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Cost Analysis of the Treatment of Severe Burn Injuries in a Tertiary Burn Center in Northern Iran

Fatemeh Rangraz Jeddi[1,2], Mohammadreza Mobayen[3], Alireza Feizkhah[3], Razieh Farrahi[2], Safiyehsadat Heydari[1] and Parissa Bagheri Toolaroud[1,2,*]

[1]Health Information Management Research Center, Kashan University of Medical Sciences, Kashan, Iran
[2]Department of Health Information Management and Technology, School of Allied Health Professions, Kashan University of Medical Sciences, Kashan, Iran
[3]Burn and Regenerative Medicine Research Center, Guilan University of Medical Sciences, Rasht, Iran

*** *Corresponding author:*** Parissa Bagheri Toolaroud, Health Information Management Research Center, Kashan University of Medical Sciences, Kashan, Iran. Tel: +989112812842; Email: bagheri-p@kaums.ac.ir

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Abstract

Background: One of the most expensive aspects of healthcare is providing treatment for burn victims. However, just a few burn cost analysis studies have been conducted in Iran.
Objectives: This study, thus, aimed to estimate the cost of treating severe burn patients in a burn center.
Methods: This retrospective study was performed on medical records of 143 severe burn patients referred to a specialized burn center between March 2020 and March 2021. The data were collected regarding the treatment costs and were analyzed using the SPSS software (version 16.0).
Results: The mean±SD total per-patient cost was US$ 5445.53±4742.45. Electrical burn patients had a higher average total cost of care and length of stay, compared to other burn patients. Bed charges (21.97%), the surgeon's salary (27.17%), as well as equipment and consumables (17.83%), were the main cost drivers.
Conclusion: The results of this study can help hospital authorities and governments understand the direct costs of a burn center and the total budget a country might need to cover the annual costs of treating burn victims. In addition, the cost of burn care in this study differed from that in other studies. The disparity in reported numbers can be attributed to variations in methodologies being used, costing viewpoints, study site, treatment procedures, hospitalization regulations, medications, surgeries, health service providers' salaries, nonclinical support, and indirect costs.

Keywords: Burns, Direct service costs, Health care costs, Hospital costs

1. Background

Burn is a widespread and complex public health problem that has disproportionately affected low-middle-income countries (LMICs) (1). Burn trauma happens due to body contact with thermal, chemical, and electrical energies (2). Thermal burns induced by fire/flame and scalds are the most prevalent types of burn (3). According to a report released by the World Health Organization, more than 95% of thermal burns occur in LMICs (4,5). In addition, about 500,000 burn victims require medical attention each year, nearly 40,000 of whom need hospitalization (6).

The treatment of severe burn victims is a major undertaking that includes numerous components, such as wound excision, grafting, coverage, nutritional support, medication, physiotherapy, as well as wound administration to control infection (7). Despite significant advances in methods of treating burn patients, the financial burden of burn care remains high (3) due to burn victims' long stay in the hospital which results in substantial healthcare expenses (1,8,9). A study in Bangladesh showed that the cost of treating and caring for burn patients was four times the cost of other injuries (10). Based on the American Burn Association Statistical Report, total expenses for burn patients with >10% total body surface area (TBSA), who have survived, was US$ 269,523, and for those who did not survive averaged US$ 361,342 (11). In addition, the average estimated costs of treating deep partial and full-thickness burns were US$ 1725.1 and US$ 4227.6, respectively, among those admitted to burning centers in Nepal (1).

Various studies have shown that general burn care delivery in LMICs has significant challenges (9,12). There are deficiencies in health infrastructure, such as the operating room and the number of doctors and nurses. Furthermore, most LMICs face severe restrictions on supplying essential medicines and wound dressings (9,13). Burn prevention strategies are, thus, required for each geographical location, although the implementation will take time (13). Therefore, understanding the cost of burn care can aid policymakers in making health-care spending decisions (1,9). However, despite the rising demand for this information and the increased focus on health-treatment costs, to our knowledge, there is little data reporting burn care costs and the resources utilized in Iranian hospitals.

2. Objectives

Therefore, this study aimed to conduct a cost analysis of the treatment of severe burn injuries in a tertiary burn center in northern Iran.

3. Methods

3.1. Study design and setting

This retrospective study reviewed medical records of severe burn patients admitted to Velayat Burn Center in Guilan, Iran. This burn center is the only referral center for all burn injuries in the region. All patients admitted to this center between March 2020 and March 2021 were included in the initial screening. The inclusion criteria were a TBSA of ≥20% with a degree of ≥2. Patients were excluded if any of the following occurred: death during admission, a TBSA of less than 20%, readmission(s), multiple traumas, pregnancy, or incarceration (Figure 1). Data were collected using the hospital information system and the International Classification of Diseases diagnostic codes (T20 to T32). Data collected included the patients' age, gender, marital status, the cause of the burn, TBSA, infection, the number of surgeries, health service costs, and health insurance.

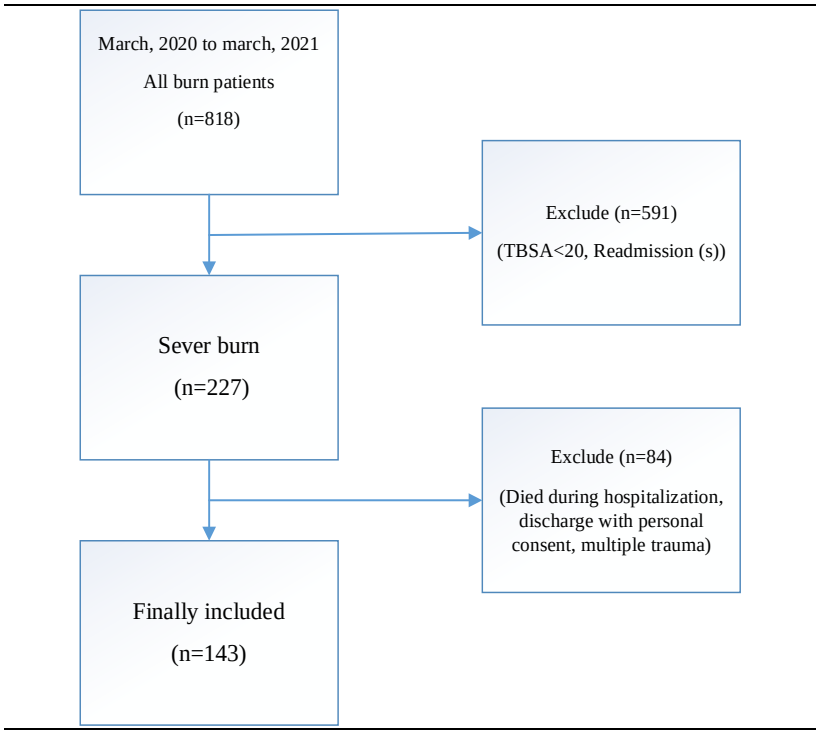

Figure 1. Flow chart for patient selection

3.2. Statistical analysis

In this study, descriptive statistics were used to examine the data obtained from the sample. Based on the Kolmogorov-Smirnov test, the data did not have a normal distribution. The Kruskal-Wallis variance test was, therefore, used to compare variables, such as the length of stay (LOS) and the number of surgeries, with costs. In addition, the post hoc test was utilized to identify differences between variables. The statistical analysis was performed using the SPSS software (version 16.0, SPSS Inc., Chicago, IL, USA). P-values of less than 0.05 determined the statistical significance.

4. Results

During 2020 and 2021, 818 patients were admitted to the burn center under study, 675 of whom were excluded from the present study for the following reasons: deaths during admission (n=63), discharges with personal consent (n=14), multiple trauma (n=7), and a TBSA of less than 20% (n=591). Only 143 patients remained for analysis.

The median age of patients was 36 years. Most of them (95.1%) were covered by health insurance. The burns were more frequent in males (74.83%). Thermal burns were the most common burns (55.2%). Blood cultures were positive in 38 patients (26.6%). The most common infectious agent was pseudomonas (71.1%). Demographic and clinical characteristics of burn patients are shown in Table 1.

The median LOS of severe burn patients was 9 days (1-48). There was a statistically significant correlation between hospitalization days and the type of burn (P=0.002). The post hoc test was used to recognize the source of this correlation. There was a statistically significant correlation between hospitalization days after hot liquid and thermal

Table 1. Demographic and clinical characteristics of severe burn patients

Variable		All burn patients (n=143)
Age (years)	Median[a]	36 (1-82)
	≤18[b]	38 (26.6%)
	>18[b]	105 (73.4%)
Marital status[b]	Single	62 (43.4%)
	Married	81 (56.6%)
Length of stay (days)[a]		9 (1-48)
Gender[b]	Female	36 (25.17%)
	Male	107 (74.83%)
Co-morbidities[b]	Yes	31 (21.7%)
	No	112 (78.3%)
TBSA[a]		26% (20-53)
Burn cause[b]	Hot liquid	54 (37.8%)
	Thermal	79 (55.2%)
	Electrical	7 (4.9%)
	Chemical	3 (2.1%)
Infection	Yes	25.17%
	No	74.83%
Insurance[b]	Yes	136 (95.1%)
	No	7 (4.9%)
Number of Surgeries[a]		4 (0-23)

a: Median (min-max)
b: N (%)
TBSA: Total body surface area

burns (P<0.001), as well as hot liquid and electrical burns (P=0.042). Each one percent of burn corresponded to a mean LOS of three days. The median burned TBSA was 26%, which was the highest in electrical burns. There was also a statistically significant correlation between TBSA after hot liquid and thermal burns (P<0.001), as well as hot liquid and electrical burns (P=0.010).

Table 2 shows the treatment costs of burn patients by etiology. The mean total per-patient cost was US$ 5445.53±4742.45. The average out-of-pocket cost of the direct treatment for burn patients during the treatment was US$ 405.78±714.06. The highest hospitalization cost was related to electrical burns, with a mean daily price of US$ 865.34 and a total cost of US$ 9518.80±7090.17. Burns caused by hot liquids had the lowest cost, with a mean daily fee of US$ 498.52 and an average total cost of US$ 3240.41±2145.67. At a significance level of 95%, the average treatment costs of burn patients differed significantly depending on the type of burn. Based on the post hoc tests, the average costs of patients referred due to burns caused by hot liquids and thermals (P<0.001), as well as patients with burns caused by hot liquid and electricals (P=0.007), were significantly different from each other.

Based on Table 3, the most significant component of the total charge was the operative cost at 55.54%. Within operative expenses, the surgeon's salary was the highest cost (55.26%), followed by ward expenditures (39.77%). Bed charges were equal to approximately US$1196.65 and accounted for 55.25% of the total cost of ward expenditures. The surgeon's salary (27.17%), bed charges (21.97%), as well as equipment and consumables (17.83%), were the main cost drivers.

Most patients (63.6%) had a TBSA of 20% to 30%. The average LOS in the hospital for this subgroup was seven days in the hospital and three days in the ICU. In addition, the median number of surgeries was four. Patients with a TBSA of >40% had the most significant mean expenditure (US$ 11282) and the highest LOS (14 days) (see Table 4). There was a statistically significant correlation between TBSA with costs, the number of surgeries, and LOS.

Table 2. Average length of hospital stay, TBSA, and medical costs, stratified by the type of burn injury

Type of burn	Number of patients	Length of hospital stay (days)[a]	TBSA[a] (%)	Total cost (US$)[b]	Insurance contribution[b] (US$)	Patient contribution[b] (US$)	Cost per 1% of TBSA (US$)
Thermal	79	10 (1-48)	30 (20-53)	6606.93±5241.32	5270.30±4462.07	434.52±660.19	220.23
Hot liquid	54	6.50 (1-24)	23 (20-38)	3240.41±2145.67	2390.51±1711.27	270.67±573.92	140.88
Electrical	7	11 (1-32)	32 (20-50)	9518.80±7090.17	7385.50±5808.70	636.83±601.64	297.46
Chemical	3	9 (1-10)	30 (20-35)	5048.33±3126.79	1701.54±1702.91	1551.43±2574.98	168.27
Total	143	9 (1-48)	26 (20-53)	5445.53±4742.45	4187.53±3987.64	405.78±714.06	213.28

a: median (min-max)
b: Mean±SD
TBSA: Total body surface area

Table 3. Average direct cost of different care pathways

Parameters		Average direct cost (US$) per patient	
		Cost (mean±SD) (US$) (%)	Mean(US$) (%)
Visit and consultations	Visit	23.55±52.47 (0.43%)	89.25 (1.64%)
	Consultation	65.70±91.04 (1.21%)	
Operative cost	Surgeon's salary	1479.38±1009.04 (27.17%)	3024.41 (55.54%)
	Anesthesiologist's salary	187.73±177.46 (3.45%)	
	Equipment and consumables	813.100±832.13 (14.93%)	
	Surgery room	423.39±279.29 (7.78%)	
	Medication	120.81±266.90 (2.22%)	
Ward	Nursing services	71.38±69.79 (1.31%)	2165.64 (39.77%)
	Equipment and consumables	157.95±265.28 (2.90%)	
	Bed charges	1196.65±1030.46 (21.97%)	
	Medication	739.66±1378.22 (13.58%)	
Detective services	Laboratory	99.59±124.90 (1.83%)	109.83 (2.02%)
	Radiology (CT-Scan and X-ray)	10.24±14.70 (0.19%)	
Physiotherapy	Physiotherapy	20.94±35.23 (0.38%)	20.94 (0.38%)
Other services and procedures		35.46±20.19 (0.65%)	35.46 (0.65%)
Total costs		5445.53±4742.45	5445.53 (100.00%)

Table 4. Average total costs stratified by TBSA

TBSA (%)	Number of patients	LOS ICU (days)	LOS in hospital (days)	Average number of surgeries	Average cost per patient (US$)
20-30	91	3	7	4	3921
30-40	38	5	12	6	7158
>40	14	7	14	10	11282
P-value	-	0.002	0.007	<0.001	<0.001

LOS: Length of Stay
TBSA: Total Body Surface Area

5. Discussion

This is the first study to estimate the cost of severe burn treatment in a tertiary burn center in Northern Iran. The average costs of treating severe burns were estimated at US$ 5445.53±4742.45. The highest hospitalization cost was related to electrical burns, with a mean daily price of US$ 865.34 and a total cost of US$ 9518.80±7090.17. The surgeon's salary (27.17%), bed charges (21.97%), as well as equipment and consumables (17.83%), were the main cost drivers.

Based on the findings of the present study, burn injuries most frequently happened in males. The majority of research has found a male predominance among burn injury patients (55% to 75%) (14,15). This finding may be explained by the fact that men work in more hazardous situations than women and engage in more unusual risk-taking behavior, thereby suffering from larger burned skin areas. However, some surveys show that females make up a higher proportion of the population, with 53% in Egypt (16), 56% in India (17), and 67% in Turkey (18). Cultural and lifestyle differences may be responsible for these inconsistencies.

In the present study, adults accounted for a large proportion of the population with burn injuries, which is in line with the findings of previous studies (19,20). This finding can be justified based on the fact that large-area burns mainly occur in working-age adults.

The median LOS was nine days, which was consistent with the findings of some previous studies (21,22). The recommended hospital stay in a burn center is one day per 1% of TBSA (23). In the current study, it was three days. These differences might have occurred because the current study considered only severe burn patients in contrast to other studies evaluating all patients. Patients with severe burn injuries usually require more surgical interventions, such as frequent debridement, skin graft, and local or free flap surgery. Such operations directly affect the length of hospital stay and costs.

In the present study, the mean direct cost of burn treatment was significantly lower than the average burn care cost reported in high-income countries. For example, the average cost of per-patient burn care has been reported as US$ 73,532 in Australia (24), US$ 15,250 in Turkey (19), US$ 114,576 in the United Kingdom (25), and US$ 22,759 in the Netherlands (26). However, the average total cost (US$ 1060.52) and the average daily price (US$ 134.96) reported in India were lower than that in the present study. Additionally, the authors presented burn care costs in a younger population (23 years vs. 36 years) with a significantly shorter mean length of hospital stay (7.86 days vs. 9 days) (17).

In the present study, the most direct hospitalization costs were related to electrical burns (US$ 9518.80±7090.17). On the other hand, the lowest prices were caused by hot liquid (US$ 3240.41±2145.67), which was similar to the finding of surveys in Sweden (27) and Ankara (19). However, the mean total was higher in these studies, compared to that in the present study.

The costs of burn patient treatment varied greatly from country to country for many reasons, including

admission and discharge policies, gross national income per capitate, gross domestic product, the quantity and quality of healthcare services, the costs of medicine, healthcare providers' salaries, and the cost calculation methods. The discrepancies between studies are caused by variances in the costs of different items, which affect the total costs. In the present study, the cost of surgical procedures was a considerable proportion of the overall expenses**.** Although varied methods of cost breakdown make comparisons difficult, this outcome was inconsistent with that in other studies. The surgical costs contributed just 11.4% in the study by Gallahe (9) whereas operation costs contributed 8.36% in that by Sahin (19). In the current study, the high price of operation procedures could be due to higher staff salaries and more surgeries for severe burn victims (an average of eight). Another significant component of burn costs was bed costs, which accounted for 21.97% of the total costs**.** A study in South Africa (9) reported bed costs accounted for 59% of the total costs, which was significantly different from the results found in this study. The difference in the proportions could be related to differences in TBSA% (mean 8% TBSA vs. 26%), study subjects (children vs. all patients), and the cost estimation approaches. Equipment and consumables were the third-largest cost of the center, accounting for 17.83% of the overall expenditures. The main clinical consumables used were staplers, ointments, bandages, gauze, and gloves for each patient. A study in sub-Saharan Africa showed that clinical consumables accounted for 15.5% of the overall burn treatment costs (9). The mean medication cost per-patient was US$ 860.47, which accounted for 15.80% of the total expenses. The mean cost obtained in this study was low, compared to that in two previous studies by Ahachi et al. (28) and Gallaher et al. (9), but significantly higher than that in the study by Ahuja et al. (29). Antibiotics accounted for 53.6% of the cost in the study by Ahachi whereas analgesics accounted for only 18.5%. According to a previous study (30), pharmaceuticals accounted for 33% of the overall burn care costs, with antibiotics and analgesics accounting for 85% and 11% of the total medication costs, respectively. In the present study, analgesics and antibiotics accounted for 15.4% and 73.3% of the total medication costs, respectively, differing from the above two studies. Due to the over-prescription of antibiotics for this group of patients (31) and the high cost of medication, there is a crucial need for further attention and planning to reduce medication costs and avoid risks, such as antibiotic resistance.

5.1. Strengths and Limitations

The present study offers evidence of the exact costs of providing reasonable burn care in a low-income country. The main strength of this study is that it reports the relative cost of each of the services provided to severe burn patients. However, the present study suffered from several limitations. The first limitation was a lack of access to indirect costs, such as transportation and employment loss. In addition, the present study focused only on cases of severe hospitalized burn patients and did not consider minor or moderate burn injuries. Moreover, it did not assess the costs of readmission and outpatient referral to the clinic. Although data on indirect costs would broaden the perspective of the cost analysis, collecting such data was not feasible within the resources available at the time of data collection. The absence of these expenses may have affected the findings and conclusions of this study.

5.2. Recommendations for Future Research

This research is the first step in calculating the total cost of severe burns in Iran. The current study may provide methodological assistance to those researchers who want to perform similar analyses in low-resource locations. Nevertheless, this information is preliminary, and additional research is undoubtedly required.

5.3. Clinical Implications for Health Managers and Policymakers

Given the global financial constraints, ensuring that the treatment provided is cost-effective and safe is crucial. Therefore, this research can help policymakers and health managers to better understand the direct costs of a burn center and the total budget required to cover the annual costs of treating burn patients.

6. Conclusion

The present study determined the relative contribution of the costs of each service provided to patients from the total cost. Costs associated with surgery accounted for 55.54% of the total cost, and the surgeon's salary was the most expensive part of surgical costs. Ward expenditures (39.77%) were the next most expensive aspect of care, and the most expensive part of the total cost of ward expenses was bed charges. Finally, the highest hospitalization charge was associated with electrical burns.

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Footnotes

Conflicts of Interest: The authors have no conflicts of interest to declare.

Authors' Contributions: F.R., M.M., R.F., A.F., S.H., and P.B. contributed to the concept and design of the study. R.F., A.F., S.H., and P.B. contributed to the field data collection. S.H., R.F., and A.F. conducted the

analysis and P.B. drafted the first version of the manuscript. F.R. provided a critical review of the article. All authors reviewed and approved the final manuscript.

Ethical Considerations: The ethics approval for the current study was received from the Ethics Committee of Kashan University of Medical Sciences, Kashan, Iran (code: IR.KAUMS.MEDNT.REC.1400.018). Because it was a retrospective design, only information from the electronic records was collected. The patients were not hospitalized during the study period, so informed consent was waived.

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