

EFFECT OF EARLY GRAFTING ON IMPROVEMENT OF LETHAL AREA INDEX (LA50) IN BURN PATIENTS: A 7-YEAR INVESTIGATION IN A BURN REFERRAL CENTRE IN THE NORTH OF IRAN

EFFET DE LA GREFFE PRÉCOCE SUR L'AMÉLIORATION DE L'INDEX DE SURFACE LÉTALE (LA 50) CHEZ LES BRÛLÉS: UNE RECHERCHE DE 7 ANNÉES DANS UN CENTRE DE BRÛLÉS DE RÉFÉRENCE AU NORD DE L'IRAN

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SUMMARY. Burning is a major health challenge in all societies. In this descriptive cross-sectional study, health information about hospitalized burn patients was extracted from the hospital information system from April 2009 to February 2015. Logistic regression method was used to identify risk factors and mortality predictors. Lethal area index (LA50) was investigated to evaluate the quality of annual hospital medical care. A total of 7725 patient medical files were examined. Mean age of the patients was 32.3±22.5 years old. The most common cause of burning accidents was hot liquids. Mean percentage of total body surface area was 15.8±17.9%. The most and the least common affected areas were upper parts and posterior thorax, respectively. Total calculated LA50 was 56.22 (CI95% = 50.09-62.20). This index was 43.89%, 46.43%, 52.29%, 52.29%, 57.00%, 62.08% and 67.53% annually from 2009 to 2015, respectively. There was a statistically significant difference with regards to mortality rate in the different age groups, higher-degree burns, burn location and burn causes. Analysis of mortality predictors in a model adjusted by age and sex showed that old age ($p < 0.0001$), inhalational injuries ($p < 0.0001$) and burn percentage ($P < 0.0001$) were the three mortality predictors in the multiple logistic regression model. The relationship between early grafting and decreased mortality and increased LA50 was nearly significant in statistical analyses. Burn patient survival rate and annual LA50 had an increasing trend in this hospital. Early grafting surgery seemed to be effective on this trend and decreased mortality risk to a large extent.

Keywords: lethal area index, mortality, mean percentage of total body surface area, burn, early grafting surgery


RÉSUMÉ. La brûlure est dans toutes les sociétés un défi majeur de santé publique. Dans cette étude descriptive transversale, les informations concernant les brûlés hospitalisés ont été extraites du système informatique de l'hôpital entre Avril 2009 et Février 2015. La méthode de régression logistique a été utilisée pour identifier les facteurs de risque et les indicateurs de mortalité. L'index de surface létale (LA 50) fut utilisé pour évaluer annuellement la qualité des soins médicaux à l'hôpital. Un total de 7725 dossiers médicaux de patients a été colligé. L'âge moyen des patients était de 32,3 + ou - 22,5 années. La cause la plus fréquente des accidents de brûlures était les liquides chauds. Le pourcentage moyen de surface corporelle brûlée était entre 15,8 + ou - 17,9 %. Les zones les plus fréquentes, ainsi que les moins étaient respectivement les régions supérieures et les régions postérieures du thorax. Les chiffres de surface létale étaient de 56,22 (CI95% = 50.09 - 62.20). Cet index était 43.89 %, 46.43 %, 52.29 %, 52.29 %, 57.00 %, 62.08 % et 67.53 % par an entre 2009 et 2015. Il y avait une différence statistiquement significative en ce qui concerne le taux de mortalité et les différents groupes selon l'âge, la profondeur des brûlures, leur localisation et leur cause. L'analyse des indicateurs de mortalité dans un modèle adapté en fonction de l'âge et du sexe montre que l'âge ($p < 0.0001$), les lésions par inhalation ($p < 0.0001$) et le pourcentage de brûlures ($P < 0.0001$) sont les trois indicateurs de mortalité dans les multiples modèles de régression logistique. Le lien entre greffe précoce, diminution de la mortalité, et accroissement de l'index LA 50 était assez significatif dans les analyses statistiques. Le taux de survie des brûlés et le LA 50 annuel avaient tendance à augmenter dans cet hôpital. La greffe précoce semble être effective sur cette évolution et diminue le risque mortel dans une large mesure.

Mots-clés: surface létale, mortalité, pourcentage moyen de la surface corporelle brûlée, brûlures, greffe précoce

Introduction

Seventy years ago people had few expectations about burn treatments, even in most developed countries. At that time, most patients died due to serious complications of tissue in-

juries and fluid and electrolyte abnormality.¹ Since the 1970s, with breakthrough advances in burn medicine, such as the discovery of broad spectrum and local antibiotics, various serum therapies, improvement in nutritional conditions, equipping hospitals with advanced specialized burn wards, use of modern

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methods for wound debridement, temporary closure and advanced dressings, burn mortality rate has significantly decreased.¹⁻³

Nowadays, lethal area fifty percent (LA50) index is extensively used as a quality factor in different studies. LA50 is the burn percentage at which 50 percent of affected patients will die.⁴ The index is a valuable tool for evaluating the quality of medical care in burn centres. On the other hand, repetitive measurement of this index can show whether the medical care of burn patients has been efficient or not. Also, it can demonstrate the extent of the required renovation and improvement.^{4,5} Although burn mortality rate is still a demonstrator of resuscitation efficiency and medical care quality, LA50 can predict medical care quality much better.⁵

According to previous statistics in Iran, 10% of burn patients die annually.⁶ Burn is the 8th leading cause of years of life lost (YLL) and the 13th leading cause of disability adjusted life years (DALY) in Iran.⁷ These figures imply the importance of determining predicting factors effective on negative or positive outcomes during the treatment of burn patients. In a study in Rasht (a city in the North of Iran) in 2012, a mortality rate of 8.7% was reported for burn patients.⁸

In our study, we investigated the quality of medical care for burn patients in this centre through inspection of annual LA50 index trend from 2009 to 2015. We also investigated the effect of early grafting surgery (which has been the main treatment in this centre since 2012) on LA50 trend.

Material and methods

This retrospective cross-sectional study was carried out in Rasht Velayat Hospital from April 2009 to February 2015. In this study, only the medical history and files of patients with burn injuries at the time of admission and referred to the Velayat Burn Hospital right after burn were investigated. Patients who had been referred to the hospital by other centres after 5 days or more, and those admitted because of elective choices (such as reconstructive surgery) or burn complications (such as burn scar) were excluded from the study.

A checklist was designed for information registration. A trained operator extracted information such as age, sex, burn type, body surface area percentage, burn degree, burn cause, early grafting surgery, duration of hospitalization, clinical outcome and patient survival from the patients' files and recorded it in the checklist. In addition, LA50 was calculated with linear regression method as a general index for investigation of resuscitation efficiency and annual medical care quality.

Initially, data were analysed using descriptive statistics (prevalence, percentage and mean) with SPSS version 21. Then, linear regression was employed to calculate LA50 and R square. Comparison of burn percentage classified by age group, sex and year was conducted by independent t test and analysis of variance (ANOVA). To compare mortality percentage with respect to sex, age and year of investigation, Chi-square and Fisher exact tests were used. P values of less than 0.05 were considered statistically significant.

Results

A total of 7725 medical records were included in this study, with 6034 (78.11%) males and 1691 (21.88%) females. Mean age of patients was 32.7±22.1 years (with an age range

Table I - Demographic features of patients

Demographic Features		N	Percent (%)
Gender	Male	6034	78.11
	Female	1691	21.88
Age group, years	< 1 yr	604	7.82
	1 - 5 yrs	677	8.76
	6-10 yrs	329	4.25
	11 - 20 yrs	709	9.17
	21 - 30 yrs	1606	20.82
	31 - 50 yrs	2183	28.25
	> 50	1617	20.93
Mortality	Death	447	5.8
	Survived	7278	94.2
Location of Burn	Upper limb	2988	36.27
	Lower limb	2532	33.07
	Head and neck	396	4.21
	Genitals	93	1.12
	Back	45	0.58
	Anterior chest	67	0.86
	Total body	324	10.22
	Upper and lower limb	1280	13.56
Cause of burn	Hot liquid	3302	42.74
	Fire	1508	19.52
	Electrical	267	3.45
	Steam	72	0.94
	Gas	1188	15.37
	Oil	351	4.54
	Hot Tool	396	5.14
	Chemical	216	2.79
	Radiation	6	0.08
	Alcohol	210	2.72
	Others	209	2.71

Table II - LA50 by year

Year	95% Confidence Limits		
	Estimate	Lower Bound	Upper Bound
2009	43.89	39.09	48.42
2010	46.43	41.82	51.51
2011	52.29	46.95	58.14
2012	57.00	50.22	64.31
2013	62.08	54.88	69.68
2014	64.25	57.24	71.66
2015	67.53	59.65	71.70
Total	56.22	50.09	62.20

of less than 1 year to 104 years old). Demographic information of the patients is shown in *Table I*.

Most of the patients had second-degree burns (37.7%). The mean and the median of total body surface area (TBSA) percentage was 15.8±17.9% (range: 1-100) and 10%, respectively. Mean TBSA in the different years did not show a statistically significant difference. TBSA percentage in the different years from 2009 to 2015 was 16.6%, 15.33%, 16.14%, 15%, 15%, 12% and 16.8%, respectively. Average burn percentage classified by age group was significantly different (P=0.0001). The highest percentage belonged to the 21-30 year-old age group, with 17.5%. Mean TBSA% in men and women was 17.5 ± 15.5 and 19.7 ± 16.9, respectively. This difference was not statistically significant (p> 0.05).

Table III - Logit analysis on LA50 difference between the study years

Year	Year	95% Confidence Limits		
		Estimate	Lower Bound	Upper Bound
2010	2009	2.544	-2.913	8.199
	2011	8.405	2.235	14.984
2012	2010	5.861	-.750	12.682
	2009	13.118	5.478	21.356
	2010	10.574	2.664	18.884
2013	2011	4.713	-3.542	13.157
	2009	18.195	9.555	27.778
	2010	15.651	6.935	25.112
	2011	9.790	.937	19.178
2014	2012	5.077	-4.616	15.115
	2009	20.366	11.669	30.107
	2010	17.822	9.099	27.392
	2011	11.961	3.155	21.403
	2012	7.248	-2.353	17.295
2015	2013	2.171	-7.771	12.214
	2009	23.643	13.679	34.903
	2010	21.098	11.208	32.087
	2011	15.238	5.380	25.983
	2012	10.525	.050	21.698
	2013	5.448	-5.168	16.416
	2014	3.276	-7.199	14.004

The mean age of mortality was 47.62±23.9 and mean TBSA was 58.7±27.25% in these patients. Most of these patients were in the over 50 age group. Mortality rate in the years from 2009 to 2015 was 74, 72, 63, 63, 72, 74 and 55, respectively. Altogether, 94.2% of investigated patients survived in this 7-year period.

Additionally, logistic test was used to calculate LA50, which is shown in *Table II* (classified by year). A comparison between the different years is given in *Table III*.

Investigation of mortality predictors among the different variables in a model adjusted by age and sex revealed the three factors of early grafting (P=0.01), age (P<0.0001) and burn percentage (P<0.0001) to be the three main mortality predictors in a multiple logistic regression model. Late grafting surgery had a 1.7 times higher chance of mortality compared to early grafting surgery (Crude OR was 1.7, P<0.006). As can be seen in *Table IV*, patients over 50 years old were 16 times more at risk of mortality compared to children (Crude OR: 14.4, P<0.0001) (*Table IV*).

Table IV - Probability of mortality, crude and adjusted Odds Ratio of death among subgroups

Variable	Mortality rate %	Crude Odds Ratio [95% Confidence Interval]	P-value	Adjusted Odds Ratio [95% Confidence Interval]	P-value
Graft					
Late	5.8%	1.72(1.19-2.5)	0.004	1.68(1.16-2.44)	0.006
Early	4.8%	1		1	
Age					
< 1 yr	1.3%	1		1	
1 - 5 yrs	1.8%	3.08(0.81-11.62)	0.097	3.0(0.8-11.2)	0.101
6-10 yrs	1.1%	0.63(0.085-4.63)	0.647	.592(0.8-4.38)	0.608
11 - 20 yrs	3.0%	1.11(0.27-4.63)	0.884	1.1(0.27-4.51)	0.896
21 - 30 yrs	4.3%	1.31(0.40-4.27)	0.649	1.3(0.41-4.15)	0.656
31 - 50 yrs	5.3%	2.96(0.96-9.17)	0.059	2.9(0.95-8.83)	0.060
> 50	10.7%	16.4(5.36-50.18)	0.000	16.04(5.33-48.23)	0.000
TBSA		1.11(1.1-1.12)	0.000	1.114(1.1-1.2)	0.000

a. Variable(s) entered on step 1: graft, age, gender, percent

Discussion

Worldwide, burns and associated complications are among the most important causes of mortality and morbidity.^{7,8} In this study, the 21-50 year-old age group was the most populated group. In a study by Fazeli et al., most burn patients were in the 15-35 year-old age group,⁹ while the most populated age group was 16-25 years in another investigation.¹⁰

In this study, the most common type of burn was scald. Epidemiologic burning statistics in Iran show that more than 85% of burns occur in the home (due to boiling water and cooking), and only 15% of them happen in a work environment. The results of our study are consistent with previously mentioned studies.¹¹

Mean burn percentage (TBSA) in this study was 15.8%, while it was 16.5% in Forootan et al.'s study.⁶ Mean TBSA in Africa, Taiwan and Spain was 18.5%, 14% and 14% respectively.¹²⁻¹⁴ Mean burn percentages classified by age group in this study were statistically significant. The highest burn percentage was seen in the 21-30 year-old age group, with 17.5%.

Consistent with other studies, mortality rate was higher in women than men, but this difference was not statistically significant. Meanwhile, mortality rate difference in the age groups, higher-degree burns, location and existence of inhalational injuries was statistically significant (P<0.0001). In patients over 50 years-of-age, mortality rate was significantly higher among those with total body burn and gasoline induced burns. In Forootan et al.'s study, age, sex and mean burn percentage were the main mortality risk factors in patients. However, cause of burn was not associated with any difference in outcome.⁶

The results of this study showed that mortality rate difference in patients categorized by the years of investigation was statistically significant (P<0.0001). For example, a study conducted in Spain demonstrated a 24% mortality reduction from 1992 to 1995 and a 12% reduction from 2001 to 2005.¹⁵ The reduction in burn mortality rate may be due to increased hospital care, hospital control improvement, and increased patient awareness about seeking rapid treatment.

Total calculated LA50 in this study was 56.22%, which means 50% of patients with 56.22% burn died in this therapeutic centre. Various LA50s have been reported in different internal and external studies. For example, in Iran, Forootan et al. reported LA50 to be 62.31%⁶ while annual LA50 at the

Shahid Motahari Burn and Accidents Hospital was 52.38%.¹⁰ LA50 in different studies in the UK, Africa and Kuwait was 60%,¹⁶ 39%¹² and 76.5%¹⁷ respectively.

Velayat Burn Centre, as referral centre for the north of Iran, is the main specialized burn hospital in Guilan, and most serious burns are referred here. An increasing LA50 trend from 43.89% to 67.53% over the last 7 years indicates a significant improvement in treatment quality and mortality reduction. Effective possible factors for improving LA50 are: observing principles of burn patient transfer, adequate and correct primary resuscitation, good cooperation between different therapeutic groups involved in the care of burn patients, adequate knowledge and instruments for infection control, therapeutic facilities and specific equipment for burn treatment, appropriate education for preventive methods and burn prevention, and employment of skilled and trained forces.

Early grafting surgery was used for all patients in this centre in the last three years of our study from 2013 to 2015. Comparison of LA50 in the patients showed an increase in LA50 in patients who underwent early grafting surgery. In other words, patients who underwent early grafting surgery died only if they were affected with higher-degree burns. Our findings showed a decrease in the mortality rate in early grafting surgery patients. Statistically, this decrease was considered nearly significant.

In spite of our clinical experience showing better resistance in females than males, LA50 difference between males and females was not statistically significant. Some studies show that

burn injuries are more severe in females compared to males, and females stand to die with a lower burn surface.¹⁸ Also, comparison of LA50 in different types of burn shows that mortality rate is higher in heat burns. This finding is consistent with the results of other studies.

Investigation of LA50 categorized by age showed that in the over 50 year-old age group, this index has significantly decreased. Consistently, results of a study by Jeevan and colleagues showed that LA50 decreased in older patients. In that study, LA50 in the 5-44 and 45-64 age groups was 71.08 and 56.64 respectively, and decreased to 28.82 for the over 64 year-olds.¹⁶ This finding can be attributed to the presence of comorbidities such as hypertension, diabetes, cardiovascular and systemic diseases, which decrease the body's resistance. Therefore, these patients have a higher mortality risk, even with a lower burn percentage.

Conclusion

Generally, LA50 increased over the years of our investigation (from 43.89% to 67.53% in the last 7 years). It can be said that factors such as early grafting surgery may be effective on this increasing trend to a large extent. Also, employment of highly skilled specialists, isolated rooms, advanced dressings for infection control, modern instruments, regular training for nurses, supervision, follow up and non-governmental organization efforts to support burn patients could be effective in increasing life expectancy and LA50.

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