Burn-care in Practice

Epidemiology of severe burns in North-East of Iran: How is the burn size different in a developing country from developed ones?

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ABSTRACT

In contrast to the high prevalence of burn injuries in the low and middle-income countries, accurate data about the epidemiological and etiologic pattern of burns in these countries is limited and scattered. The aim of this study is to present accurate information about the demographical and geographical pattern of burns severely enough to be hospitalized, in the northeast of Iran, in the years 2010–2015. In this cross-sectional study, we included all patients admitted because of acute burn injuries to Imam Reza Burn Center. There were 3352 admissions and approximately three-quarter of them were from Razavi Khorasan province (73.3%, 2458). The mean age of patients was 26.5 ± 19.3 years and 2065 (62%) were male. The overall mortality rate was 21.4% (717). The mean of burnt total body surface area (TBSA) (50.7 ± 26.3%), mortality rate (41.3%) hospitalization period (20.1 ± 16.7 days) and Abbreviated Burn Severity Index (8.8 ± 3.1) were higher in patients referred from the South Khorasan Province (all p < 0.001). Patients referred from other provinces had the second rank for all mentioned indices. In 63% of patients, burnt TBSA was ≥ 20% and the mortality rate in this group was 10 folds more than patients with burns less than 20% of TBSA. Burn injury was more common in individuals with lower skills and competencies. About two-thirds of patients had a burnt TBSA ≥ 20% and it was the most important factor involved in high mortality rate in this center. In designing preventive policies in developing countries, safety aspects of mechanisms and activities which lead to severe forms of burn injury must be considered as a priority.

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1. Introduction

Burns is one of the most common and life-threatening injuries throughout the world, especially in developing countries including Iran. Every year, only fire-related burns are accounted for over 300,000 deaths in the world [1]. More than 95% of fire-related burns occur in the low and middle-income countries (LMICs) and mortality rate in poor countries is 10 folds more than high-income countries [1]. Previous reports show that 5% of all injury deaths (mostly in children and young adults less than 44 years old) in 2000 was due to fire [2]. If mortality due to electrical injury, scald injury, and chemical burns are taken into account, all burn-related deaths far exceed these statistics. The WHO Eastern Mediterranean region – to which our country belongs – has the second most frequent fire-related mortality rate (6.4 deaths per 100,000 population annually) just after South-East Asia; whereas in high-income countries it reaches as few as 1.0 deaths per 100,000 population annually [1].

Although it is estimated that only one percent of burn injuries will lead to death, burns are one of the most devastating injuries which besides of death, lead to disability, disfigurement and emotional distress [3,4]. Disability Adjusted Life Years (DALYs) lost because of fire-related burns is about 10 million years all around the world annually [1], and more than 50% of these lost years are in children less than 14 years old [2]. In 2004, globally about 11 million burns required medical attention [5]. In some countries
including Pakistan and Egypt from The WHO Eastern Mediterranean region, 8% of burnt children have permanent and 17% temporary disabilities. Burn as the second most common injury accounts for 5% of disabilities in Nepal [5].

In the Eastern Mediterranean region, the incidence of burns is between 112 and 518 per 100,000 population per year [6]. In 2003, burns with more than 200,000 DALYs per year had a 13th position in the burden of disease among all diseases and injuries in Iran [7]. It is estimated that burns account for about one percent of all deaths and about 18% of injury-related deaths in Iran [8]. Most burns are minor injuries and are treated as outpatients. Almost about 5% of burnt patients are hospitalized in or transferred to burn a center [3]. Unfortunately, in LMICs in-hospital mortality rate of burn patients is high and in the Eastern Mediterranean region, it ranges from 5 to 37% and more than 20% in most countries [6]. In our burn center, the in-hospital mortality rate was calculated to be 25.9% in years 2000–2002 [9].

In spite of the high prevalence of burn injuries in LMICs, accurate data about epidemiological and etiological patterns of burns in these countries is limited and scattered. There are different risk factors for burn injuries in different regions of the world. It should be noted that preventive policies appropriately working in a high-income country, may not be effective in LMICs, especially in rural areas. These countries need to develop preventive approaches which are specially designed based on epidemiological researches in their communities. This explains why the World Health Organization (WHO) had considered data and measurement as a challenge in prevention and care of burns in LMICs [1]. To the best of our knowledge, the only previous epidemiologic study of burns patients in Mashhad has been performed about 15 years ago [9].

Due to the necessity of updating the previous knowledge and understanding the current situation, this study was conducted with an aim to present accurate information about the demographical and geographical pattern of burns severely enough to be hospitalized, in the northeast of Iran, in the years 2010–2015.

2. Methods

The protocol of this cross-sectional study was approved by the Ethics Committee of the Mashhad University of Medical Science (MUMS-960802). It was performed in Imam Reza Burn Center (IRBC), as the only referral burn center of Khorasan Provinces from 21 of March 2010 to 20 of March 2015. Khorasan province, the largest province of Iran, was separated to 3 provinces after 2004 including North Khorasan (NK), Razavi Khorasan(RK) and South Khorasan (SK) provinces. These all together consist 20% of the total country area (NK: 28,434 km², KR: 118,854 km², and SK: 151,193 km²) and 10 percent of the total population of Iran (NK: 863,000, KR: 6,400,000, and SK: 770,000 inhabitants).

We included all patients admitted because of acute burn injuries to (IRBC) during this time period and extracted demographic and clinical findings from the hospital information system (HIS) and patients’ medical records. The Abbreviated Burn Severity Index (ABSI) was calculated and reported. Patients admitted due to complications of previous burns such as contracture deformities or for conditions other than burn injuries (such as toxic epidermal necrolysis) were excluded from the study. In our center, patients with acute burn injury are hospitalized mostly based on criteria compatible with American Burn Association (ABA) Burn Center Referral criteria. They stay in hospital until almost wounds heal are be treated by excision and graft. Some patients with extensive burn may be discharged while still there is open wound in some small area. These patient are readmitted after few days and are treated appropriately. All patients are referred to out-patient clinic for rehabilitation and scheduled visit by burn specialists. In patients with several hospitalizations due to one burn incident, we aggregated the information of each patient as a single record.

While in most studies, the explosion is considered in fire and flame category, because of the wide application of domestic natural gas in this country and high incidence of natural gas-related explosions, we considered it as a separate mechanism of burn injury. We did not exclude patients referred from other provinces of Iran or other countries, but data related to those patients were analyzed separately.

We classified patient’s jobs according to major groups in the international standard classification of occupations (ISCO-08). Retired persons, children less than 18 years old, and unemployed patients were excluded from this classification.

The data were analyzed by SPSS 16 using descriptive (mean, standard deviation, range, frequency, percentage) and inferential analysis (ANOVA and Chi-squared tests). Also, logistic regression analysis was used to find predictor variables using the odds ratio (OR) and 95% confidence interval (CI). All tests were two-tailed and p-value below 0.05 was considered as the statistically significant threshold.

3. Results

There were 3352 admissions to IRBC during the study period. The majority of admitted patients were from Razavi Khorasan province (73.3%, 2458) followed by North Khorasan Province (10.6%, 356) and South Khorasan Province (3.8%, 126). There were also 364 (10.9%) referred patients from other provinces of Iran and 48 cases (1.4%) from the neighborhood countries.

The mean age of admitted patients was 26.5 ± 19.3 (range: 0.1–94) years. Sixty-two percent (2065) were male. Most patients (21.9%, 732) were admitted with a 20–29% of burnt total body surface area (TBSA) followed by 10–19% (20.2%, 675) and 30–39% (14.8%, 494). The overall ABSI and mortality rate in the whole study period was 7.2 ± 3.0 and 21.4% (7 1 7), respectively.

As Table 1 shows, the highest mean burn percentage of TBSA, ABSI and mortality rate altogether with the longest hospitalization period were observed in patients referred from South Khorasan province. Fire and flame was the most prevalent mechanism in patients referred from Razavi Khorasan (49.0%, 1203), North Khorasan (45.5%, 162), South Khorasan (57.1%, 73), and other provinces (191, 52.5%). But, the most common mechanism in patients referred from other countries was explosion (45.8%, 22) (p < 0.001). The OR of death for patients referred from all other cities except Mashhad only adjusting for ABSI score (OR = 2.24, 95CI = 2.11–2.37, p < 0.001) was 1.29 (95CI = 0.98–1.70, p < 0.06). Table 2 demonstrates a detailed logistic regression analysis for determining predictors of death based on important factors, such as the age, gender, TBSA, burn mechanism, and referring province.

To avoid referral bias, we analyzed patients from the Razavi Khorasan province separately and the results were as following: Sixty-four percent (1559) of patients admitted from Razavi Khorasan province were male. Half of the patients (1235, 50.2%) were in the 18–45 age group (1235, 50.2%) and almost a similar percentage were married (1247, 51.3%). The majority were recovered (2002, 81.4%). While 456 (18.6%) died and 153 (6.2%) were discharged against medical advice. Services and sales workers (category 5 of ISCO-8) were the most frequent job category (1231, 83.3%) followed by elementary occupations (category 9 of ISCO-8) (110, 7.4%). A more detailed analysis showed that self-employed (670, 27.3%) and housewives (534, 21.7%) were the most frequent jobs.

Flame (1203, 49.0%), scald (588, 23.9%), and explosion (463, 18.8%) were the top three burn mechanisms. Explosion caused the highest burnt TBSA% (42.6 ± 25.0) followed by flame...
and scald (25.1 ± 12.4) (p < 0.001). However, the highest mortality was observed in flame (27.7%, 303) followed by explosion (19.0%, 88) and chemical (11.1%, 3) (p < 0.001) burns. The longest hospital stay (LOH) (days) observed in flame (18.9 ± 15.9), explosion (16.7 ± 14.0), and electrical (14.2 ± 16.0) (p < 0.001) burns. Male to female ratio of burnt patients by different mechanisms was 1.3 for scald, 1.5 for flame, 1.5 for chemical, 2.8 for explosion, 4.3 for contact, and 16.4 for electrical (p < 0.001) burns. Female patients had a higher burn percentage compared to males (40.2 ± 25.9 vs. 33.4 ± 23.3, p < 0.001) and mortality rate (28.4 vs. 12.9%, p < 0.001). Regarding age categories, the prevalence of females at the end of age continuum was more prominent than males (P < 0.001). Mortality rate increased from 3.3% in patients <6 years to 51.2% in patients older than 65 years. Also, the highest rate of discharge against medical advice was observed in <6 age group (68, 12.4%) (P < 0.001). Being burnt by scald was a prevalent mechanism in <6 age group while flame was the most prevalent burn mechanism in all other age groups (Table 3).

The majority of patients were admitted once (2332, 94.9%). However, there were readmissions for two (98, 4.0%) and three times (19, 0.8%). The most anatomical burn area was trunk (1344, 54.7%) followed by head and neck (1106, 45.0%), hip and lower limb (1015, 41.3%), shoulder and upper limb (861, 35.0%), wrist and hand (264, 10.7%), and ankle and foot (81, 3.3%). It is notable that nearly half of the patients (1018, 41.4%) had multiple body burnt regions.

### Table 1
Comparison of some of the main demographic and clinical indices among admitted patients referred from different geographic regions.

<table>
<thead>
<tr>
<th>Razavi Khorasan province</th>
<th>North Khorasan province</th>
<th>South Khorasan province</th>
<th>Other provinces of Iran</th>
<th>Other Countries</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (year)</td>
<td>26.7 ± 19.7</td>
<td>25.5 ± 20.3</td>
<td>28.1 ± 18.9</td>
<td>25.0 ± 15.9</td>
<td>25.8 ± 16.0</td>
</tr>
<tr>
<td>Male/Female ratio</td>
<td>1.7</td>
<td>1.3</td>
<td>0.8</td>
<td>1.3</td>
<td>2.2</td>
</tr>
<tr>
<td>Burnt TBSA (%)</td>
<td>35.9 ± 24.5</td>
<td>38.8 ± 26.0</td>
<td>50.7 ± 26.3</td>
<td>48.4 ± 26.8</td>
<td>44.3 ± 21.1</td>
</tr>
<tr>
<td>Hospitalization (day)</td>
<td>16.6 ± 14.3</td>
<td>18.2 ± 15.6</td>
<td>20.1 ± 16.7</td>
<td>19.2 ± 15.3</td>
<td>18.3 ± 14.3</td>
</tr>
<tr>
<td>ABSI</td>
<td>7.0 ± 3.0</td>
<td>7.3 ± 3.2</td>
<td>8.8 ± 3.1</td>
<td>8.3 ± 3.1</td>
<td>7.8 ± 2.5</td>
</tr>
<tr>
<td>Mortality (%)</td>
<td>18.6</td>
<td>21.1</td>
<td>41.3</td>
<td>33.2</td>
<td>29.2</td>
</tr>
</tbody>
</table>

TBSA: total body surface area; ABSI: abbreviated burn severity index.

In this study, we have presented epidemiologic and demographic data related to hospitalized patients in IRBC in the years 2011–2015. This is the only burn center in the east of Iran and is located in Mashhad, the metropolitan city of Razavi Khorasan province and the second-most populous city in Iran. It is a 100-bed burn and reconstruction center, where 60 beds are assigned for acute burn care.

Totally 3352 burn patients were hospitalized in a 5 years period, which the majority of them (65.6%) were referred from other cities of the province, other provinces and neighborhood countries. So, it is a referral burn center with a wide catchment area. In recent years, some burn wards have been established in other cities in the east of the country, so, only the most severe cases are referred to our center. As it was shown, the mean age of referred patients is not statistically different from inhabitants. Also, male to female ratio in referred patients from other provinces is not statistically different from inhabitants of Razavi Khorasan province, but in referred patients from other countries, male patients were 2.2
times more than females. Epidemiology of burn injury in neighborhood countries is not completely characterized and more referred male patients may be due to much higher incidence of burn injury in male patients in those countries or just a reflection of the importance of male gender in this cultural territory. Burnt TBSA was significantly higher in referred patients. It shows that the most of smaller burn injuries presumably are managed in local burn wards or general hospitals and only the most severe cases are probably referred to our burn center. On the other hand, a considerable percent of severely injured patients is referred from cities as far as 900 km, and almost all of them are transferred by ground transportation, while enough trained personnel and appropriate equipment may not be available. It has been shown that transport of burn patients in a well-organized system of patient transfer may be safe, even for regions as far as 7 h of a burn center 10, but in an ill-organized transport system, this condition can worsen the prognosis of burned patients and this study showed that both burned TBSA and mortality rate was higher in referred patients; however, adjusting for severity score, namely ABSI, revealed that mortality was not significantly different in referred patients from inhabitants.

Although self-immolation was reported to be higher in females (2.2% vs. 1.7%) in Mashhad, north-east of Iran 11, like many other injuries, burns are more common in male gender throughout the world 3 even in preschool ages 12. In this study, burn injury in males was 1.6 times more common than females. Female dominance over males was only observed in >65 years age group. This is the age group in which we observed the second-lowest burn percentage of TBSA, lowest LOH, and in return the highest mortality rate. The most discrepancy in gender distribution was observed in electrical injuries. This is in line with other researches, too 13–15. Men are involved in more high-risk activities for injury and boys are permitted to play more freely, and they inherently like high-risk activities more than girls. This difference was observed between the two genders in all age groups except patients older than 65-year. In another study on elderly patients...
in Iran, burn injury was reported to be more common in males [16]. But that study was performed on burn patients older than 55 years, and a little more than half of the patients were in the 55–64-year category. As the life expectancy in women is 2.2 years more than men in Iran (76.87 vs. 74.67 years) [17], it can be expected that the population of old and very old women (>65 years) to be more than men, and the excessive number of burns in female patients older than 65-years can be attributed to the higher number of women in this age group. Occupational data of this study showed that persons working in simpler jobs such as self-employed workers and housewives are more exposed to burn injuries, so it seems logical that preventive measures to be targeted for these high-risk job groups.

The in-hospital mortality rate for burn injuries in most countries of the East Mediterranean region is more than 20% (ranges from 5% to 37%) [6]. In this center, the in-hospital mortality rate decreased from 25.9% in one decade ago [9] to 21.4% in this study. Although mortality rate alone is not a perfect measure and a combination of standardized mortality ratio along with lethal area 50 percent has been proposed for evaluation and comparison of burn centers performance [18], but, it seems that the in-hospital mortality rate in our study is unacceptably higher than developed countries. However, it must be considered that the severity of burn injury in this study is completely different from many developed countries. In the US from 124,196 patients for whom the extent of burn injury was recorded, 3.7% died, but in 90% of total patients, the burn TBSA was less than 20%. The mortality rate increased from 0.6% and 2.8% in patients with less than 1% and 20% burn TBSA to 74% and 82.8% in patients with 80–89% and >90% burn TBSA, respectively [19]. In our study, only 27% of patients had less than 20% burn TBSA, and the mortality rate in those patients was 2.8% while the mortality rate of patients with more than 20% burn TBSA was 28%. A population-based estimation of burn-related mortality rate may be a better index, but to calculate it, besides in-hospital mortality, the prehospital mortality must be considered. The in-hospital mortality rate was about 61 patients per year for inhabitants of Razavi Khorasan province which considering to about 6 million population of this province, the burn-related mortality rate is about 1/100000 per year. But according to the reports of Razavi Khorasan Forensic medical council, there were about 120 (in and out of hospitals) deaths per year because of burn injury in those years in this province [20], which is equal to 2/100000 population, and it seems to be in an acceptable range. This index is between 0.6/100000 and 5.6/100000 in different countries in the Eastern Mediterranean region [6].

This study is not without limitations. We used hospital information system and patients’ medical records are not free from errors, but, we believe that these are not systematic errors. On the other hand, to our knowledge, this is the first study in this country which investigates the severity of burn injury and the effect of distance from a burn center on mortality rate.

5. Conclusion

This study showed that in a referral burn center with a wide catchment area, where about two-thirds of patients are referred from other cities of the province or other provinces as far as 900 km, the adjusted mortality rate in referred patients is not significantly higher than inhabitants. So, considering economic constraints in developing countries, focusing on quality improvement in available burn centers may be more efficacious than the establishment of new burn centers. It seems that the high mortality of burn-related injuries in this center is not only due to the high incidence of burns and quality of burn care in this country, but also, due to severity and extensively of burn injuries in comparison to developed countries. So, we suggest preventive measures tailored for most fatal mechanisms of burn injury such as natural gas explosion to be considered as a priority in burn preventive policies.

6. Declarations

- Ethics approval and consent to participate: This study had been approved by Mashhad University of Medical Sciences.
- Consent for publication: All authors declare their consent for publication.
- Availability of data and material: Not applicable.
- Competing interests: none to be declared.
- Funding: None to be declared.

Authors’ contributions: Study design: Majid Khadem-Rezaiyan, Ali Ahmadabadi, Minoo Zanganeh, Data gathering: Minoo Zanganeh, Seyed Hassan Tavouei, Alireza Sedaghat, Saeed Esfandi Hasanabadi; Data Analysis: Majid Khadem-Rezaiyan, Hosein Aghajani, Ali Ahmadabadi; Drafting the manuscript: Majid Khadem-Rezaiyan, Ali Ahmadabadi, Minoo Zanganeh; Final approval: Majid Khadem-Rezaiyan, Hosein Aghajani, Ali Ahmadabadi, Minoo Zanganeh, Seyed Hassan Tavouei, Alireza Sedaghat, Saeed Esfandi Hasanabadi.

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Disclosure

The authors declare no conflicts of interest.

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