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A Study of Propensity Score on Influencing Factors of Length of Stay in Hospitalized Patients with Burns

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Abstract

Background: Burns are a global public health problem, which are universal and can happen to anyone. Because the physical functions in children and adults are different, the confounding factors are easy to affect the results of study. Objective: In this study, we aimed to explore influencing factors of the length of hospital stay (LOS) when the confounding factors were excluded by Propensity Score (PS) in children and adults. Methods: Patients hospitalized for burn from 2014 to 2016 were retrieved from the medical record system of a general biggest hospital in Zunyi. A database was established to analyze the influencing factors of LOS between children and adults by the PS. Results A total of 465 children (61.7% males) and 327 (69.7% males) adults were recruited. The average age was 3.61±3.57 years and 42.48±14.76 years in children and adults with burns respectively. Before PS matching, low age and skin grafting were the protective factors for LOS (Hazard Ratio [*HR*]=0.993 and 0.339). The risk factors of LOS were male (*HR*=1.234), the burn depth and total body surface area (TBSA), and burn etiology (*HR*=1.497). After PS matching, only skin grafting (*HR*=0.080) and treatment within 24 hours (*HR*=1.865) were the common influencing factors of LOS. Conclusion the confounding factors were excluded by the PS method, and skin grafting was still a protective factor of LOS for both children and adults. The results provide a reference for the promotion of skin grafting to reduce LOS in burn patients.

Keywords: Burns; Propensity score; Risk factors; Length of stay.

1. Introduction

Burns refer to damage to the skin or other organs caused by heat (including hot fluid, flame, hot steam, hot solids, etc.), current, chemicals, radiation, radiation, etc. [1, 2]. Worldwide, burns are the fifth most common cause of injury in non-fatal children [3], especially in low- and middle-income countries, where more than 90% death of children are attributed to burn-related events [4]. In addition to bringing severe pain to the patient, burns also cause different degrees of scarring on the skin [5] . It usually affects the appearance and function of the limbs, and even lead to disability [6]. Burns not only endanger the physical and mental health of patients, but also bring heavy economic burdens and a series of social problems to families and society [7-10].

With the improvement of medical technology, the mortality rate of children's burns has decreased, but the incidence of burns in children is still on the rise [11], and the hospitalization rate of children after burns is high [12, 13]. A research reported by Iran showed that overall median length of hospital stay (LOS) was 10 days in burn children under 15 years old, and LOS increased in accordance with different burn areas [14]. In China, an epidemiological survey of pediatric burns in the Southwest region from 2011 to 2015 showed that the average hospital stay was 14 days [3]. A study by Yao and colleagues in China showed that the average LOS for patients aged more than 16 years old was longer than those under the age of 16 [15]. Differences in length of hospital stay

may be related to local economic development, health care, and the severity of the condition. Meanwhile, children differ adults in length of hospital stay because of their physical activities and working environments [16].

Zunyi is located in a remote area of the southwest China, at an altitude of 800-1300m [17]. People have a great possibility to expose burn risk factors in terms of underdeveloped socio-economic conditions and poor working environments. Moreover, in the underdeveloped areas of the west, adult skin grafting is relatively accepted by local people, however many guardians of burn patients are suspicious of children's skin grafting. Because doctors lack relevant clinical epidemiological survey data to convince their families, it may adversely affect the treatment and prognosis of children.

Propensity Score (PS) refers to the possibility that an observed subject may accept certain processing (or exposure) factors under certain covariate conditions [18]. In epidemiological studies, this method can synthesize multiple covariates into one variable-propensity score. It can effectively reduce the confounding effect, making the results of the study closer to the results of randomized controlled research by balancing the propensity scores between groups [19, 20].

This study retrospectively analyzed the clinical data of hospitalized burn patients in northern Guizhou, China and explored the influencing factors of LOS. In addition, we put the hypothesis that skin grating was a protective factor of LOS for both children and adults in common when the confounding factors were excluded by the PS method. We aimed to explore the common influencing factors of LOS in burn hospitalized children and adults, and provide theoretical basis for relevant departments to take burn prevention measures.

2. Research Subjects and Methods

2.1. Research Subjects

According to the inclusion and exclusion criteria, the information of patients was retrieved from medical data. They were hospitalized for the first time in the Burn and Plastic Surgery Department of the Affiliated Hospital of Zunyi Medical University from January 2014 to August 2016.

2.2. Inclusion Criteria and Exclusion Criteria

Inclusion criteria: patients were hospitalized for the first time in the Burn and Plastic Surgery Department due to tissue damage caused by hot fluid, flame, hot solids, electricity, chemicals, etc.

Exclusion criteria:(1)patients were re-admitted to the hospital due to plastic surgery and worsening of the condition; (2) those who were transferred to other hospitals less than 24 hours after admission or who gave up treatment due to economic reasons; (3) outpatient burn patients.

2.3. Research Methods

Self-made burn inpatient questionnaire referred to the previous literature and combined the characteristics of the northern Guizhou. The information included general conditions: gender, age, place of residence, parental education level, etc.; clinical data: etiology, TBSA, burn depth, whether complications, whether inhalation injury, whether skin grafting surgery, LOS, etc.. The possible influencing factors (excluding age) were statistically significant in the multivariate Cox proportional-hazards regression model, combined with the existing clinical experience were both included in the PS model. Finally we performed the multivariate Cox proportional-hazards regression analysis once again.

2.4. Statistical Analysis

The data were input using Epidata software **(**Version3.02, EpiData Association, http://www.epidata.dk/, Denmark). The Cox proportional-hazards regression model was used to analyze the influencing factors of LOS. SPSS software (Version 24.0, IBM Corp. Armonk New York, USA) was used to analyze the data of children and adults by using Propensity Score (*PS*), and then compare the influencing factors before and after matching. All tests were two-sided, with $P<0.05$ considered statistically significant.

2.5. Ethics Statement

This study was approved by the Institutional Review Board of Zunyi Medical University (No.[2015] 1-003).

3. Results

3.1. The Result of the PS Model Matching

A total of 465 children (61.7% males) and 327 (69.7% males) adults were recruited. The average age was 3.61±3.57 years and 42.48±14.76 years in children and adults with burns respectively. Due to differences in the physical functions of children and adults, they are likely to be a common type of stratified data in epidemiology. Besides, it may lead to some bias in direct comparison or simple merged analysis. Thus, the PS method was used to match the burn children with those having the same or similar propensity scores in adults (see section 2.3 for PS matching factors), and the matching accuracy was 0.2. This study successfully matched 223 groups of children and adults.

3.2. Goodness of Fit Test of ROC Curve to PS Model

In this study, the area under the receiver operating characteristic curve (C value) was used to judge the ability of the model to correctly categorize the subjects. The results showed that the area under the ROC curve was 0.793, and 95% Confidence interval (*CI*) of the C value was 0.758~0.828. The standard error was 0.018, and the model was statistically significant (P<0.001). (See Figure 1)

3.3. Analysis of Influencing Factors the LOS of Burn Patients before and After PS

The PS method was used to match the case data of hospitalized children and adults with burns, including general conditions: gender, season, place of residence; clinical data of burns: burn etiology, burn depth, total body surface area (TBSA), complications, surgery (including amputation, skin grafting, etc.), respiratory burns. We wanted to find the same affecting factors of LOS when the confounding factors were excluded by the PS method. Before PS, male (Hazard Ratio [*HR*]=1.234), deep partial thickness(*HR*=3.128), full thickness (*HR*=1.791), TBSA ranging from 10% to 29% (*HR*=3.978), TBSA ≥30% (*HR*=1.787) and heat etiology(*HR*=1.497) were risk factors for LOS. Low age (*HR*=0.993) and skin grafting (*HR*=0.339) were protective factors for LOS. After PS, age, gender, burn depth, TBSA, etiology, inhalation injury, and complications were not influencing factors for LOS yet. Skin grafting (*HR*=0.080) was still a protective factor for LOS, and admission to hospitals within 24 hours (*HR*=1.865) was a risk factor for LOS. (See Table 1)

4. Discussion

This study retrospectively analyzed the demographic data and clinical data of burn hospitalized children and adults in the past 3 years. We aimed to explore the common influencing factors of LOS between children and adults by Propensity Score (PS) matching to eliminate the influence of confounding factors.

The results of this study showed that the median LOS of burn patients was 9 days, similar to the results of Cornet and colleagues [21].The median LOS for children was 8 days and the median LOS for adults was 12 days. Analysis of the multivariate Cox regression model before PS showed that age (*HR*=0.993) was a protective factor for LOS. A possible reason why age reduced LOS is that the skin of young people is thin and tender, and the tolerance to high temperature is weak, thus wound damage is often more serious. Meanwhile the functions of all tissues and organs are not perfect, and the body repair function is poor. Therefore, the treatment period is longer than that of older people. Male was risk factors for burns (*HR*=1.234), which was consistent with previous studies [22-24]. Boys like to explore unknown things and novel environments with they being active, lively and naughty. Therefore they are more likely to be exposed to burn hazards. Adult males are the main source of income for the family. They often Working outside, due to the harsh working environment and lack of occupational protection measures, are more vulnerable to burns [25].

Our study found that the risk of deep partial thickness was higher than that of full thickness (*HR*=3.128 vs 1.791). Full thickness often involves subcutaneous tissues, neuromuscular, and even bones, and most patients need to undergo pedicle flap transfer surgery. Flap transfer can fill the tissue defect by mobilizing the surrounding tissue, so it can promote the wound to heal successfully [26]. The patient can be discharged from the hospital when the patient's vital signs are stable and the flap model survives. TBSA was a risk factor for LOS. With the increase of TBSA, the exposure of the wound to the environment leads to an increased risk of bacterial infection, accompanied by internal environmental dysfunction. The patient's condition is complicated and requires long-term hospitalization. Heat etiology was also a risk factor for LOS (*HR*=1.497). It may be because heat not only directly damages the skin, but also damages deep tissues. Deep tissue burns often increase the LOS.

After PS matching between both burn children and adults, only skin grafting (*HR*=0.080) and treatment within 24 hours (*HR*=1.865) were the common influencing factors of LOS. Both before and after matching showed that skin grafting could reduce the patient's LOS. The reason may be that under the same burn condition, the skin graft can quickly seal and protect the wound. It can prevent the wound infection from worsening, and accelerate wound healing and shorten the course of treatment [27]. Clinicians hold the idea that when the burn wound reaches a certain area, skin grafting should be carried out. Although adult skin grafting is relatively be accepted in the poor areas of the west, many families of burn patients are skeptical about children's skin grafting. They think that the child's skin can grow fast by itself and there is no need for skin grafting. In addition, the child cannot bear the risk of surgery and the skin transplant process will bring unnecessary pain to the child. Because doctors lack relevant clinical epidemiological survey data to convince their families of patients, they may adversely affect the treatment and prognosis of the child. Within 24 hours, attending the hospital was a risk factor for LOS. It may be associated with the following two reasons: Firstly, the study was limited to inpatients, not including outpatients and non-burn new patients; secondly, Affiliated Hospital of Zunyi Medical University is a professional burn treatment center in Guizhou province. Patients without serious burns generally choose to seek medical treatment at the local county hospital. Only when the condition is serious, they choose to go to the higher hospital for medical treatment. Therefore, LOS tends to be longer.

In order to take preventive measures of the burns in the whole population, the government should give administrative, educational and financial support. First of all, we should strength and implement the system and responsibility of safety supervision departments at all levels, and earnestly do a good job in security prevention [28]. Secondly, the prevention and control of burns in children and adults should focus on high-incidence populations, time, place and common causes of injury, and timely take targeted interventions, such as improving the industrial environment and raising the awareness of workers' occupational protection. At the same time, knowledge of burns

and first-aid measures when burns occurring should be popularized in some places such as communities (villages), schools and homes [29, 30]. Finally, in order to alleviate the financial burden of patients and improve their quality of life, the government, society, and enterprises should provide financial support. And government should unite with higher medical institutions to provide quality medical services to patients, and encourage rehabilitation training so that they can regain their survival skills.

5. Conclusion

In this study, age and skin grafting were protective factors for LOS. On the contrary, etiology, male, deep partial thickness, full thickness, TBSA ranging from 10% and 29%, and TBSA more than 30% were risk factors. Moreover, this study conducted a PS matching analysis of both burn adults and children. The result showed that skin grafting was still a protective factor of the LOS for burn patients. The results provide a reference for the promotion of skin grafting to reduce LOS in burn patients.

6. Limitation

There were some limitations in our study. Firstly, this study was limited to inpatients and exclude multihospital patients and outpatients. Thus the burn severity might be higher than the average level. Secondly, because the deaths never were involved in this study, we could not analyze the risk factors for mortality. Thirdly, the patients in our center mainly originated from the northern Guizhou, therefore more studies of patients with large sample sizes and multicenters may be conducted in the future.

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Conflicts of Interest

All authors declare no conflicts of interest related to this manuscript.

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Author Contributions

Conceptualization: XHL. Data curation: XHL, XW, HTY, TW, HZ. Formal analysis: XHL, XW, HTY, TW. Funding acquisition: XQS. Methodology: TW. Project administration: None. Visualization: None. Writing - original draft: XHL, TW. Writing - review & editing: XQS.

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Ethics Statement

This study was approved by the Institutional Review Board of Zunyi Medical University (No.[2015] 1-003).

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Table-1. Factors influencing LOS of burn patients before and after Propensity Score

Influencing factors	Variable assignment	Before PS		After PS	
		P-value	*HR(95%CI)*	*P-value*	*HR(95%CI)*
Age	Continuous variable	0.001	0.993(0.988~0.997)	0.720	0.998(0.990~1.007)
Gender	1=Male; 0=Female	0.026	1.234(1.026~1.484)	0.991	1.002(0.656~1.532)
Burn depth	Dummy variable	<0.001		0.431	
Superficial partial thickness			1.00 (Ref.)		1.00 (Ref.)
Deep partial thickness		<0.001	3.128(2.349~4.166)	0.649	0.873(0.488~1.564)
Full thickness		<0.001	1.791(1.379~2.327)	0.206	0.744(0.470~1.177)
TBSA(%)	Dummy variable	<0.001		0.069	
<10			1.00 (Ref.)		1.00 (Ref.)
10~29		<0.001	3.978(2.551~6.205)	0.277	0.654(0.304~1.407)
≥30		0.012	1.787(1.135~2.813)	0.838	1.081(0.515~2.269)
Etiology	1=Heat; 0=Non-heat*	0.001	1.497(1.189~1.886)	0.633	1.123(0.697~1.809)
Skin grafting	1=Yes; 0=No	<0.001	0.339(0.254~0.451)	<0.001	0.080(0.028~0.230)
Inhalation burn	1=Yes; 0=No	0.721	1.076(0.721~1.605)	0.990	1.004(0.498~2.025)
Complications	1=Yes; 0=No	0.218	0.819(0.597~1.125)	0.495	1.234(0.674~2.570)
Medical treatment ≤24 h	1=Yes; 0=No	0.773	0.968(0.777~1.207)	0.006	1.865(1.197~2.906)

*: Heat etiology includes hot fluid, flame, hot steam, hot solids, and all other factors belong to non-heat etiology.

Fig-1. Goodness of fit test of ROC curve to Propensity Score Model