

CHARACTERISTICS AND FACTORS AFFECTING THE OUTCOMES OF MASSIVE BURN PAEDIATRIC PATIENTS

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SUMMARY

This study investigated characteristics and factors affecting the outcome of massive burns in children. A retrospective study was conducted on 288 pediatric burn patients (≤ 16 years old) with burn extent $\geq 30\%$ of total burn surface area (TBSA) admitted to the Le Huu Trac National Burns Hospital from 1/1/2018 to 31/12/2022. Patients were divided into two groups of survival and death comparing demographic characteristics, burn features, and outcome. The results showed that most patients were under 6 years old (79.51%), boys (64.58%), due to scald (76.69%). Inhalation injury accounted for 6.25% and the overall mortality rate was 6.94%. There was no remarkable difference between survival and death groups in terms of age, gender, and admission time ($p > 0.05$). Meanwhile, the death group had significantly greater burn extent, deep burn area as well as the rate of inhalation injury than the survival group ($p < 0.01$). The most fatal causal agent was flame as compared to scald and other agents (18.75%; $p < 0.01$). Multivariate analysis showed that the increased deep burn area and the presence of inhalation injury were independent risk factors for mortality with AUC = 0.82; sensitivity: 80%; specificity: 91.42% in the case of combining both variates.

Keywords: Massive burns, pediatric, outcomes

1. INTRODUCTION

Burns in children account for a large proportion of burn patients in the community as well as those treated at medical facilities. Along with advances in

fluid resuscitation, necrosis excision, early coverage with skin substitutes, infectious control, and comprehensive care the complication and mortality rate have been improved in burn patients including pediatric burns [1], [2]. However, the treatment of massive burn patients remains a global challenge due to the lack of autologous skin and the great risk of complications. In children, a massive burn was defined as a burn extent $> 30\%$ of the total body surface area (TBSA) [3].

Due to anatomical and physiological

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characteristics, the responses and progression of pediatric burn patients were different from those of adult burn patients. According to reports, in developed countries, the mortality rate in massive burn children patients currently ranges from 5% to 25% [3], [4], [5]. There were very few reports on this topic in developing countries, including Vietnam. In this study, we analyzed the characteristics and factors predicting mortality in massive burn pediatric patients treated at the National Burn Hospital over 5 years (2018 - 2022).

2. PATIENTS AND METHODS

A retrospective study was conducted on 288 burn pediatric patients (0 - 16 years old), burn extent $\geq 30\%$ of TBSA admitted to the National Burns Hospital from 1/1/2018 to 31/12/2022. Patients were divided into two groups of survival and

death comparing demographic characteristics, burn features, and outcome. Bivariate and then multivariate analyses were analyzed to identify factors that independently affect mortality. Area under the curve (AUC), sensitivity, and specificity were determined by ROC test:

- + AUC > 0,9: Very good
- + AUC = 0,8 ÷ 0,9: Good
- + AUC = 0,7 ÷ 0,8: Quite good
- + AUC = 0,6 ÷ 0,7: Medium
- + AUC < 0,6: Low

The optimal cutoff point was determined by the Youden index:

$$J = \max(\text{Se} + \text{Sp} - 1).$$

In which: J: Optimal cutoff point; Se: Sensitivity; Sp: Specificity

Stata 14.0 software was used and p value < 0.05 was considered a statistically significant level.

3. RESULT

Table 3.1. Patient's characteristics

Parameter	Sub-group	Total (n = 288)	Survival (n = 268)	Death (n = 20)	p
Age, n (%)	< 6	229 (79.51)	213 (79.48)	16 (80)	0,97
	6 - 16	59 (20.49)	55 (20.52)	4 (20)	
	Median	3 (2-6)	3 (2 - 6)	3.5 (2 - 5.5)	0.76
Gender, n (%)	Male	186 (64.58)	177 (95.16)	9 (4.84)	0.06
	Female	102 (35.42)	91 (89.22)	11 (10.78)	
Admission time n (%)	< 24h	230 (79.86)	217 (94.35)	13 (5.65)	0.09
	$\geq 24h$	58 (20.14)	51 (87.93)	7 (12.07)	
Causal agents, n (%)	Scald	218 (75.69)	211 (96.79)	7 (3.21)	0.001
	Flame	64 (22.22)	52 (81.25)	12 (18.75)	
	Others	6 (2.1)	5 (83.3)	1 (16.7)	
Burn extent, % TBSA		35 (30 - 45)	35 (30 - 41)	59 (36 - 62)	0.001
Deep burn area, % TBSA		6 (0 - 15)	6 (0 - 13)	30 (10 - 40)	0.001
Inhalation injury, n (%)		18 (6.25)	8 (44.44)	10 (55.56)	0.001

TBSA: Total body surface area

In 5 years (1/2018 - 12/2022), there were 288 massive burn pediatric patients treated at National Burn Hospital, of which 20 patients died, accounting for 6.94%. Most patients were < 6 years old (79.51%), boys (64.58%), and hospitalized before 24 hours after burn (79.86%). The common casual agent was scald (75.69%) and inhalation injury was recorded in 6.25%.

There was no significant difference

between the two groups in terms of age, gender, and admission time after burn injury ($p > 0.05$). However, the death group had significantly greater burn extent, deep burn area as well as the rate of inhalation injury than the survival group ($p < 0.01$). The most fatal causal agent was flame as compared to scald and other agents (18.75%; $p < 0.01$).

Table 3.2. Multivariate analysis of mortality

Parameter	Coef. (95% CI)	OR (95% CI)	p
Flame burn	0.63 (-2.52 ÷ 1.26)	0.53 (0.08 ÷ 3.54)	0.52
Burn extent	0.02 (-0.02 ÷ 0.07)	1.02 (0,98 ÷ 1,07)	0.29
Deep burn area	0.08 (0.03 ÷ 0.13)	1.08 (1.03 ÷ 1.14)	0.002
Inhalation injury	3.10 (1.07 ÷ 5.14)	22.3 (2.9 ÷ 170.6)	0.003
_cons.	-5.15 (-7.15 ÷ -3.16)	0.006 (0.001 ÷ 0.043)	0.000

OR: Odds ratio; Coef. : Coefficient; CI: Confidence interval; cons.: Constant

Multivariate analysis showed that the deep burn area (OR: 1.07) and the presence of inhalation injury (OR: 9.07) were independent factors predicting mortality ($p < 0.01$). The presence of inhalation injury increases the risk of mortality by 22.3 times, and each 1%

increase in deep burn area increases the risk of death by 1.08 times.

The logit equation of deep burn area (DBA) and inhalation injury (IH) was obtained as follows: $\text{Logit (mortality)} = 0.08 \cdot \text{DBA} + 2.68 \cdot \text{IH} - 4.31$.

Table 3.3. Mortality prognostic value of deep burn area and inhalation injury

Parameter	AUC (95%CI)	Cutoff	Sensitivity (%)	Specificity (%)
DBA	0,77 (0,61 - 0,93)	20	75	88.06
IH	0,74 (0,62 - 0,85)	Có	50	97.01
DBA+IH	0,82 (0,67 - 0,96)		80	91,42

DBA: Deep burn area; IH: Inhalation injury

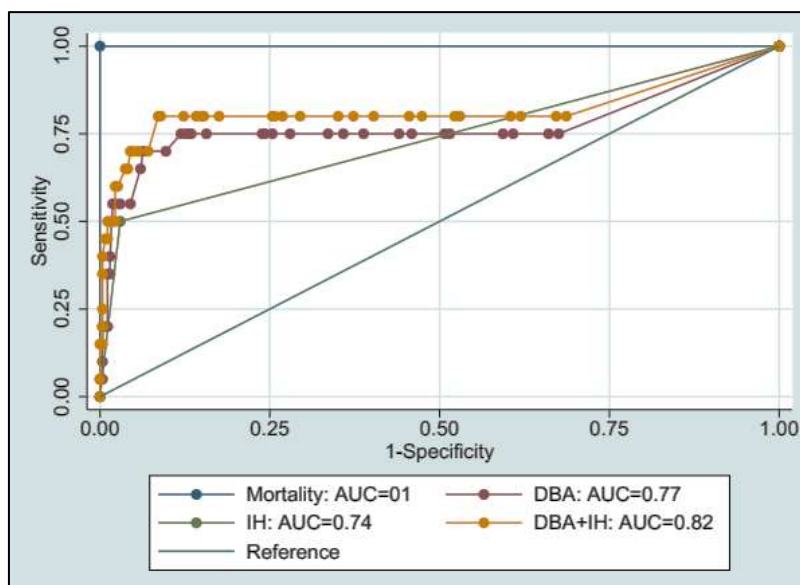


Figure 3.1. ROC curve showing the mortality prognostic value of DBA, IH, DBA+IH

The prognostic value of mortality in massive burn pediatric patients of deep burn area and the presence of inhalation injury were quite good (AUC = 0.77 and AUC = 0.74). When combining these two factors, the results: AUC = 0.82; 95%CI: 0.67-0.96; sensitivity: 80%; specificity: 91.42%.

4. DISCUSSION

Regarding the characteristics of massive burn pediatric patients, there were differences in age and gender ratios. In our study, children under 6 years old account for the majority of hospitalizations (79.51%), mainly boys (64.58% vs. 35.42%). This was similar to other reports around the world. Lee et al (2016) analyzed 2273 pediatric burn patients hospitalized from 1995 - 2013 in the United States and showed that the majority of children hospitalized were aged 0 - 6 years old (73.2%), mainly males (61.6%) [6]. A multicenter analysis in China of 486 pediatric burn cases reported that 58.64% were male [3].

Regarding the causal agent, reports around the world showed that the main causal agent of burns were scald [3], [6], [7]. Our research results were also consistent with the above statement with 75.69% of burn patients suffering scalds. Regarding inhalation injury, Cheng and colleagues (2019) studied 486 massive burn pediatric patients in 106 burn centers in China and found that the rate of inhalation injury was 8.85% [3]. The rate of inhalation injury in our study was 6.25%. The mortality rate in our study was 6.97%; higher than other studies [3], [5]. This shows that we still have a lot of work to do to improve the quality of treatment for massive burn paediatric patients.

Multiple studies have confirmed that increasing age, burn extent, deep burn area, and the presence of inhalation injury were independent predictors of mortality [5], [8], [9], [10]. Research by Martens and colleagues (2023) on 69 massive burn pediatric patients hospitalized for 10 years at the Children's Hospital of Northern California

found that the presence of inhalation injury was an independent predictor of mortality (OR = 3, 4; p = 0.04) [5].

Another report in Iran (2015) also showed similar results, inhalation injury was one of the risk factors for mortality in pediatric burn patients (OR: 8.75; p = 0.009) [11]. Chalya and colleagues (2011) analyzed 342 pediatric burn patients hospitalized at Bugando Medical Center (Tanzania) from January 2008 to December 2010 and found the mortality rate was 11.7%. In addition, burn extent (OR = 2.54; p = 0.012), inhalation injury (OR = 6.43; p = 0.011), along sepsis (OR = 6.86; p = 0.000) were independently related factors to the mortality [12].

In our study, multivariate regression analysis for mortality showed that an increased thickness of the burn area (OR = 1.07; 95%CI: 1.02-1.11; p = 0.002) and presence of inhalation injury (OR = 9.07; 95% CI: 2.13 - 38.59; p = 0.003) were independent factors predicting mortality. The presence of inhalation injury increases the risk of death by 22.3 times, each 1% increase in deep burn area increases the risk of death by 1.08 times. When combining these two factors, the results: were AUC = 0.82, 95%CI: 0.67 - 0.96, sensitivity: 80%, specificity: 91.42%.

5. CONCLUSION

Burn deep area and the presence of inhalation injury were independently associated with mortality in massive burn pediatric patients. When combining the thickness of the deep burn area and inhalation injury, the predictive value of mortality was good.

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