with severe burn are 87.18% from March 2014 until March 2016 at Sanglah Hospital.

Table 1. Spearman Test's for Respiratory Rate, Systolic Blood Pressure, and Heart Rate with Inhalation Injury

	1	2	3	
1. Inhalation injury	-	.514*	.357*	-.078**
2. Respiratory Rate	.514*	-	-	-
3. Systolic Blood Pressure	.357*	-	-	-
4. Heart Rate	-.078**	-	-	-
N = 78, * $p < .001$, ** $p > .05$				

Table 1 shows that the inhalation injury is only related to respiratory rate and systolic blood pressure and is not related to heart rate. Among the three, the highest correlation value between inhalation injuries with respiratory rate (r_s (78)= .514, p < .001) and it indicated the moderate correlation strength.

Table 2. Lambda Test's for Survival Patients Severe Burn with Inhalation Injury

		Survival		Total	*r*	*p*
		Survive (n)	Die (n)	(N)		
Inhalation injury	None	67	1	68	.800	.008
	Yes	1	9	10		
		68	10	78		

Table 2 shows that inhalation injury and survival patients with severe burn in the emergency phase were significantly correlated r (78)= .800, p < .001). That indicated that there was a strong relationship between inhalation injury and survival rate among patients with severe burn in the emergency phase.

Table 3. Spearman Rho Test's for Haemodinamyc status and Survival Patients Severe Burn

	1	2	3	
1. Survival Patients Severe Burn	-	.514*	.474*	-.142**
2. Respiratory Rate	-.514*	-	-	-
3. Systolic Blood Pressure	.474*	-	-	-
4. Heart Rate	-.142**	-	-	-

N = 78, * p < .001, ** p > .05

Table 3 shows that heart rate in the first 8 hours is not correlated with the survival of severe burn patients with p > .05. There was a significant positive association between systolic blood pressure and survival of severe burn patients (r_s (78)= .474, p < .001) and respiratory rate after 8 hours fluid resuscitation has a significant negative association with survival of severe burn patients in emergency phase r_s (78)= -.514, p < .001).

Table 4. Result form Logistic Regression Test

Variable	B	SE	Wald	Sig.	Exp (B)	95% CI for Exp (B)	
						Lower	Upper
Inhalation injury (II)	5.589	1.508	13.726	.000	267.359	13.903	5141.55
Respiratory Rate (RR)	-6.608	2.369	7.784	.019	6.975	.362	134.229
Constant	-6.608	2.369	7.784	.005			

Note : CI = confidence interval

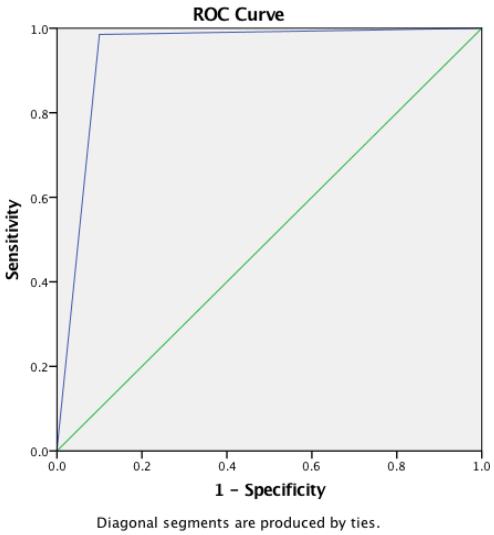

Figure. 2. ROC curve

Table 4 shows the relationship between inhalation injuries mediated by a respiratory rate on the survival of severe burn injury was demonstrated by equation y" = -6.608 + (5.589) (CI) + (1.942) (RR). Based on that equation by using the probability formula p = 1/(1+e-y), the probability of severe burn patient to die in emergency phase is 71.4%, if there was inhalation injury with respiratory rate post fluid resuscitation more than 24 times per minutes. Figure 2 shows that the quality of equations obtained based on the value of Area Under on ROC Curve discrimination is 94.3%. It means that the quality of the equation obtained is very strong.

DISCUSSION

This study found the survival rate of severe burn patients in the emergency phase retrospectively from March 2014 to March 2016 reached 87.18%, which means that the survival rate of severe burns patients during the emergency phase at Sanglah Hospital is quite high. In contrast, Davis et al. [12] showed the survival rate of burn patients in the emergency phase is 54%. It means the previous study by Davis et al. [12] has a lower survival rate than this study. The differences in survival rates are due to the characteristics of the samples used are different regarding age group, which in this study specifically using the sample of adult patients while Davis et al. [12] using samples from elderly patients. This is also supported by a study from Zanasi et al. [9] which is suggests that older age groups have a higher risk of death. The high mortality rates in elderly people affected by burns result from a combination of various functional disorders [16].

Based on table 1, we can see that the highest correlation value with inhalation injuries is the respiratory rate (r_s (78)= .514, $p < .001$). The higher of the respiratory rate, the more severe the degree of inhalation injury patient with severe burn. An inhalation injury will induce cascade complement activation followed by aggregation of pulmonary leukocytes and free oxygen radicals that cause pulmonary edema and as result respiratory rate will increase in response to inadequate respiratory function [11]. Edema obstructs the airway is also caused by increased capillary permeability along the airway and pulmonary that occurs when fluid resuscitation is ongoing [6]. This explains that the inhalation injury correlates to the respiratory rate, although the respiratory rate is measured 8 h after fluid resuscitation. Thus, it can be concluded that the hemodynamic status associated with significant inhalation injury is respiratory rate and systolic blood pressure, where the respiratory rate has the strongest relation strength compared with another hemodynamic status after the first 8 hours of fluid resuscitation.

The present study confirms the previous finding that inhalation injury is significantly correlated with the survival rate of patients with a severe burn on emergency phase [6, 8, 9, 10]. Based on table 2, it

shows that there was a strong correlation between inhalation injury and survival of severe burn patients in the emergency phase at Sanglah Hospital with r (78)= .800, p < .001). Another study from Kraft's et al. [10], shows the same thing that inhalation injuries contribute to mortality of burn patients and have a strong correlation. Compared with Taylor's et al. [8] through national data in the United States for ten years also proves that inhalation injury correlated to mortality of burn patients with a value of p <.05. A study from Zanasi, et al. [9] show that burn patients with inhaled injuries have shorter survival.

In severe burn injury, there is a systemic response to injury that leads to capillary leakage throughout the body that usually persists for 8 hours to 12 hours following injury [11]. Based on Table 3, it can be seen that the hemodynamic status correlated significantly to the survival of the patient within the first 48 hours was systolic blood pressure with p <.001 and respiratory rate with p < .001 measured 8 hours post fluid resuscitation, while the heart rate is not significantly correlated to survival. The results were consistent with one study by Davis et al. [12] who found that respiratory rates and blood pressure significantly affected the survival rate of severe burn patients.

Inhalation injury directly may result in edema of the upper airway leading to mortality within hours of injury [6]. Black, et al. [15], explained that a second fatal result of inhalation injury was decreased in pulmonary compliance, which can be reduced by more than 50% in the first 24 hours after injury. In more severe inhalation injuries can cause hypoxemia and acute micro vascular injury with an increase in trans-vascular fluid resulting in a clinical picture of acute respiratory distress syndrome (ARDS). Research from Dries and Endorf [6], also revealed that mortality increased 20% in burns with inhaled injuries and could increase 60% chance of death if there was pneumonia as a complication of inhalation injury.

Based on the results of logistic regression analysis with intervening variables, it was found that the probability of severe burn patient to die in emergency phase is 71.4%, if there was inhalation injury with respiratory rate after fluid resuscitation more than 24 times per minutes. Also, there was also an indirect effect generated through mediation with RR of 12.67% of the total effect of inhalation injury on patient survival. This finding indicates that involving a respiratory rate increases the probability of patient mortality. An inhalation injury causes edema of airway and pulmonary, then affecting the respiratory rate increase as respiratory insufficiency responses and an increase in respiratory rate is one of the predictors of mortality in severe burn patients [11,13]. In Yang et al. [14] study, in patients with a percentage of TBSA burned of 10 to 40%, the mortality was significantly higher in patients with inhalation burn injury as compared with the total hospitalized patients.

During the emergency phase, inhalation injury to burns can cause problems with airway, breathing, and circulation. Primary inhalation injury will cause a disturbance change in the patient's anatomy such as laryngeal edema that obstructs airway and secondary cause breathing problems due to alveolar injury affected by mechanical ventilation, secondary pneumonia and acute respiratory distress syndrome (ARSD) leading to respiratory failure [14]. Inhalation injuries can result in respiratory failure from 12 hours to 48 hours after first exposure to burns [6].

CONCLUSION

Inhalation injury is a predictor of survival factor in severe burns in the emergency phase, which is mediated by respiratory rate more than 24 times per minutes of patients after 8 hours of fluid resuscitation with a probability of death within the first 48 hours is 71.4%. This finding suggests that as an emergency nurse have to improve the management of burns in the emergency phase by prioritizing airway and breathing problems caused by inhalation injuries.

REFERENCES

1 Marx JA, Hockberger RS & Walls RM. Rosen's Emergency Medicine: Concepts and Clinical Practice, 7th Edition. Philadelphia: Mosby Elsevier, 2009.
2 Bláha J. Physiology and pathology of skin after burns and derangement of gene expression. *Acta Chir Plast* 2006; 48:127-132.
3 Singer AJ, Lee CC, Thode HC Jr: Epidemiology of burns in the ED, 1996-2004. *Ann Emerg Med* 2007; 14:S65
4 Tanizaki S. Assessing inhalation injury in the emergency room. Open Access Emergency Medicine. 2015; 7: 31-35. doi: 10.2147/OAEM.S74580
5 Chen M, Chen M, Wen B, Lee M, & Ma H. The impact of inhalation injury in patients with small and moderate burns. Burns, 2014;40:1481–1486.
6 Dries FW & Endorf DJ. Inhalation injury: epidemiology, pathology, treatment strategy. Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine. 2013;21(31).
7 You K, *et al.* Inhalation injury in burn patients: Establishing the link between diagnosis and prognosis. Burns. 2014; 40: 1470–1475.
8 Taylor SL, et al. Predicting mortality from burns: The need for age-group specific models. Burns. 2014; 40:1106–1115.
9 Zanasi S, de Abreu LC, Heinke T, et al. Factors Associated with Survival of Burned Patients. International Archives of Medicine. 2015; 8 (77). doi: 10.3823/1676
10 Kraft, R, et al. Optimized Fluid Management Improves Outcomes of Pediatric Burn Patients. Journal of surgical research. 2013;181.
11 Chen C, Chen, L, Wen B, Liu S, & Ma, H. Objective estimates of the probability of death in acute burn injury: A proposed Taiwan burn score. Trauma Acute Care Surgical. 2012; 73:1583-1589.
12 Davis JS, Prescott AT, et al. A New Algorithm to Allow Early Prediction of Mortality in Elderly Burn Patients. Burn. 2012; 38: 1114-1118.
13 Snell JA, Loh WN, Mahambrey T, & Shokrollahi K. Clinical review: The critical care management of the burn patient. Critical Care. 2013; 17 (241).
14 Yang TH, Yim H, Cho YS. et al. Investigation of relationship between inhalation injury assessment and prognosis in burn patients. Journal of the Korean Surgical Society. 2011*;* 81:1-9. Doi: 10.4174/jkss.2011.81.1.1
15 Mlcak RP, Suman OE, & Herndon DN. Respiratory management of inhalation injury. Burns. 2007; 33:2–13.
16 Rahayuningsih T. Penatalaksanaan Luka Bakar (Combustio). Profesi. 2012; 8.