



## Original Article

## Lethal Area 50 in Patients with Burn Injuries in North West, Iran

Ahmad Mirza Aghazadeh<sup>1</sup>, Mojgan Lotfi<sup>2\*</sup>, Akram Ghahramanian<sup>2</sup>, Farideh Ahadi<sup>2</sup><sup>1</sup>Department of Basic Sciences, Paramedical Faculty, Tabriz University of Medical Sciences, Tabriz, Iran<sup>2</sup>Department of Medical-Surgical, Nursing and Midwifery Faculty, Tabriz University of Medical Sciences, Tabriz, Iran

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## \*Corresponding Author:

PhD in Nursing

Email:

mojgan.lotfi@yahoo.com

## ABSTRACT

**Introduction:** In view of their considerably high rates of mortality and morbidity, burns are still viewed as one of the most important health-threatening environmental hazards imposing a significant burden on the health care system in low and middle-income countries. This study seeks to determine the lethal area fifty percent (LA50) in all burn patients admitted over a period of five years and the factors influencing mortality in burn injuries.

**Methods:** This study was a cross-sectional carried out from 2010 to 2014 in Sina Hospital of Tabriz, 1226 participant including 319 women, 346 men, 272 girls, and 289 boys were selected through stratified sampling. The demographic and clinical data of patients ( their age, gender, burn type, TBSA, the season and consequences of burning) were all extracted and then analyzed, using descriptive statistics (measures of central tendency and variability) and inferential statistics (chi-square and linear regression) at a significance level of 0.05. The LA50 was calculated through determining the relationship between the total body surface area and mortality rate (The extent of the body burns measured and recorded based on Lando Chart in hospitals).

**Results:** The highest (47.6%) and the lowest (3.8%) rates of burns were observed among those aged below 16 and above 65, respectively. The majority of the participants were residents of cities (55.4%), married (34.6%), illiterate (56.6%), and housewives (14.8%). Most burns were caused by accidents (98.4%) at home (90.6%). Most patients had suffered first- and second-degree burns (68.4%), with no inhalation damages (99.5%). Hot liquids were the main culprit in most of the burns (58.7%) and the upper extremities were the most frequently affected areas (34.8%). There was .99 rise in mortality for every percent increase in TBSA, and there seemed to be a significant relationship between the age level and the eventual outcome- the higher the age, the more likely for the incident to end in death. LA50 was also determined 43.73 percent for five years. Finally, the study findings showed that female gender, TBSA and age are associated with death from burn.

**Conclusion:** Given the high LA50 index at this center, it is of high priority in our country to enhance the public knowledge and the quality of the care provided for the burn patients. Patients at risk including women, children, elderly and extensive burns should be considered.

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## Introduction

As the second leading cause of sudden death, second only to car accidents, burns are no doubt one of the most severe and one of the most serious health-threatening traumas.<sup>1-3</sup> The Physical and psychological consequences of burns affect not only the patients but also their families.<sup>4,5</sup>

Burn injuries are considered a major problem around the globe<sup>6</sup> Damages resulting from burns are among the major concerns of the public health which may afflict the victims both acutely and chronically, bringing about serious death toll.<sup>4</sup> The highest rate of deaths resulting from burns belongs to South-East Asia, particularly India, and the Middle East.<sup>7</sup> In the US, 1.25 million people are annually hospitalized for burn injuries, 4500 of whom eventually die. This imposes a total cost of \$ 7 million per year on the health system of the US, with a mortality rate of 10%.<sup>8,9</sup> The mortality rate of burns in Iran is also quite high, with 24000-28000 people annually afflicted with burn injuries requiring hospitalization while the figure is even higher for the victims receiving outpatient services. Given non-standard burn hospitals, low budget, and the shortage in manpower, the treatments are often incomplete and sometimes even end in the death of

patients.<sup>10</sup> According to the reports issued by Accident Records Office in Iran, burns comprise 5% of the total number of accidents and account for 6% of all deaths from accidents in this country.<sup>8</sup> The annual death toll resulting from burns has been reported to be 4.6-5.6 out of every 100,000 people.<sup>11</sup>

Determining the mortality rate is of a special significance in the evaluation of care and services provided for the patients and the development of survival standards in burns.<sup>1</sup> In other words, the mortality rate in a particular unit could be taken as an index reflecting the quality of care provided in a hospital.<sup>8</sup> The care provided by nurses is particularly important in this respect, because they are in charge of the care and treatment provided for the patients throughout the day.<sup>2</sup> However, the provision of care in burn wards is especially challenging, considering the mental and physical needs of these patients. Hence, the managers and planners in this area are seeking to establish reliable indices to enable them better evaluate their particular situations.<sup>12</sup>

Nowadays, the burn lethality index (LA50) is definitely one of the most important indices indicating the quality of burn care, which is essentially employed in the

evaluation of burn patient's mortality, and in determining the quality of care provided at different burn centers. LA50 implies an extent of burn in the total body surface area, where 50 percent of the patients do not survive the incident, in other words the burn is so severe that one out of every two patients dies.<sup>13</sup>

LA50 in the burn care centers of the United State was 55% in 1970, while they now claim that have managed to improve it to 95%. LA50 has risen from 45% to 52.38 in Shahid Motahari Hospital of Tehran over the past 10 years and it has been reported to be 55% in Imam Reza Hospital of Birjand, which is still far from the standards expected. Nowadays, the survival rate of patients has increased to 95% in developed countries and their major concern is to enhance the quality of life for burn survivors and help them return to the regular social and family life. However, lowering the mortalities caused by burn injuries and saving the lives of the patients at the acute phase are among the top priorities of the health system in our country, and all efforts are directed at realizing this aim.<sup>8,13,14</sup>

As Sina Hospital is one of the major burn treatment centers in the northwest of Iran, and the quality of healthcare services at this hospital is of great importance, and since few studies have been conducted on this subject in Iran, the present study aimed to determine burn lethality index at this center over a period of five years (2010-2014). It is hoped that the results could yield a more realistic understanding of the situation, and thus inform the managerial decisions and policies adopted to enhance the quality of healthcare services provided for burn patients.

## Materials and methods

It was conducted by a descriptive cross sectional method in Sina Hospital of Tabriz, affiliated to Tabriz University of Medical Sciences, Tabriz, Iran, having been approved by the ethics committee. The research samples of the data extracted from the medical records of the patients comprised 1226 cases from 2010 to 2014. Of these, 319 were women, 346 men, 272 girls and 289 boys, all of whom had been selected systematically through stratified sampling, considering the inclusion criteria, and the sample size. The selected files were studied to, having obtained the permission from the archive unit. The check lists for all cases were filled out after establishing the

related validity and reliability. One hundred and four cases belonging to all age groups from 2011 were dropped from consideration due to the unavailability of the files. Thus, a total of 1122 cases were studied, 158 of which were dropped from consideration in view of the exclusion criteria, which eventually left us with the data extracted from 964 files to work on. The inclusion criteria for all age groups of both genders were hospitalization in the studied center immediately after the burn injury or referral from other centers within the first 48 hours, having received no specialized care at the original center.

The data were collected, using two forms of basic and demographic information. The basic information form consisted of three parts, and included factors related to burns (i.e. the degree and extent of burns, burns agent, burned areas, inhalation injuries, type of burns, cause of burns, and the season when burns had occurred), specialized care (i.e. artificial ventilation, the number of days during which intensive care has been provided, and the number of debridement or grafting), and the eventual outcome of the burn (i.e. discharge or death).

Demographics also included age, gender, place of residence, marital status, occupation, educational attainment, race, and nationality. The data obtained from the medical records of the patients were statistically analyzed, using SPSS v.13 at a significance level of 0.05. In addition, LA50 of patients in each age group was calculated by determining the relationship between Total Body Surface Area and mortality rate.

## Results

The findings of the demographic variables show that the Mean (SD) of patients' age was 36.16 (76.04) with a median of 33 for adults and 3.10 (2.76) with a median of 2.6 for children (Table1). In total, 54% of subjects were male and 46% of them were female. The results showed that there a significant relationship between gender and burns outcome ( $P<0.001$ ) (Table 2).

In terms of other demographics, most participant were urbanite, illiterate, housewives, and villagers. The mortality rate in patients in urban areas, suburban areas, and villages was 4.5%, 10%, and 16.4%, respectively. This suggests a significant relationship between the place of residence and burn outcomes in all studied groups ( $P<0.001$ ) (Table 3).

**Table 1.** Inhalation burns, TBSA, burns outcome, and LA50 in different studied groups

Age group (year)	Mean ( SD)	Inhalation Injury (%)	Mean TBSA (%)	Mortality rate (%)	LA50	Total N (%)
<16	3.1 (2.70)	0 (0)	1.7	18(21.68)	41.93	459(47.6)
16-44	28.5 (7.71)	2 (40)	20.59	44(53.03)	52.63	371(38.4)
45-64	53.2 (5.53)	3 (60)	19.37	17(20.48)	35.47	97(10.2)
>64	73.7 (6.20)	0 (0)	13.19	4(4.81)	27.5	37(3.8)
<b>Total</b>	<b>20.7 (20.46)</b>	<b>5 (100)</b>	<b>15.47</b>	<b>83(100)</b>	<b>39.38</b>	<b>964(100)</b>

**Table 2.** Causes and outcome of burns in children and adults

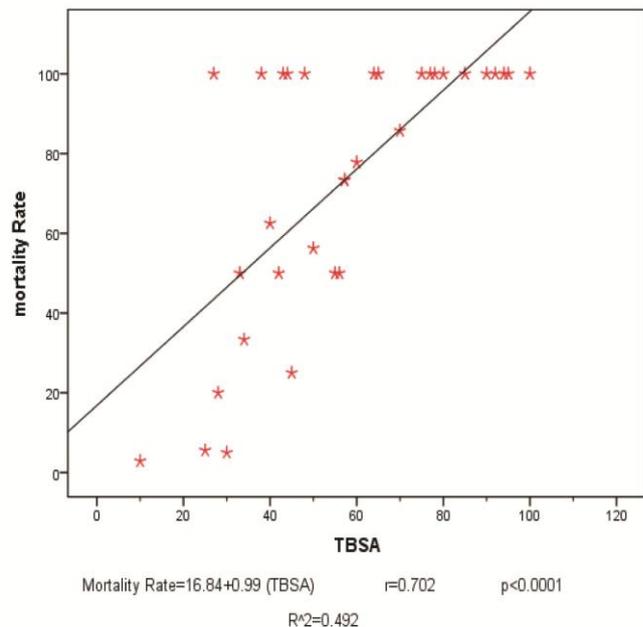
Burns cause	Studied groups				Total N (%)	Mortality rate (%)
	Women N (%)	Men N (%)	Girls N (%)	Boys N (%)		
Boiled water or hot liquids	96 (40.3)	72 (27)	183(89.3)	215 (84.6)	566 (58.7)	12(14.4)
Flame	69 (29)	74 (27.7)	14(6.8)	23 (9.1)	180 (18.7)	36(43.4)
Electric burns	1 (0.4)	28 (10.5)	1(0.5)	8(3.1)	38 (3.9)	1(1.2)
Chemical burns	58(24.4)	74(27.7)	6(2.9)	5(2)	143 (14.8)	33(39.8)
Contact burns	4(1.7)	4(1.5)	0	2(0.8)	10 (1)	0
Gas explosion	2 (0.8)	3(1.1)	1(0.5)	0	6 (0.6)	0
Gasoline	3 (1.3)	5(1.9)	0	0	8 (0.8)	1(1.2)
Petroleum	0	7(2.6)	0	1(0.4)	8 (0.8)	0
Hot solid materials	5(2.1)	0	0	0	5 (0.5)	0
<b>Total</b>	<b>238 (100)</b>	<b>267(100)</b>	<b>205(100)</b>	<b>254(100)</b>	<b>964 (100)</b>	<b>83(100)</b>

Although the majority of subjects (66.2%) were married, no significant relationship was found between the marital status and burn outcomes ( $P=0.377$ ). About 7.3% of them had the history of underlying diseases, making for no significant relationship with burns outcome among men ( $P<0.001$ ) (Table 3).

**Table 3.** Demographic information of patients with burns and their relationship with burns outcome in Sina Hospital of Tabriz over 2010-2014

Variable	Mortality Rate (%)	N (%)	P-Value
<b>Gender</b>			$P<0.00$
Female	46 (55.5)	238 (24.7)	
Male	19 (22.9)	267 (27.7)	
Female child	7 (8.4)	205 (21.3)	
Male child	11 (11.2)	254 (26.3)	
<b>Marital status</b>			$P=0.92$
Single	6 (31.57)	171 (33.8)	
Married	13 (68.43)	334 (66.2)	
<b>Age group</b>			$P<0.00$
<16	18 (21.68)	459 (47.6)	
16-44	44 (53.30)	371 (38.4)	
45-64	17 (20.48)	97 (10.2)	
>64	14 (4.81)	37 (3.8)	
<b>Place of residence</b>			$P<0.00$
Urban areas	24 (28.9)	534 (55.3)	
Rural areas	41 (49.4)	250 (25.9)	
Suburban areas	18 (21.7)	180 (18.8)	
<b>History of underlying disease</b>			$P<0.00$
No	68 (81.92)	894 (92.7)	
Yes	15 (18.08)	70 (7.3)	
<b>Burns severity</b>			$P<0.00$
<10	0 (0)	505 (53.4)	
10-19	2 (2.4)	231 (23.9)	
20-29	3 (3.6)	67 (6.9)	
30-39	7 (8.4)	47 (4.8)	
40-49	11 (13.2)	24 (2.4)	
50-59	13 (15.7)	26 (2.6)	
60-69	11 (13.2)	14 (1.4)	
70-79	16 (19.2)	20 (2.5)	
80-89	6 (7.5)	6 (0.6)	
90-100	14 (14.8)	14 (1.5)	
<b>Cause of burns</b>			$P<0.00$
Unintentional	75 (90.4)	949 (98.4)	
Intentional	8 (9.6)	15 (1.5)	
<b>Season of burns</b>			$P=0.62$
Spring	25 (30.1)	284 (29.6)	
Summer	26 (31.3)	265 (27.4)	
Autumn	12 (14.5)	189 (19.6)	
Winter	20 (24.1)	226 (23.4)	

As for the severity of burns, most burns in all age groups (68.4%) were of second- and third-degree, ranging from 1% to 100%, with the third- and fourth-degree burns having the lowest frequency (7%). The severity of burns in the majority of patients in this study (53.4%) was below 10%. In the present study, the mortality rate increased with an increase in TBSA ( $P=0.001$ ) (Figure 2). have the highest (59.8%) and the lowest (1%) frequencies



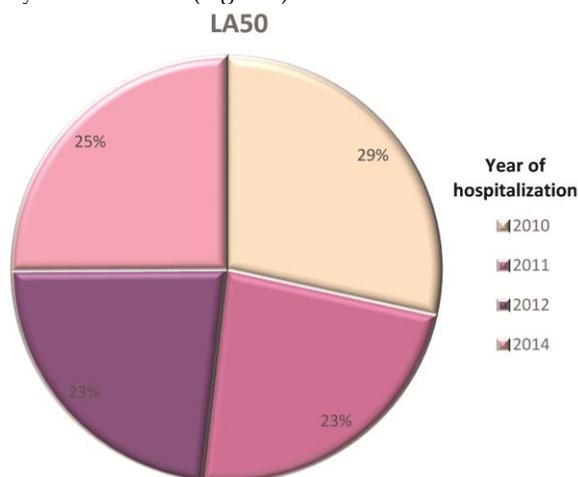
**Figure 2.** The results of linear regression for the relationship between the mortality rate and TBSA

of burns, respectively. The mean TBSA was 10.6% for children aged under 16, and 19.8% for adults. There were inhalation injuries observed only in 0.5% of the patients, which resulted in death in 100% of the women and 66.7% of men. About 95% of burns were of the thermal type, with hot water and liquids as the leading cause of burns in women and children (58.7%), while burns resulting from fire and gas explosion seemed to be more frequent among men (27.7%). Burns with hot water and liquids were also common among those aged under 16. In addition, inflammable materials were the main cause of burns in the age group 16-44 (32.9%), whereas hot liquids

were responsible for most cases of burns among those aged 45-64 (41%) and over 64 (62.2%) (Table 2). On the other hand, 98.4% of burns were unintentional and accidental, and self-immolation was more frequent among women (4.6%) than men ( $P < 0.001$ ) (Table 1). Thermal and chemical burns were the most (95%) and the least (1%) frequent types of burns, respectively. The mean duration of hospitalization was 9.6 days, with a minimum and maximum of 1 and 86 days, while the mean duration of hospitalization in the intensive care unit was 8 days, ranging from 1 to 31 days.

As for the place where burns had occurred, accidents at home accounted for (90.6%), with the work place and streets accounting for 5.2% and 4.3% of the burns, respectively. About 7.7% of patients were transferred to hospitals by ambulance, with the rest (92.3%) taken to medical centers in a car. The highest frequency of burns was observed in the spring (29.5%) and summer (27.5%), and there seemed to be no significant relationship between burn outcomes and the seasons ( $P = 0.627$ ) (Table 1). Overall, 8.6% of the burn patients had died.

To study the effect of TBSA on the mortality rate of burn patients, Pearson correlation coefficient was employed, which suggested a significant and positive relationship ( $P = 0.0001$ ,  $r = 0.702$ ). Thus, simple linear regression analysis was used to determine the degree of correlation between the mortality rate and TBSA. The results seemed to indicate that, for every 1% increase in TBSA, there was 0.99% increase in the mortality rate. In addition, according to the coefficient of determination, 49.2% of variances of mortality rate is accounted for by TBSA. It must also be pointed out that, through studying the standard predicted values, standardized residues, and the P-P diagram, it was found that there was no problem of Iso-variance in investigating the relationship between these two variables. The results on LA50 indicated that the value of this index is 27.5% for subjects aged over 65 (27.5%), which is lower than that for other age groups, while the highest LA50 seemed to belong to the age group 16-44 (52.63%) (Table 3). As for the growth of LA50 index, the results showed that it had dropped by 9% and 0.5% from 2010 to 2012, but that it had increased by 3.48% in 2014 (Figure 2).



**Figure 2.** LA50 index in Sina Hospital of Tabriz in the period 2010-2014

## Discussion

Studies indicate that burns are still the most common cause of injuries in Iran, which may lead to the death of the afflicted people.<sup>15</sup> The results of the present study indicated that burns afflict men and boys more frequently than they do women and girls, which is consistent with the findings of other studies in the field.<sup>16-18</sup>

Given that burns resulting from electricity and chemicals usually occur at work, they are naturally more common among men than women. In the present study, the frequency of burns from these two factors was 13% higher among men than women. However, some studies have reported a higher prevalence of burns among women.<sup>19</sup> The mortality rate in women was 19.3%, which was higher than that for other groups, which is consistent with the findings of studies conducted in Ardebil and Shiraz, but inconsistent with the results of a study carried out in Guilan Province.<sup>14,19,20</sup> The second- and third-degree burns were found to be more common, which is consistent with the results of the previous studies.<sup>21,22</sup> The present study showed that although the rate of burn injuries is higher among urbanites, the burns ending in death are comparatively more frequent among villagers, which seems to imply that there exists a significant correlation between mortality place of residence shows.

This is consistent with the findings of Ghaderi and Attar<sup>13</sup> and a study in Columbia.<sup>3</sup> Lower accessibility of villagers to healthcare services is probably the reason for the higher rate of mortality resulting from burns in this group of patients.

Studies of Maghsoudi et al.,<sup>23</sup> in Tabriz and Song and Chua<sup>24</sup> in Singapore have indicated that children and young adults are more likely than other age groups to suffer burns, and hot liquids in children and fire and gas explosion in adults are the most common causes of burns. These findings are consistent with the results of the present study. Despite the low frequency of self-immolation in this study (1.55%), its share of mortality was determined to be 9.6%, with more prevalence among women than men. This is consistent with the findings of studies conducted in Pakistan,<sup>25</sup> Kohgiluyeh and Boyer-Ahmad province,<sup>26</sup> Kerman,<sup>22</sup> and India.<sup>27</sup>

In contrast to the present results, the study of Khashaba in Kuwait shows that burns from the fire are the main cause of injuries and burns caused by hot liquids rank second, with a higher frequency among children.<sup>28</sup> The present study suggested that 90.6% of burns occur at home which accounts for the high prevalence of burn injuries in women, children, and retired men who were exposed to the heater, gas, and boiled water. Thermal burns are the most common and the deadliest type of burns.

Unfortunately, burns annually claim the lives of thousands of people in developing countries. The findings of studies conducted in Iran show that most burns have occurred at home.<sup>13,22</sup> Other studies undertaken in the Eastern Mediterranean,<sup>11</sup> the US,<sup>29</sup> Denmark, and Australia also seem to have come up with similar results. What all this means is perhaps there is a

need for a global collaboration for public education and securitization of the home environment in order to prevent burn injuries.<sup>30,31</sup> In total, the rate of mortality caused by burns was found to be 8.6 in the present study, with the highest rate belonging to the age group 45-64. The study results also indicated that being female and increased TBSA are among the major risk factors for death in burn patients. This is consistent with the findings of some previous studies.<sup>1,25,32,33</sup>

## Conclusion

LA50 is a valuable benchmark for assessing the quality of care in the burn ward of hospitals. Continuous and annual measurement of LA50 is essential for any burns center because it suggests the efficiency of medical and nursing care in that center.<sup>13</sup> The present study seemed to point to negative correlation between the adults' LA50 index and their age. The higher the age of the adults, the lower their LA50 index. Age has been reported to be one of the most important factors affecting the LA50 in patients.<sup>34</sup> The lowest value of LA50 has been reported for the elderly. Studies show that quality care can be very important in preventing the unnecessary deaths. Currently, LA50 reflects the quality of care received by burn patients more clearly than any other index.<sup>13,35</sup>

LA50 index in Sina Hospital of Tabriz in the 2010-2014 period was about 73.43%. It has been reported that LA50 is equal to 76.5%,<sup>36</sup> 39%,<sup>37</sup> and 55% in Kuwait, Africa, Czech Republic, respectively. LA50 in the burn care centers of the US was 55% in 1970, while they now claim that they have managed to improve it to 95%.<sup>7</sup> Based on studies in Iran, this figure has increased from 45% to 52.38 in Shahid Motahari Hospital of Tehran over the past 10 years<sup>8</sup> and it has been reported to be 55% in Imam Reza Hospital of Birjand,<sup>13</sup> which is still far from the standards expected. Nowadays, the survival rate of patients has increased to 95% in developed countries and their major concern is to improve the quality of life for burn survivors and help resume their regular social and family life.<sup>14</sup> Studies show that the survival rate of burn patients in Iran has improved in recent years, but it is still lower than LA50 in developed countries.<sup>7</sup> This can be attributed to insufficient attention to public education and raising public awareness in an attempt to reduce the incidence of severe burns, the inadequacy of facilities and equipment, and shortage of trained staff to provide optimal care to these patients. The elimination of these barriers can lead to a marked increase in patient survival. After the expansion of specialized burn centers and provision of public education to reduce the possible damages, the quality of rehabilitative services provided for the survivors of burn injuries should be set as a top priority in Iran, like developed countries.<sup>7,8</sup>

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## Ethical issues

None to be declared.

## Conflict of interest

The authors declare no conflict of interest in this study

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