Research Article

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Etiology, Pathogenesis and Outcomes of Patients Treated at the Burn Center of N.V. Sklifosovsky Research Institute for Emergency Medicine

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BACKGROUND We identified patients treated at our Burn Center over a 14-year period.

MATERIAL AND METHODS The following data were studied: the annual and total number of patients, the number of patients admitted to the Intensive Care Unit (ICU) and the Burn Unit (BU), gender and age of the patients, the epidemiology of burn injury, percentage of total body surface area (TBSA) burned, percentage of inhalation injury, percentage of full thickness burns, mortality.

RESULTS It was revealed that the annual number of patients averaged 730 (692; 747). The proportion of those hospitalized to the ICU was 35–49%, and 51–65% to the BU. These figures did not differ significantly (all p>0.05; Fisher exact test [FET]). The male to female ratio was 2.3-1.6:1. The age of the patients increased from 44 (31; 59) to 48 (33; 62) years (p=0.003; M–W test). The percentage of the etiological factors changed: flame burns accounted for 60% of cases in 2006 and 34% of cases in 2019 (p<0.001; FET). The number of patients with scalds increased from 18% in 2006 to 33% in 2019 (p=0.023; FET). The proportion of patients with inhalation injury without burns did not exceed 15% for the entire study period. Median burn area among all hospitalized decreased by almost twice from 2006 to 2019: total area from 12% to 7% TBSA (p<0.001; M–W test); superficial, from 10 to 6% TBSA (p<0.001; M–W); deep burns, from 9 to 3% TBSA (p<0.001; M–W). In patients in the ICU, the median of the total burned area was 20–25% TBSA, the area of superficial burns prevailed without a statistically significant difference between 2006 and 2019. (p=0.285; M–W test). The median area of deep burns gradually decreased by more than twice: from 15% TBSA in 2006 to 7% TBSA in 2019 (p<0.001; M–W test). For the period from 2006 to 2019 overall mortality in the burn center decreased from 16.7% to 7.4% due to a 2.4-fold decrease of mortality from 16.3% to 6.9% in the ICU (p<0.001; FET). In the BU, for the entire period it was 0.4-1.6%. In 2019, the highest mortality of 27% was observed in combined burns and inhalation injury (InI) followed by InI without burns (13.6%), and then came electrical injury (11.8%).

CONCLUSION For 14 years, mortality has decreased by more than twice. The highest number of deaths was observed among patients with skin burns and InI, InI without burns and electrical injury. Annual number of admissions in ICU and BU, gender ratio remained steady. The median area of total burns decreased by 2-3 times, the median area of deep burns in patients in the ICU decreased by 2 times. The median age of burn patients increased by 4 years and began to refer to the middle age group according to the WHO classification.

Key words: burns, mortality, inhalation injury

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BU, Burn Unit
FET, Fisher's exact test (добавлено РИО)
ICU, Intensive Care Unit
InI, inhalation injury
TBSA, total body surface area

INTRODUCTION

Burn injury is a serious injury characterized by a long course, the development of severe complications and leading to high mortality and disability.

According to the Federal State Statistics Service (Rosstat) data in 2019, the number of casualties suffered from thermal or/and chemical burns in Russia increased from 363 thousand to 493 thousand for the period from 2005 to 2018. The number of patients per 100,000 adults increased from 255 to 335 [1].

The problems in rendering specialized medical care to burn injury casualties remain urgent [2].

In order to arrange properly the provision of qualified medical care to patients with burn injuries, it is important to trace the changes in the number and structure of hospital admissions over time. Increasing numbers of burn injury cases, surgical interventions require the solution of staff issues, available additional beds for burn patients, the implementation of new technologies, dressings, and medicines [3].

All of the above explains the relevance of our study.

Our **purpose** was to study the specific characteristics and mortality rates of patients hospitalized to the Burn Center of the N.V. Sklifosovsky Research Institute for Emergency Medicine in 2006-2019.

MATERIAL AND METHODS

The characteristic parameters and mortality of 10,255 patients hospitalized in the burn center of the N.V. Sklifosovsky Research Institute of SP in 2006-2019 were retrospectively studied. The data source was the electronic database of patients of the Burn Center.

Inclusion criteria were flame burns, scalds, electrical injury and electrical burns, chemical and contact burns, inhalation injury, patients' age of 18 years and older.

The exclusion criteria were sunburn, frostbite, toxic-allergic dermatitis (cow-parsnip), patients aged under 18 years.

We studied the annual number of patients admitted to the Burn Center (Intensive Care Unit [ICB] and Burn Unit [BU]), gender and age of patients, epidemiology of burn injury, burn area (total, superficial and deep burn area), and mortality.

Statistical processing of the obtained results was performed using the software of Statistica™ TIBCO® Software Inc., version 13.3. Descriptive statistics are presented as absolute and relative values (%), medians (Me), interquartile ranges (Q1; Q3). Nonparametric statistic methods: Fisher's exact test (FET) and the Mann-Whitney test (M-W test) were used to compare the groups, since some part of the data had the distribution different from normal. The differences were considered statistically significant at $P < 0.05$.

RESULTS AND DISCUSSION

For the period from 2006-2019 the median number of hospitalized patients per year was 730 (692; 747), with the minimum number of admitted patients being 655 in 2011 and the maximum number being 803 in 2007 (Figure 1).

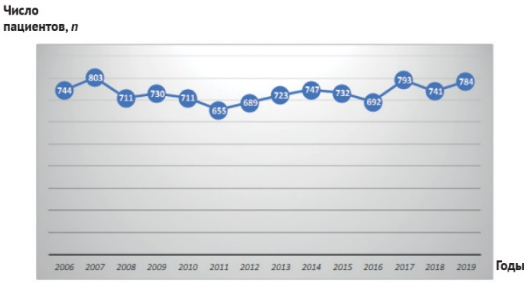

Fig. 1. Dynamics of annual hospital admissions of burn patients as distributed by year

Y: Number of patients

X: Year

During the studied time period, the proportion of patients hospitalized in the Burn Center ICU was 35-49% of the total number of burn admissions; those admitted in BU made up 51-65%. These figures did not differ significantly ($p > 0.05$ for all throughout the study period (Figure 2).

Fig. 2. Dynamics of distribution of hospitalized patients by departments

Y: Number of patients

X: Year

ICU

BU

The male to female ratio of hospital admitted patients did not change statistically significantly from 2006 to 2019. ($p > 0.05$ for all; FET). Men accounted for 61-70%, women made up 30-39% of the total number of hospitalized patients (Figure 3). A similar ratio of men and women has also been noted by other authors [4, 5].

Fig. 3. Dynamics of the distribution of hospitalized patients by gender

Y: Number of patients

X: Year

Men

Women

The age analysis of the hospitalized patients showed that compared to the period from 2006-2008, median age of patients in 2009 increased to 48 years old, remaining at a higher level until 2019. Patients in 2019 were statistically significantly older than patients in 2006 ($p = 0.003$; M-W test) (Figure 4).

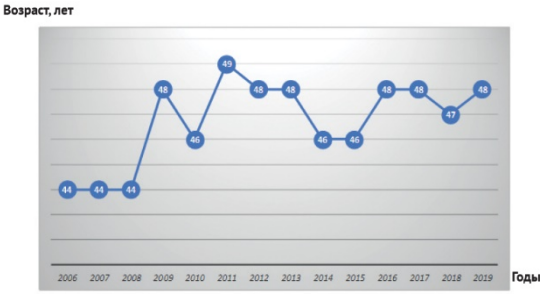

Fig. 4. Dynamics of age changes among hospitalized patients

Y: Age, years

X: Year

Other authors also provide similar data on the age of patients, noting that the majority of burn patients belong to the working age group [4, 6].

The study of burn injury epidemiology showed that over the analyzed period of time, its structure changed (Figure 5). Among the patients of the Burn Center, the proportion of those who sustained flame burns gradually decreased: those cases made 60% in 2006, and 34% in 2019, the difference being statistically significant ($p < 0.001$; FET).

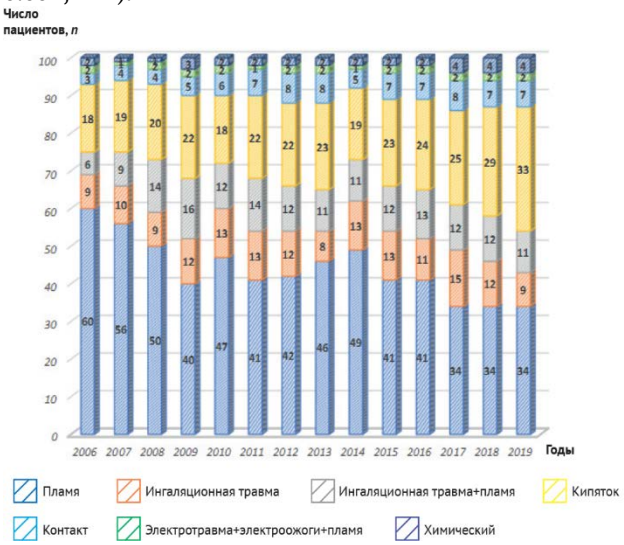

Fig. 5. Dynamics of the patient distribution by etiology

Y: Number of patients

X: Year

Flame burn, InI, InI+flame burn, Scald Contact burn, Electrical injury + electrical burn + flame burn, Chemical burn

The number of patients with skin burns and inhalation injury (InI) in 2006 was 6% of the total number of hospitalized, and increased significantly to 16% in 2009 ($p = 0.040$; FET). In 2019, the proportion of such patients decreased to 11%, which did not differ statistically significantly from either 2006 ($p = 0.311$; FET) or 2009 ($p = 0.408$; FET).

At the same time, the proportion of patients with scald burns gradually increased from 18% in 2006 to 33% in 2019, the difference being statistically significant ($p = 0.023$; FET). Thus, the number of patients with scalds and flame burns in 2019 became equal.

The number of patients with contact burns varied over the years from 3% to 8%, but did not differ significantly ($p > 0.05$ for all; FET).

Patients with electrical injury and electrical burns accounted for a small proportion (1-2%) of all hospitalized patients during the study period, the difference between 2006 and 2019 was not statistically significant ($p > 0.05$ for all; FET).

The proportion of patients with chemical burns slightly increased from 1% (in 2007-2008) to 4% (in 2017-2019), but the difference was not statistically significant ($p = 0.369$; FET).

The proportion of patients with isolated InI fluctuated at the level of 9-15% throughout the study period (all p >0.05; FET).

The structure of epidemiological factors in burn injury has its specific characteristics in different countries. Thus, in the analysis of 1694 cases, the author from Belarus reported a similar proportion of flame burns and larger proportions of hot liquid burns, contact, chemical, and electrical burns [4]. In Bangladesh, with a similar number of flame burns, the authors noted a significant number (31%) of injury from electric current [7]. Flame burns predominate in Saudi Arabia [5].

Speaking about the epidemiology of burn injury, we should say about electronic cigarettes (EC) as a new currently emerged damaging factor. The authors summarized data from 90 patients who received flame burns, contact, chemical and combined burns from electronic cigarettes, and required surgical treatment [8]. In our practice, there were no such cases. However, in our practice, there were burns from the explosion of batteries in phones, scooters, watches.

The proportion of patients with deep burns, which mainly determine the severity of the patient condition, varied from 27% to 52% during the study period: the minimum was noted in 2007, and the maximum in 2010. In 2019, the proportion of patients with deep burns was 39%, which was not statistically significantly different from the same figure in 2007 (p = 0.098; FET) and in 2010 (p = 0.088; FET). Almost all patients (96-100%) had superficial burns (Figure 6).

Fig. 6. Changes in the proportions of patients with superficial and deep burns by year

Y: Number of patients

X: Year

Patients with superficial burns

Patients with deep burns

Between 2006 and 2019 the median burn area among all hospitalized patients decreased by almost twice (Figure 7): the total burn area from 12% to 7% of the total body surface area (TBSA) (p < 0.001; M-W test), the superficial burn area from 10 to 6% of TBSA (p <0.001; M-W test), the deep burn area from 9% to 3% of TBSA (p < 0.001; M-W test).

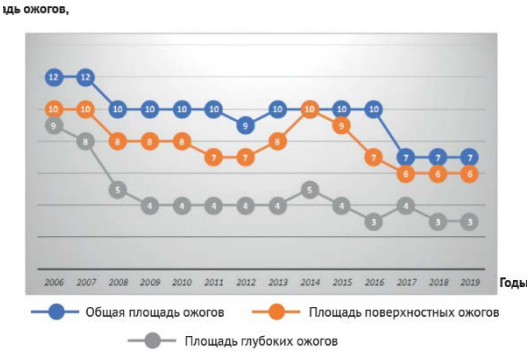

Fig. 7. Changes in the proportions of patients with superficial and deep burns by year

Y: Burn area, % TBSA

X: Year

Total burn area

Superficial burns, % TBSA

Deep burns, % TBSA

We analyzed the dynamics of the median burn area in patients admitted in ICU (Figure 8). It turned out that during the studied period, the median of the total burn area among ICU patients remained at the same level, making up 20-25% TBSA. At the same time, superficial burns prevailed making 15-18% TBSA, and their area had increased to 20% TBSA by year 2019 ($p = 0.285$; M-W test). The median area of deep burns, making 15% TBSA in 2006-2008, decreased to 9-12% TBSA from 2009 and had reached its minimum of 7% TBSA by 2019 ($p < 0.001$; M-W test).

Fig. 8. Dynamics of changes in the median area of burns in patients hospitalized in the intensive care unit

Y: Burn area, % TBSA

X: Year

Total burn area

Superficial burns, % TBSA

Deep burns, % TBSA

The study of overall mortality in the Burn Center for the period from 2006 to 2019 revealed the decrease on overall mortality rate from 16.7% to 7.4%. Meanwhile, it was always low in the BU making 0.4-1.6%, but in the ICU, the number of deaths decreased almost 2.4 times over the study period, namely, from 16.3% in 2006 to 6.9% in 2019, which was a statistically significant difference ($p < 0.001$; FET) (Figure 9).

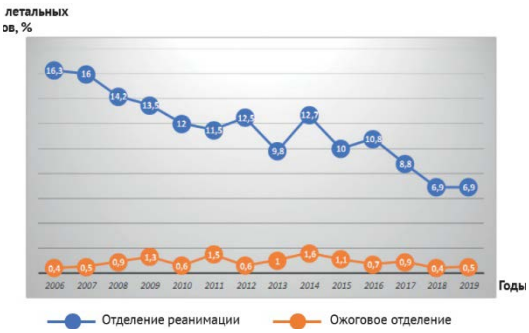

Fig. 9. Dynamics of death cases by departments by the Burn Center Units

Y: Number of deaths, %

X: Year

ICU

BU

There has been an opinion that the highest mortality is observed in patients with flame burns [6]. We studied mortality across the epidemiology structure of burn injury in 2019. The results of our study showed that the highest mortality was observed among the patients with skin burns and InI (27%), which is due to mutually increased severity in combination damage, while in flame burns only, the mortality rate, according to our data, was only 7.7%. According to our data, the second place in terms of mortality rates in the structure of burn injury belongs to isolated InI (13.6%). The third place in terms of the fatal outcomes belongs to electrical injury (11.8%). Scalds results in the lowest mortality (1.6%) among all kinds of burn injury. Some authors cite an overall mortality rate similar to ours (6.9%) among patients of all ages, however, these data are not comparable, since the mortality rate among only children of this group only was 0.76% [5].

CONCLUSION

For the period from 2006-2019 the annual numbers of patients admitted to the Burn Center remained at the same level (mean 730 (692; 747) per year). At the same time, the ratio of hospitalized in ICUs to BUs, as well as admitted men and women, remained steady. Over the studied period of time, the median age of the burn patient increased by 4 years. The distribution of patients according to the etiology of the damaging factor had changed: the number of patients with flame burns decreased almost twice, and the number of patients with scalds two-fold increased. The proportion of patients with isolated InI throughout the studied periods did not exceed 15%. The minimum proportion of all casualties was accounted for the patients with contact burns and electrical injury. Among all those admitted, the median burn areas (for total, superficial, and deep burns) decreased by 2-3 times. In the ICU patients, the median of the total burn affected area during the study period was 20-25% TBSA with superficial burns predominating. The median area of deep burns in patients in the ICU gradually decreased by more than 2 times. For the period from 2006 to 2019, the overall mortality in the Burn Center decreased from 16.7% to 7.4% due to a 2.4-fold reduction in mortality in the ICU: from 16.3% to 6.9%. In the BU was 0.4-1.6%. The most severe patient population of the Burn Center were those with skin burns and InI in whom the mortality rate was the highest (27%) in 2019 compared to mortality rates among those with other etiological factors of the injury, isolated InI came second with mortality of 13.6%, electrical injury (11.8%) came third.

FINDING

1. From 2006 to 2019 the overall mortality in the Burn Center decreased due to a decrease in ICU mortality by more than 2 times.
2. The highest number of deaths was observed among patients with skin burns and InI (27%), isolated InI (13.6%), and electrical injury (11.8%).
3. The number of annual admissions, gender ratio and distribution of patients between the ICU and BU remained steady from 2006 to 2019.
4. The median burn area (for total, superficial, deep burns) among all patients decreased by 2-3 times, the median area of deep burns in patients in the ICU decreased by 2 times.
5. The median age of burn patients increased by 4 years and began to refer to the middle age group according to the WHO classification.

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