

Epidemiologic and Bacteriologic Study of the Burned Patients from the Plastic Surgery Department of the County Emergency Hospital of Ploiești, over a 4 Years Period (2010-2013)

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Rezumat

Studiu epidemiologic și bacteriologic al pacienților arși din Secția de Chirurgie Plastică a Spitalului Județean de Urgență Ploiești, pe o perioadă de patru ani (2010-2013)

Acest studiu analizează datele epidemiologice și rezultatele bacteriologice pentru un număr total de 759 de pacienți arși, care au fost tratați și externați din Secția de Chirurgie Plastică a Spitalului Județean de Urgență din Ploiești, între 01/01/2010 și 31/12/2013. Parametrii investigați au fost: distribuția în funcție de vârstă și sex, domiciliul în mediul rural sau urban, etiologia arsurilor, suprafața totală arsa (TBSA), localizarea și profunzimea leziunilor, managementul terapeutic, durata spitalizării, tipurile de bacterii izolate din plagile infectate și sensibilitatea lor la antibiotice, precum și mortalitatea pacienților. Analiza statistică a relevat următoarele rezultate: vârsta medie 51.33 ± 18.44 ani, raportul sex masculin / sex feminin 1.35/1, raportul rural/urban 1.34/1, cauzele cele mai frecvente au fost lichidele fierbinti (44,8 %) și flăcările (37,6%), TBSA medie $7,7 \pm 8,4\%$, localizarile principale au fost extremitățile, grefele de piele au fost practicate la 15 % din pacienți, durata spitalizării 15.57 ± 13.84 zile, bacteriile principale izolate au fost *Pseudomonas aeruginosa* (26,3%) și *Staphylococcus aureus* (22,9%), rata mortalității 0,13 %. Cele mai bune metode de a reduce morbiditatea în arsuri sunt prevenția producerii lor și prevenirea infecției, pentru care sunt discutate mai multe măsuri.

Cuvinte cheie: pacient ars, epidemiologie, studiu bacteriologic, sensibilitatea la antibiotice, prevenția arsurii

Abstract

This study analyses the epidemiologic data and the bacteriologic results of a total number of 759 burned patients, which were treated and discharged from the Plastic Surgery Department of the County Emergency Hospital of Ploiești, between 01/01/2010 and 31/12/2013. The investigated parameters have been: age and gender distribution, rural or urban population, burn etiology, total burn surface area (TBSA), TBSA, location and depth of lesions, therapeutic management, length of hospital stay, types of bacteria isolated from the infected wounds and their sensitivity to antibiotics, patients' mortality. The statistical analysis revealed the following results: mean age 51.33 ± 18.44 years, male/female ratio 1.35/1, rural/urban ratio 1.34/1, most common etiologies were scalds (44.8%) and flames (37.6%), mean TBSA $7.7 \pm 8.4\%$, main locations were the extremities, split-thickness skin grafting in 15% of the patients, hospital stay 15.57 ± 13.84 days, main bacteria isolated were *Pseudomonas aeruginosa* (26.3%) and *Staphylococcus aureus* (22.9%), mortality rate 0.13%. The best methods to decrease the burn morbidity are the burn and infection prevention, for which several measures are discussed.

Key words: burned patient, epidemiology, bacteriologic study, antibiotic sensitivity, burn prevention

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Introduction

According to World Health Organization, the burn injuries represent a global public health problem, with major physical, psychological and socioeconomic impact and significantly affecting nearly every group of population and every geographical zone in the world (1, 2). The effective approach to burn prevention and treatment should be based on detailed knowledge of burn epidemiology and bacteriology, including etiological and bacteriological patterns, geographical variations and socioeconomic differences (2). In 2004, nearly 11 million people worldwide suffered burns severely enough to require medical treatment (1). Worldwide, the fire-related burns alone determine over 300 000 deaths annually, with more deaths from scalds, electricity and chemical burns, the majority occurring in low- and middle-income countries (3). The non-fatal burns are a leading cause of morbidity, including prolonged hospitalization, disfigurement and disability (1).

Although a considerable amount of studies on epidemiology of burns has been published all over the world, an extensive investigation of burn epidemiology in Romania is not yet achieved and presented in the literature.

This work intends to fill this gap and to contribute to the epidemiologic study of burned inpatients from the Plastic Surgery Department of the County Emergency Hospital of Ploiesti, which provides medical care for adult people from the third most populated Romanian administrative region, after Bucharest and Iasi, with over 762 900 inhabitants, according to 2011 census. This study investigates the relevance of the matter, the role of age and gender in burns, the burn extent, the lengths of hospital stay, the burn mortality and the therapeutic approach. The study also analyses the bacteriologic profile of the burned patients and the bacterial susceptibility to antibiotics, an extremely important aspect due to the prevalence and the severity of infection to these immunodeficient patients and to the bacterial multiresistance to antibiotics.

Material and Methods

Based on the hospital records from 01/01/2010 to 31/12/2014, a retrospective review of a total number of 759 burned patients discharged from the Plastic Surgery Department of the County

Emergency Hospital of Ploiesti during 01/01/2010-31/12/2014 was performed, including patients' demographics, burn etiology, rural or urban population, total burn surface area (TBSA), location and depth of lesions, therapeutic management, length of hospital stay and patients' mortality. The admission criteria in our department were the patients with moderate and severe burns, according to the national and to the international recommendations (4-6).

Also, the study analyses retrospectively the bacteriologic determinations of the burn wounds and the bacterial sensitivity to antibiotics. The culture swabs from the burn wounds were taken depending on the clinical assessment of localized or spreading infection. All the data were subjected to statistical analysis. Means and standard deviations were calculated with Excel for Windows.

Results

A total of 759 hospitalized patients, mean age 51.33 ± 18.44 years (range 15-93 years) were admitted in the study: 211 patients in 2010, 171 in 2011, 195 in 2012 and 182 in 2013. Out of these, 436 (57.44%) were males and 323 (42.56%) were females. The male/female ratio was 1.35/1. The studied group comprised 434 (57.18%) rural and 325 (42.82%) urban residents; the rural/urban ratio was 1.34/1. The age and gender distribution of the patients are shown in Table 1.

Most common etiologies were scalds, flames (flame burns and explosions) and contact with hot objects, while electrical (electrical flash and electrocution), chemical, solar and radiations burns were rare (Table 2).

With respect to burn severity, the mean TBSA of the inpatients was $7.7 \pm 8.4\%$ (range from 0.1% to 60%). The vast majority of patients (615=81%) had TBSA $\leq 10\%$ (of which 455=60% had TBSA $\leq 5\%$), 103 patients (13.6%) had TBSA between 10.1% and 20%, 25 patients (3.3%) had TBSA between 20.1% and 30% and TBSA exceeded 30% in only 16 patients (2.1%), of which 6 (0.8%) suffered solar burns (Fig. 1).

Most of the burns were partial thickness, IIA-IIIB degree (73%). Inhalation injury was found in 25 (3.3%) patients, complicating the evolution.

Most of the burns were accidental and only 11 (1.5%) were intentional. Among the intentional burns, 7 patients (0.9%)

Table 1. Age and gender distribution of the patients (n=759)

Age (years)	Males		Females		Total		M/F Ratio
	Number	%	Number	%	Number	%	
0-20	11	2.5	14	4.3	25	3.3	0.79
21-30	58	13.3	35	10.8	93	12.3	1.66
31-40	85	19.5	35	10.8	120	15.8	2.43
41-50	84	19.3	50	15.5	134	17.7	1.68
51-60	83	19.0	49	15.2	132	17.4	1.69
61-70	46	10.6	57	17.7	103	13.4	0.81
71-80	59	13.5	60	18.6	119	15.7	0.98
81-90	9	2.1	22	6.8	31	4.1	0.41
91-100	1	0.2	1	0.3	2	0.3	1

Table 2. Distribution of the causes of burns (n=759)

Causes	Males		Females		Total		F/M Ratio
	Number	%	Number	%	Number	%	
Scalds	143	32.8	197	61.0	340	44.8	1.38
Flame	168	38.5	67	20.7	235	31.0	0.4
Explosion	32	7.3	18	5.6	50	6.6	0.56
Electrical flash	18	4.1	0	0	18	2.4	0
Electrocution	13	3.0	1	3.1	14	1.8	0.08
Contact with hot objects	35	8.0	23	7.1	58	7.6	0.66
Chemical	21	4.8	4	1.2	25	3.3	0.19
Solar	5	1.1	13	4.0	18	2.4	2.6
Infrared radiations	1	0.2	0	0	1	0.1	0

had self-inflicted burns, while 4 patients (0.5%) had assault-related burns. Discharge against medical advice was recorded in 61 patients (8%).

All body areas were involved, especially the lower and upper limbs. The right upper and lower limbs were more affected than the left upper and lower limbs. The perineum and genitalia were the least frequently involved (Fig. 2).

Among the hospitalized patients, the mean length of hospital stay was 15.57 ± 13.84 days (range 1-128 days).

Only one of the 759 hospitalized patients died (0.13% mortality rate), a woman with 30% TBSA burns by explosion, IIB-III degree, with severe inhalation injury, which required continuous mechanical ventilation since her admission until she died, one month later. However, a few other critical patients were discharged on demand or were transferred to other burn units. Also, according to legal dispositions, some patients with very extensive burns were referred directly from the emergency unit to other burn centers, after initial first aid, without being hospitalized in the Plastic Surgery Department.

Altogether 626 patients (82.5%) received conservative treatment of the burn wounds (initial debridement followed by daily dressing changes), while 133 (17.5%) were treated surgically. As regards surgical procedures, a wide range of operations was performed:

- split-thickness skin grafting in 114 patients (15%), on granulated or excisional wounds, in a single stage (98

patients, 86%), two (12 patients, 10.5%), three (3 patients, 2.6%) or four stages (1 patient, 0.9%). Of all skin grafting operations (including all stages), 22.6% were performed in the first 10 days from admission (14.5% in the first 7 days), 18.5% between the 11th and the 20th day, 28.2% between the 21st and 30th day and 30.6% were performed after 31st day.

- decompression incisions in 8 patients (1.1%);
- amputations of different segments in 7 patients (0.92%): fingers of the hand in 3 patients (0.39% - Fig. 3) or of the leg in 2 patients (0.26%); arm amputations in 2 patients (0.26%);
- local skin flaps in 2 patients (0.26%);
- one patient (0.13%) suffered early relaxation of cervical and facial scar contractures (bilateral ectropion, microstomia, lower lip and submental area), followed by local flaps or skin grafts;
- excision of granulated wounds followed by direct suture in one patient (0.13%);
- minimal pleurotomy in one patient with inhalatory lesions and serious pulmonary comorbidity (chronic obstructive pulmonary disease and chronic pulmonary heart disease).

The culture swabs were taken from the burn infected wounds, clinically assessed, in different stages of burn evolution. A total number of 289 bacteria were isolated, single

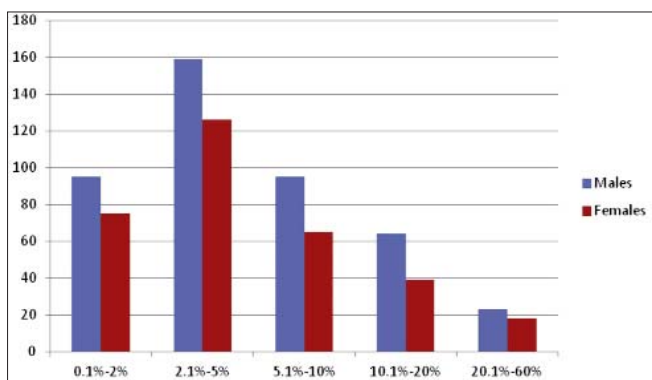
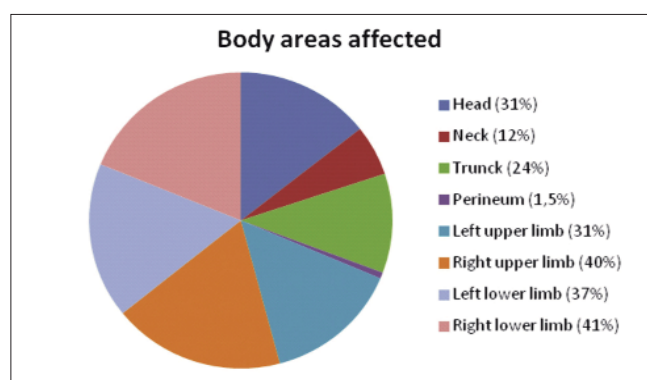
**Figure 1.** Distribution of the patients according to TBSA (n=759)**Figure 2.** Distribution of body areas affected



Figure 3. Burn by flame of the left hand, III degree, with digital necrosis

or in combination of two (in 56 cases) or three (in 4 cases) different species. The main organisms involved were *Pseudomonas aeruginosa* (26.3%) and *Staphylococcus aureus* (22.9%). Other frequently discovered bacteria were *Staphylococcus albus* (13.5%), *Escherichia coli* (12.1%), *Proteus* (9%) and *Klebsiella* (7.6%). A series of bacteria were less frequently or occasionally found: *Acinetobacter* (3.5%), Non-hemolytic *Streptococcus* (3.5%), Hemolytic *Streptococcus* (0.7%), Nontypable Gram-negative *Coccobacilli* (0.7%) and Gram-positive *Diphtheroids* (0.3%). The sensitivity to

antibiotics of the bacteria isolated from the burned infected wounds is represented in Table 3. Other positive bacterial inseminations were obtained from tracheal secretions (11 cases, mostly Gram-negative germs), blood cultures (14 cases, mostly staphylococci), urine cultures (4 cases, of which 3 were *Escherichia coli*), urinary catheters (4 cases), central venous catheters (2 cases), and sputum (3 cases).

Discussions

Up to 200 patients were hospitalized annually in our hospital, a number which is comparable to that of a burn center. For instance, in 2013, 30.000 burned patients were hospitalized in 127 burn centers in USA, which means an average of over 200 annual admissions per burn center (7).

Most of the burned inpatients resided in rural areas (57.18%), due to lower socio-economic and educational status and to higher incidence of fire accidents related to improper conditions of cooking and heating.

As in other reports (8-12), most of the patients were males (57.44%). Most of the males (57.8%) belonged to the age group 31-60 years and most of the females (66.9%) belonged to the age group 41-80 years.

Burn patient management requires significant financial resources, and length of stay (LOS) has a large impact on hospital cost (13). The mean hospital stay in our study was 15.5 days, in the range of the LOS found in literature, up to 31 days (14), but it could perhaps be lower, as the large majority of the burns were less than 10% TBSA. It would also be lower if

Table 3. Bacterial sensitivity to antibiotics (in percents; NA=not assessed)

Antibiotic	<i>Pseudomonas</i>	<i>Staph. aureus</i>	<i>Staph. albus</i>	<i>Escherichia coli</i>	<i>Proteus</i>	<i>Klebsiella</i>
Ampicillin	0	4.8	5.4	10.3	4	0
Amoxiclav	0	59.3	50	27.3	10	7.1
Biseptol	0	7.1	19.4	13.3	0	0
Cefalexin	NA	29.2	28.9	NA	NA	NA
Ciprofloxacin	11	37.5	23.7	57.1	36	13.6
Colistin	100	NA	NA	100	3.8	100
Erythromycin	NA	23.3	25	NA	NA	NA
Fortum	38.6	7	10.5	68.8	34.8	28.6
Gentamicin	5.6	36.5	17.9	28.1	7.7	15
Imipenem	50	NA	NA	78.6	87.5	76.5
Ceclor	NA	46.8	42.1	NA	NA	NA
Cedax	0	NA	NA	56.2	78.6	50
Cefobid	11.1	NA	NA	83.3	16.7	33.3
Levofloxacin	0	NA	NA	40	14.3	0
Norfloxacin	12	NA	NA	60	30	15.8
Oxacillin	NA	29.2	10.3	NA	NA	NA
Penicillin	NA	0	2.6	NA	NA	NA
Rocephin	12.7	23.3	22.2	64.7	38.1	19
Tazocin	51.4	NA	NA	63.3	95.8	38.9
Teicoplanin	NA	98.5	97.4	NA	NA	NA
Timentin	13.3	NA	NA	66.7	55.6	33.3
Vancomycin	NA	98.2	100	NA	NA	NA
Zinacef	2.8	45	35.1	35.3	20.8	9.1
Zyvoxid	NA	100	97.1	NA	NA	NA

surgical excision and skin grafting were performed earlier and in higher percentage. In USA, the National Burn Repository highlighted a decrease in LOS from 10.2 days for women and 9.59 days for men in 2003 to 8.4 days for both genders in 2012 (8). A Canadian retrospective study of the burned patients up to 20% TBSA admitted between 2005 and 2009 revealed significant decrease of mean LOS following a change in practical guidelines. Thus, if patients' outcomes are not compromised, earlier operative management and greater outpatient could lead to significant cost savings (13).

The mortality is related to burn severity (TBSA and degree of depth), age, inhalation injury and concomitant diseases. The mortality rate in our study was 0.13% (only one hospitalized patient died in four years). This very low rate was due to the reduced number of major burns (only 10 patients had II-III degree, non-solar burns with more than 30% TBSA).

In our study, the discharge on demand and discharge against medical advice (DAMA) had a rate of 8%, in the range of the data from literature, which varies between 0.1% (8) and 21% (14). Most of these patients were in a hurry to return home for housekeeping or had distant residencies and departed to closer medical care.

The majority of burns were cured by conservative treatment, due to the depth, the localization and the extension of injuries. However, skin grafting was performed rather late, mainly after weeks of conservatory treatment needed for eschar separation and granulating of full-thickness burns. In the future, attention should be directed towards a faster surgical approach, through more sustained practice of early excision and grafting, within 7 days from occurring burn injury. In the literature, delayed excision and grafting have been associated with longer hospitalization, increased rates of invasive wound infection and sepsis, increased mortality rate and hospital costs (15).

The localized wound infection was suspected when a series of suggestive signs and symptoms appeared (4,16-17): increasing pain, erythema and edema in surrounding areas, purulent discharge, malodor, delayed or stailed healing, petechial haemorrhages, early and rapid eschar separation. In our study, the burn wound infections were treated by application of silver sulfadiazine 1% and by systemic targeted antibiotic therapy, along with intensive care measures in more serious situations.

The main bacteria isolated from the infected wounds were *Pseudomonas* and *Staphylococcus*, as revealed also in other studies (14, 16, 18-20). *Pseudomonas aeruginosa* is an opportunistic and virulent pathogen agent, which can lead to serious nosocomial infections in burn centers, especially in patients with extensive deep burns and with compromised host defense mechanisms (20). *Pseudomonas* invasive burn wound infection is characterized by specific smell and by green or green-yellowish pigment visible in dressing, in wound and in subcutaneous fat, which is erythematous and later may turn into a black, necrotic, nodular lesion – *ecthyma gangrenosum* (21).

According to literature data (4, 22), the bacterial flora isolated in burned wounds evolves towards decreasing number

of sterile swabs, rarefaction of bacterial species and selection of *Staphylococcus aureus* and *Pseudomonas aeruginosa*. Dry dressings favor the development of *Staphylococci* and *Acinetobacter*, while moist dressings and hydrotherapy favor the appearance of *Pseudomonas* (18, 22). The intensive and prolonged use of topical and systemic antibiotic therapy leads to selection of multiresistant *Staphylococcus aureus* and *Pseudomonas*, which cause difficult therapeutic problems. In our study, *Staphylococcus aureus* cultures were more than 98% sensible only to Teicoplanin, Vancomycin and Zyvoxid, and *Pseudomonas* cultures were 100% sensible to Colistin and 50% sensible to Imipenem and Tazocin. The severe prognosis in cases of pyocyanic nosocomial infection and the limited available therapeutic options determine its gravity, hence the importance of respecting strict rules in the prescription of antimicrobial therapy and in preventive measures. In situation of deep or extensive burns, the best method to decrease immunosuppression, invasive infections and hospital length is early wound surgery by excision and skin grafting (20).

The significant risk factors for acquiring nosocomial infection are TBSA, full-thickness burn, older age, presence of inhalation injury and elevated body-mass index (18, 23). In many burn centers, the main infection control measures are early excision and grafting, improved barrier nursing and regular microbiological analyses of the hospital's environment and staff. Careful surveillance of infection and bacterial population, good isolation procedures, appropriate antimicrobial policy and surgical wound management can decrease infection rates in burn patients (24-26).

The best method of decreasing morbidity and mortality remains the prevention of burns. Prevention strategies should address the risk factors for specific burn injuries, education for vulnerable populations and training of communities in first aid (1). An effective burn prevention plan should have a multifactorial approach to: describe burden, identify risk factors, provide burn prevention programmes, better information and surveillance systems, more investment in research and training (1,27).

Conclusions

The present work has classified and stratified the burned inpatients by age, gender, residency, etiology, TBSA, location and depth of lesions, therapeutic management, length of hospital stay and survival. Thereby, this epidemiologic study wants to represent a modest contribution for the achievement of a National Burn Repository, a database which provides analysis and formulation of strategies regarding burns' prevention and care and which is still waiting to be implemented and accomplished in Romania.

Also, the bacteriologic study on types of bacteria isolated from the infected burned wounds and their sensitivity to antibiotics represents a useful tool for the appropriate antimicrobial therapy selection and for the adjustment of measures to prevent and treat infections in burn management.

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