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ORIGINAL PAPER

Short-Term Outcomes of Burn Patients: a Tertiary Hospital's Four-Year Experience

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ABSTRACT

Introduction: *Burns are the fourth cause of trauma worldwide, with a yearly death toll of 180,000. Multiple studies have investigated prognostic factors for the short-term and long-term evolution of burns, commonly citing age, percentage of total body surface area affected (BSA), percentage of third-degree burn, inhalation injury, surgery and overall depth of burn. The aim of our study is to review all cases managed in a tertiary emergency center and find factors associated with duration of hospital stay.*

Material and methods: *The official reporting of burns from 2020-2023 "Bagdasar-Arseni" Emergency Clinical Hospital was reviewed, and clinical data regarding age, gender, burn severity and duration of hospitalisation, of Burns ICU time and mechanical ventilation was gathered and analysed using SPSS, version 26.*

Outcomes: *A total of 337 cases were gathered, with a death rate of 14.54% (36.51% of inhalatory lesions are associated). 59.05% of patients were men, the majority (21.36%) were between 51 and 60 years old, most patients suffered burns on less than 10% of the total body area (50.45%). Most patients had third degree burns (60.2%), followed by second degree (39.2%). On average, patients were hospitalised for 16.5 days, of which approximately 8.5 were spent in the Burns ICU, and 3.3 days of mechanical ventilation were needed. The durations of hospitalisation, Burns ICU stay and mechanical ventilation were significantly higher in older patients, those with 31-40% BSA burns, subjects with third degree burns and those who died during the hospital stay.*

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Conclusions: *Of all managed cases, most patients were males, middle-aged, over half of them were suffering from small area burns and most of the burns were third degree. Regarding the duration of the required medical services, patients with severe burns (third degree) and those who did not survive required a longer duration of hospitalisation, more time in the Burns ICU and more time on mechanical ventilation.*

Keywords: burn, thermal burn, burn severity, intensive care unit, mechanical ventilation.

ABBREVIATIONS

BSA: body surface area
CI: confidence interval
ICU: intensive care unit
LOS: length of stay
SD: standard deviation
TBSA: total body surface area
WHO: World Health Organization

INTRODUCTION

Burns are the fourth cause of trauma worldwide, preceded by traffic accidents, falls and violence (1). They represent a public health priority with a profound impact both on the individual patient and on society, with intricate acute management and long-term psychosocial and physical sequelae. The World Health Organization (WHO) estimates that 11 million people suffer from burns each year and the death toll is 180,000 following these injuries (2).

In the last decades, the advances in burn care have decreased the overall mortality associated with burns. At the beginning of the twentieth century, estimates of burn mortality in developed countries ranged between 54% and 100%; a systematic review from 2013 reported mortality rates between 4% and 6%. Traditionally, mortality rates have been used as a measure of outcome, but at present the focus has shifted towards outcomes such as quality of life and functional status as long-term consequences of burn care. Since these parameters are difficult to measure in a consistent manner suitable for comparison, the length of hospital stay (LOS) has emerged as a parameter that is easy to collect across different services and also provides an indication of the short- and long-term effects of burn care. However, the utility of the LOS parameter is limited by a lack of standardised criteria constituting discharge following burn care. In Europe, the paucity of inpatient rehabilitation beds may suggest that patients admitted to burn services tend to be hospitalised for a longer time, in the absence of appropriate recovery facilities (3).

Multiple studies have investigated the prognostic factors for LOS. The most commonly identified significant prognostic factors are age and percentage of total body surface area affected by the burn (TBSA). Other significant factors include the percentage of third-degree burn, inhalation injury, surgery and overall depth of burn (4-8).

A study published in 2016 found that the extent of the burn was associated with an increased LOS and possibly more interventions, which were associated with higher costs (9). According to the synopsis of the National Burn Repository 2013 Annual Report, in patients with burns ranging from 0.1% and 89.9% of TBSA, the mean length of stay was correlated with the extent of the burn, every 1% of TBSA being approximately equivalent to a day of hospitalisation. However, a decreasing tendency of length of hospitalisation was reported in patients with TBSA>60%, possibly owing to higher early mortality (10). A systematic review from 2014 concluded that LOS was the most expensive component of the total cost of burn care (11).

Although burn mortality has consistently decreased and burn prevalence has generally declined in high-income countries, according to an analysis of data from the Global Burden of Disease study, Eastern Europe is expected to experience the most notable increases in prevalence, due to industrialisation, population aging and a rise in occupational injuries (12). As such, it is important to better understand the epidemiological factors of our patients and better predict the LOS and other variables related to short-term mortality and long-term morbidity of the burn.

The aim of our study is to review all cases managed in a tertiary emergency center and find factors associated with duration of hospital stay. ❑

MATERIALS AND METHODS

The data were gathered from the official reporting of the Plastic Surgery and Reconstructive Microsurgery Department of "Bagdasar-Arseni" Emergency Clinical Hospital, Bucharest, Romania. All patients presented through the Emergency department, in the period between 1 January 2020 and 31 December 2023 (spanning four years of experience).

All patients offered their informed consent at admission, and for those critically ill, who could not offer informed consent, a legally authorised representative exercised 'substituted judgement' for medical decisions and offered consent at admission. The investigation followed the principles in the Declaration of Helsinki. In order to estimate the total body surface area (BSA) involved in a burn injury, the Lund and Browder chart was used (13), by assessing the surface area of the burns in relationship with the anterior and posterior human body outline that the chart consists of. Each body division corresponds to a percentage and the total BSA is calculated by adding all surface areas affected (13).

The burns were also classified based on depth of affected tissue: superficial (first degree) burns involve the epidermis; partial thickness (second degree) burns affect the epidermis and papillary or reticular dermis, with skin appendages variably affected, full-thickness (third degree) burns involve epidermis and dermis, with all skin appendages destroyed, and full-thickness (fourth degree) burns affect the fascia, muscle, and may involve even bone (14).

Clinical, anonymised data was gathered using the Microsoft Office Suite and analysed using the Statistical Package IBM SPSS Statistics for Windows, version 26 (IBM Corp., Armonk, NY, USA).

The following data was gathered: qualitative nominal data (cause of death, gender, burn cause, body area affected, comorbidities of the patient), qualitative ordinal data (burn area and depth) and quantitative data (age, hospitalisation duration). For quantitative data the average (calculated by summing all hospital stay lengths and dividing by the total number of patients) and the median were calculated (the median hospitalisation duration was calculated as the number of days that splits the distribution into two equal halves, with half of the patients hospitalized for fewer days and half for more). For all statistical analyses, the threshold for statistical significance was considered 0.05 (p value).

In order to identify significant differences in numerical values between burn stages and depths, first the normality of the distribution was checked using the Shapiro-Wilk test. The Shapiro-Wilk test showed a significant departure from normality for the patients' age ($W(334) = 0.99$, $p = 0.011$), the number of days of hospitalisation [$W(337) = 0.82$, $p < 0.001$], the number of days in the Burns Intensive Care Unit [$W(337) = 0.65$, $p < 0.001$] and the number of days on mechanical ventilation [$W(337) = 0.46$, $p < 0.001$]. As such, when comparing the means of two groups without assuming normal distribution, the non-parametric Mann-Whitney U test was used (second- and third-degree burn, survivors and non-survivors). When comparing the means of more than two groups, the ANOVA test was used, followed by the post-hoc Tukey test (age groups, burn surface area bracket). When calculating the degree of correlation between continuous variables, the Spearman's rank-order correlation was used (as the numerical variables mentioned above are not normally distributed). ❑

RESULTS

Descriptive statistics

A total of 337 cases of burns were managed in the time period reviewed by us. The gender distribution was 40.06% women and 59.05% men. Most patients were aged between 51-60 at admission, with 2.97% being aged between 18-25, 13.95% between 26-40, 18.99% between 41-50, 21.36% between 51-60, 17.51% between 61-70, 16.02% between 71-80 and 9.20% over 80 years old (Figure 1). In total, during hospitalisations, a total of 49 deaths were registered, corresponding to a mortality rate of 14.54%. From all 337 cases, 63 also presented inhalation injuries (18.69%), and the death rate in this subgroup was 36.51%.

Regarding BSA affected by burns, most patients suffered burns on less than 10% of the total

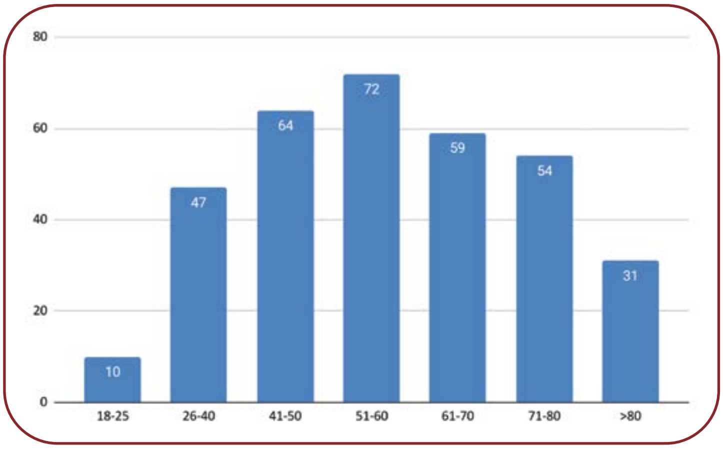

FIGURE 1. Age distribution and number of cases

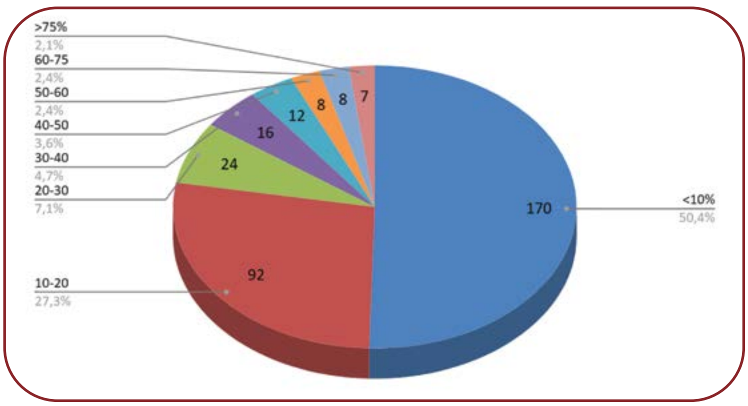

FIGURE 2. Body surface area affected by burns – distribution in the cohort of patients

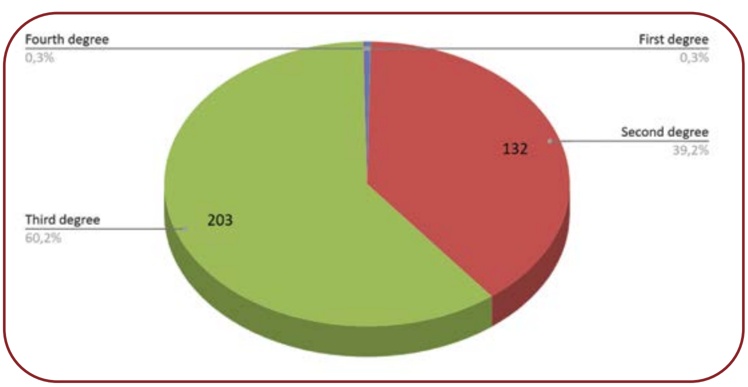

FIGURE 3. Distribution of burn depth in the cohort of patients

body area (50.45%), 27.30% on 10-20% BSA, 7.12% on 20-30% BSA, 4.75% on 30-40% BSA, 3.56% on 40-50% BSA, 2.37% on 50-60% BSA, 2.37% on 60-75% BSA, 2.08% on >75% BSA (Figure 2).

Regarding the burn depth, most patients had third degree burns (60.2%), followed by second degree (39.2%) and only one patient had a first degree burn and one patient a fourth degree burn (Figure 3).

Duration of stay depending on age and burn gravity

On average, the patients needed 16.53 (SD 15.88) days of hospitalisation following the acute setting of the burn, of which on average 8.50 (SD 14.40) were spent in the Burns Intensive Care Unit (ICU) and 3.30 (SD 8.37) days on ventilation were needed (Table 1). The median duration of stay was 12 days, the median duration of Burns ICU stay two days and the median duration of mechanical ventilation 0 days. While, on average, older patients required prolonged hospitalisation time and more time on mechanical ventilation, the difference between the age brackets was not statistically significant (Table 1). However, while calculating the correlation between LOS and age, all correlations were positive, weak, but statistically significant: a higher age is correlated with a longer hospital stay (Spearman's coefficient 0.162, p value 0.003), longer Burns ICU stay (Spearman's coefficient 0.157, p value 0.004) and longer need for mechanical ventilation (Spearman's coefficient 0.120, p value 0.029).

Moreover, the relationship age-LOS is modulated by the survival of the patient: in the group of survivors, only the correlation of age and LOS is significant (Spearman's coefficient 0.159, p value 0.007), the relationship with Burns ICU stay and mechanical ventilation is no longer significant. In the group of non-survivors, the age is not significantly correlated with none of the durations, suggesting other factors (such as burn severity) as influential.

When comparing these durations between different burn severities (classified by total BSA affected), the longest stay was needed for patients with 31-40% BSA affected, while the shortest was needed for patients with >75% BSA affected, the difference being statistically significant. Patients with 31-40% BSA affected spent the longest in the Burns ICU, while those with < 10% BSA affected spent the least amount of time, the difference being statistically significant. Not last, those patients with 31-40% of the BSA affected by the burn needed the most time on mechanical ventilation and those with < 10% the least, the difference being statistically significant (Table 2).

TABLE 1. Mean total hospitalisation duration, hospitalisation in Burns ICU, time on mechanical ventilation, depending on age bracket, followed by confidence interval (CI) limits of 95% and standard deviation (SD)

	Age group		Statistic
Hospitalisation total	**18-25**	**Mean**	**8.80**
		95% CI for mean	4.65 - 12.95
ANOVA test p value		SD	5.808
0.079	**26-40**	**Mean**	**13.04**
		95% CI for mean	09.09 - 17.00
		SD	13.471
	41-50	**Mean**	**14.91**
		95% CI for mean	11.41 - 18.40
		SD	13.996
	51-60	**Mean**	**17.22**
		95% CI for mean	13.51 - 20.93
		SD	15.779
	60-70	**Mean**	**21.51**
		95% CI for mean	15.73 - 27.29
		SD	22.184
	70-80	**Mean**	**16.74**
		95% CI for mean	12.65 - 20.83
		SD	14.838
	>80	**Mean**	**16.26**
		95% CI for mean	12.55 - 19.97
		SD	10.109
Burns ICU	**18-25**	**Mean**	**2.00**
ANOVA test p value		95% CI for mean	-1.11 - 5.11
		SD	4.346
0.132	**26-40**	**Mean**	**5.79**
		95% CI for mean	2.71 - 8.87
		SD	10.488
	41-50	**Mean**	**7.64**
		95% CI for mean	4.71 - 10.57
		SD	11.741
	51-60	**Mean**	**7.49**
		95% CI for mean	04.06 - 10.92
		SD	14.595
	60-70	**Mean**	**12.32**
		95% CI for mean	7.03 - 17.62
		SD	20.326
	70-80	**Mean**	**10.74**
		95% CI for mean	6.46 - 15.01
		SD	15.507
	>80	**Mean**	**7.71**
		95% CI for mean	4.74 - 10.68
		SD	8.088
Time on mechanical ventilation	**18-25**	**Mean**	**.50**
		95% CI for mean	-0.63 - 1.63
		SD	1.581
ANOVA test p value	**26-40**	**Mean**	**1.68**
		95% CI for mean	0.29 - 3.07
		SD	4.746
0.606	**41-50**	**Mean**	**2.83**
		95% CI for mean	1.19 - 4.46
		SD	6.541
	51-60	**Mean**	**3.53**
		95% CI for mean	1.50 - 5.56
		SD	8.633
	60-70	**Mean**	**4.17**
		95% CI for mean	0.97 - 7.37
		SD	12.274
	70-80	**Mean**	**4.15**
		95% CI for mean	1.76 - 6.54
		SD	8.681
	>80	**Mean**	**04.03**
		95% CI for mean	1.46 - 6.61
		SD	7.021

As the number of units in the first- and fourth degree burn was only one, statistical analysis of the difference in mean days was only performed between II and III degree – and on average, patients with third degree burns needed more time in the hospital, in the Burns ICU and on mechanical ventilation, compared with those with second degree burns, the difference being statistically significant (Table 3).

Similarly, when comparing the patients who survived and those who died following the burn and its complications, the difference is statistically significant: survivors, on average, needed less time in the hospital, in the Burns ICU, and on mechanical ventilation (Table 4). ❑

DISCUSSION

In our study, while the LOS was on average 16.5 days, it varied greatly between patients. While the total duration of stay, followed by scar and quality of life assessment, is an essential predictor of burns evolution, several factors may influence it: the difference between surgical and conservative management, different medical and psychological needs of the patients, variable discharge criteria, together with other administrative and logistic issues (15).

The experience of our tertiary center closely resembles the international experience regarding burn acute care. Globally, there has been a decreasing trend in the incidence of severe burns requiring hospital admission, accompanied by reduced mortality rates (16). Well-established risk factors for mortality include advanced age, a large BSA affected by the burn, the presence of inhalation injuries, a higher injury depth (third- or fourth degree burn) (17). As an important factor associated with mortality and morbidity, LOS has been closely monitored in large studies and an accurate prediction of LOS may help support patient triage and personalised care (18). Similar to our study, the LOS is highly variable, with a higher value for female patients and older patients (18).

Consistent with global data, more than half of the patients in our cohort were males. It is re-

TABLE 2. Mean total hospitalisation duration, hospitalisation in the Burns ICU, time on mechanical ventilation, depending on BSA affected, followed by confidence interval (CI) limits of 95% and standard deviation (SD)

	BSA affected		Statistic
Hospitalisation total	**< 10%**	**Mean**	**12.08**
ANOVA test p value		95% CI for mean	10.45 - 13.71
<0.001		SD	10.773
	10-20	**Mean**	**21.56**
		95% CI for mean	18.06 - 25.06
		SD	16.801
	21-30	**Mean**	**24.54**
		95% CI for mean	16.93 - 32.15
		SD	18.019
	31-40	**Mean**	**30.44**
		95% CI for mean	14.52 - 46.36
		SD	29.880
	41-50	**Mean**	**9.33**
		95% CI for mean	4.51 - 14.16
		SD	7.596
	51-60	**Mean**	**20.75**
		95% CI for mean	5.70 - 35.80
		SD	17.998
	60-75	**Mean**	**17.13**
		95% CI for mean	-2.93 - 37.18
		SD	23.991
	>75%	**Mean**	**7.00**
		95% CI for mean	4.38 - 9.62
		SD	2.828
Burns ICU	**< 10%**	**Mean**	**2.82**
ANOVA test p value		95% CI for mean	1.67 - 3.98
<0.001		SD	7.620
	10-20	**Mean**	**13.42**
		95% CI for mean	9.98 - 16.85
		SD	16.503
	21-30	**Mean**	**16.67**
		95% CI for mean	10.60 - 22.73
		SD	14.370
	31-40	**Mean**	**23.94**
		95% CI for mean	9.67 - 38.20
		SD	26.772
	41-50	**Mean**	**7.25**
		95% CI for mean	1.88 - 12.62
		SD	8.454
	51-60	**Mean**	**15.13**
		95% CI for mean	1.72 - 28.53
		SD	16.031
	60-75	**Mean**	**15.00**
		95% CI for mean	-2.77 - 32.77
		SD	21.260
	>75%	**Mean**	**6.14**
		95% CI for mean	2.54 - 32.77
		SD	3.891
Time on mechanical ventilation	**< 10%**	**Mean**	**1.15**
		95% CI for mean	0.46 - 1.84
ANOVA test p value		SD	4.553
	10-20	**Mean**	**4.48**
<0.001		95% CI for mean	2.09 - 6.88
		SD	11.488
	21-30	**Mean**	**7.79**
		95% CI for mean	2.94 - 12.65
		SD	11.497
	31-40	**Mean**	**8.06**
		95% CI for mean	1.35 - 14.77
		SD	12.593
	41-50	**Mean**	**4.92**
		95% CI for mean	1.01 - 8.83
		SD	6.156
	51-60	**Mean**	**7.38**
		95% CI for mean	3.43 - 11.32
		SD	4.719
	60-75	**Mean**	**3.63**
		95% CI for mean	1.22 - 6.03
		SD	2.875
	>75%	**Mean**	**6.14**
		95% CI for mean	2.54 - 9.74
		SD	3.891

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TABLE 3. Mean number of days of hospitalisation, hospitalisation in the Burns ICU and on mechanical ventilation, for second and third degree burns

Hospitalisation total	**Second degree**	**Mean**	**12.06**
Man-Whitney U test p value <0.001		95% CI for mean	10.02 - 14.10
		SD	11.852
	Third degree	**Mean**	**19.36**
		95% CI for mean	16.93 - 21.78
		SD	17.471
Burns ICU	**Second degree**	**Mean**	**5.02**
Man-Whitney U test p value <0.001		95% CI for mean	3.12 - 6.93
		SD	11.069
	Third degree	**Mean**	**10.59**
		95% CI for mean	8.40 - 12.78
		SD	15.766
Time on mechanical ventilation	**Second degree**	**Mean**	**2.03**
		95% CI for mean	0.64 - 3.42
		SD	8.096
Man-Whitney U test p value <0.001	**Third degree**	**Mean**	**3.91**
		95% CI for mean	2.78 - 5.03
		SD	8.100

CI: confidence interval; SD: standard deviation

ported that in the United States, the number of burns emergency department visits is 270 males and 180 females, respectively, per 100,000 inhabitants. The trend is also true regarding the number of hospitalised patients and regarding death rates – higher in male patients (16).

A regional multicenter study, which was performed in Spain, revealed a similar patient profile to ours: 61% of patients were males and 16.8% were aged between 35 and 45 years, with a mean burned BSA of 8.3% and a median length of stay of 1.8 days (19). While the length of stay was significantly longer in our study, the age median and total BSA affected were also higher, which may

Hospitalisation total	**Survivors**	**Mean**	**15.61**
Man-Whitney U test p value		95% CI for mean	13.89 - 17.34
		SD	14.90
0.014	**Death during hospitalisation**	**Mean**	**22.04**
		95% CI for mean	16.18 - 27.90
		SD	20.184
Burns ICU	**Survivors**	**Mean**	**6.35**
Man-Whitney U test p value		95% CI for mean	4.95 - 7.74
		SD	12.012
<0.001	**Death during hospitalisation**	**Mean**	**21.40**
		95% CI for mean	15.59 - 27.20
		SD	19.989
Time on mechanical ventilation	**Survivors**	**Mean**	**1.53**
		95% CI for mean	0.95 - 2.11
Man-Whitney U test p value		SD	5.011
	Death during hospitalisation	**Mean**	**13.94**
		95% CI for mean	9.71 - 18.17
<0.001		SD	14.559

CI: confidence interval; SD: standard deviation

TABLE 4. Mean number of days of hospitalisation, hospitalisation in the Burns ICU and on mechanical ventilation, for patients who survived and those who died

explain the need for a longer hospital stay. Further, as the aforementioned study included the pediatric cases as well and the proportion of inhalation injuries was also far smaller, the mortality was 3.5%, compared to 14.5% in our study (19).

A study which was also performed in a tertiary center in Bucharest, Romania, revealed similar data: 63.6% of patients were males, with a mean age of 54.49 years old; 28.7% suffered inhalation injuries as well, compared to the 18.69% in the present study. One-quarter of patients had burns covering more than 40% of TBSA, compared to just over 10% in our study. Reflecting this increased severity, the mean hospital stay was longer (24 days) and the mortality rate higher (28.5%) than in our cohort (16.5 days and 14.5%, respectively). As in our study, inhalation injury was strongly associated with mortality (20).

A retrospective analysis from another Spanish center, which included fewer patients, also reported similar demographic features (mean age 47 years, 60.9% males). As pediatric cases were included, the mean LOS was shorter (7.86 days) and only 24.5% of patients required surgical intervention. In contrast to our study, patient's age was a significant factor influencing the length of stay and the outcome, but similarly to our findings, the degree of the burn was a crucial aspect in patient's evolution (21).

A study performed on the USA National Burns registry reveals younger patients (median age 28 years), with fewer cases of inhalation injury (7%) and a median LOS of four days, with higher values for large burns and inhalation injury (22).

While the established association between burn depth and increased LOS, ICU stay and ventilation time is well known, the present study provides added clinical value by reporting median time estimates, which offer practical, readily interpretable benchmarks supporting clinicians in assessing patient trajectories and resource requirements.

Compared to the available literature, our work completes the picture of burn care in tertiary centers in Romania. Useful additions of our work, with potential value in guiding future protocols to stratify and better manage patients include: the extended time-based characterization of resource utilization (the total hospitalization duration, Burns ICU stay and duration of mechanical ventilation are separately quantified across strata of age, burn extent, depth and survival status) and the modulation of the age–length of stay relationship by survival status (while higher age correlated with longer hospitalization and ICU treatment among survivors, this association was no longer present among non-survivors).

This study has several limitations. The absence of standardized discharge criteria likely introduced variability in the length of stay unrelated to burn severity, as administrative, logistical and individual care factors may have influenced discharge decisions. In addition, we did not perform a multivariate analysis, which limits our ability to control for potential confounders such as age, comorbidities, burn mechanism, or inhalation injury. These factors should be considered when interpreting our findings and addressed in future studies.

CONCLUSIONS

To summarise, our four years of experience showed over 300 cases managed, with a majority of the patients being males, middle-aged, over half suffering from small area burns, under 10% of body surface area, and most of the burns being third degree.

Regarding the duration of the medical services needed, on average patients were hospitalised for 16.5 days, of which approximately half was spent in the Burns ICU. Patients with severe burns (third degree) and those who did not survive required a longer hospitalisation, in the Burns ICU and on mechanical ventilation, and these three parameters also positively correlated with patient's age. ❑

Informed consent: All patients offered informed consent at admission and for those critically ill, who could not offer informed consent, a legally authorised representative exercised 'substituted judgement' for medical decisions and offered consent at admission.

Data availability: The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of interest: none declared.

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