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TREATMENT PRINCIPLES AND PROGNOSIS OF FUNCTIONAL AREAS IN PATIENTS WITH SEVERE BURNS

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INTRODUCTION

Burns are among the most frequent and disabling injuries, carrying an extremely serious impact, a life-threatening risk and, depending on the extent of tissue damage, a potentially guarded prognosis. Consequently, they remain an area of active research, driven by the constant need to refine therapeutic management, deepen our understanding of the underlying mechanisms, explore treatment possibilities and develop evidence-based therapeutic algorithms.

Statistical data gathered nationally and internationally highlight not only the psychosocial burden but also the global financial cost. In the United States alone, more than 500,000 people present to specialized burn facilities every year; some 40,000 of them require hospitalization, and about 4,000 die from their burns or related complications [1, 2]. Worldwide, an estimated 300,000 people die annually from burn injuries, with 95 % of these deaths occurring in low- and middle-income countries [3]. Iran, for example, records roughly 150,000 burn injuries each year, of which around 3,000 are fatal [4, 5]. Globally, the World Health Organization (WHO) reports approximately 180,000 burn-related deaths every year, underscoring the true public-health impact of burn-related morbidity and mortality [6].

In Romania, a Ministry of Health report covering 2016 – 2021 illustrates the national scope of the problem: about 10,000 patients present to emergency departments each year with burn injuries, roughly 4,000 of whom require admission for specialized monitoring and treatment. Among these, 1,400 – 1,500 cases are of moderate to high severity, necessitating hospital stays longer than two weeks, ongoing follow-up and inclusion in specialized rehabilitation programs. Burn-related mortality remains high, with approximately 200 deaths recorded annually [7].

Comprehensive burn care is a complex endeavour that demands seamless interdisciplinary collaboration among the plastic surgeon, the intensive-care specialist and other related disciplines, depending on the anatomical regions and systems involved.

The scientific papers have repeatedly sounded the alarm about the importance of burns and the frequent underestimation of their impact and severity. Among all burn-affected body areas, injuries to functional zones are of particular concern because of their effect on quality of life, which in turn drives up morbidity and mortality. A 2022 publication pooled 7,455 burn

patients from nine studies conducted in the USA, UK, the Netherlands, Canada, Denmark and South Africa, each using different admission criteria for specialised units (ABA, EMSB, BBA). The analysis showed that the hands and face— in that order—were the most commonly injured anatomical regions [8]. One likely explanation is their greater exposure compared with other body parts, regardless of geopolitical, cultural or mechanistic variability in burn causes.

At present, no official data are available on the incidence of burns in Romania because a national registry has yet to be established. Systematising these data and formulating a set of recommendations—ultimately a therapeutic algorithm—is therefore imperative. The patients analysed in the current study were hospitalised in the Severe Burns Care Unit (UIAG) and the post-critical wards (together forming the Burns Centre, CPA) of Bucharest Emergency Clinical Hospital (SCUB), Romania's first accredited burn-treatment centre, from its opening until the end of 2023.

The results were used both to benchmark the local situation against severe burns managed in specialised centres abroad—thus broadening insight—and to highlight Romania-specific particularities, given that the study centre is the only authorised facility of its kind nationwide. Interdisciplinary collaboration is indispensable: besides the plastic surgeon, the team must include the anaesthesiologist, physiokinetotherapist and related specialists—ophthalmology, ENT, orthopaedics and general surgery—particularly for functional areas.

Our study is limited by drawing cases from a single severe-burn centre, and treatment protocols there may differ from those of other units because they have been continually refined up to the present. Although burns of functional areas are widely recognised as a critical topic, therapeutic management still needs refinement, especially since certain domains—such as joints, the perineum or the feet—remain under-studied. This work therefore seeks to contribute to a treatment framework that offers broad guidelines while emphasising the need to tailor them to each individual patient and their specific circumstances.

WORKING HYPOTHESIS AND GENERAL OBJECTIVES

The topic of burns in general—and, more specifically, injuries to functional areas in the major-burn patient—remains highly relevant and intensely discussed in the medical literature. Because the major burn is arguably the most severe imaginable trauma, with a complex pathophysiologic profile, continual advances in knowledge and ongoing refinement of therapeutic strategy are essential: from initial prevention and in-hospital care to the management of sequelae and all aspects of supportive treatment.

With this in mind, I considered it worthwhile to undertake the present doctoral study, focusing closely on the surgical component while taking advantage of a rich database available in the Severe Burns Care Unit / Burns Centre of Bucharest Emergency Clinical Hospital—the only accredited major-burn centre in Romania. The study aimed to gather the latest data from diverse sources and to compare international statistics and recommendations from experienced centres with our own findings, adapting them to the exceptionally severe case mix we encounter.

Objectives

- Conduct a local epidemiological study of major burns, including their specific features—particularly important given the absence of a national burn registry.
- Assess how the profile and severity of our burn cases differ from those reported internationally.
- Highlight the impact of functional-area involvement by demonstrating its influence on morbidity and mortality.
- Analyse length of hospital stay and severity scores (ABSI) in relation to functional-area injury, and determine how these factors affect patient prognosis.
- Although the specialty literature recognises the importance of functional areas (a key ABA admission criterion), it is also valuable to establish priorities among these areas.
- Develop a treatment/management algorithm indicating when functional areas should take precedence—and how to rank priorities among them.

RESEARCH METHODOLOGY

The present doctoral research comprises five studies: four retrospective investigations—a main study plus three subsidiary studies—and a narrative review of the specialty literature.

The main study was conducted over eight years, from the opening of the Severe Burns Care Unit on 1 May 2016 through 31 December 2023, this study collected data judged relevant to functional-area burns, their treatment and their influence on the patient's overall condition.

Subsidiary studies (targeting topics under-represented in current literature)

1. Our Experience and Clinical Findings in Perineal Burns: Implications for Patient Prognosis – three-year retrospective study (1 June 2016 – 1 June 2019)
2. Therapeutic management of burns affecting major joints of the limbs and the role of medical textiles in enhancing the rehabilitation process – one-year retrospective study (calendar year 2023)
3. Surgical management of burns in functional areas: a 5-year retrospective study (1 January 2019 – 31 December 2023)

Statistical processing was performed with SPSS v.26 (Statistical Package for the Social Sciences).

Rationale for the multi-study structure

Dividing the work into several investigations was driven by the need to emphasise the diverse problems arising from burns of functional areas and to examine their impact on both survival and functional recovery. The large eight-year cohort supplied statistically robust evidence supporting the importance of the issue; findings were compared with those reported in the literature. The main study confirmed the burden of functional-area burns, described their local incidence, regional and socio-economic particularities, and detailed surgical care and adjunctive treatments received.

Three complementary "satellite" studies were then undertaken to explore less-studied but clinically significant issues:

- Perineal involvement, notable for its inherent severity;

- Burns of major joints, which often lead to severe contracture-related sequelae;
- Surgical management of functional-area burns, where an appropriately timed and executed operation is a major determinant of outcome and long-term function.

Finally, an updated literature review collates the newest data on dermal substitutes, a particularly important adjunct in severe burns or those affecting functional regions, where they complement classic therapeutic methods.

CLINICAL STUDY I: TREATMENT PRINCIPLES AND PROGNOSIS OF FUNCTIONAL AREAS IN PATIENTS WITH SEVERE BURNS

The retrospective study covered an eight-year interval, from 1 May 2016 to 31 December 2023. During this period 824 burn patients were admitted to the Severe Burns Care Unit / Burns Centre. We excluded 24 patients who were transferred to other hospitals and could not be followed up, along with 50 patients who either lacked burns to functional areas or had insufficient data for statistical analysis. The final study cohort therefore comprised 721 burn patients.

For each case we collected the following variables:

- Demographics: surname, given name, sex, age and home environment (urban/rural)
- Clinical factors: presence or absence of inhalation injury, burn mechanism, total burned-surface area (TBSA), burn depth (with separate evaluation of second- and third-degree lesions), explicit documentation of third-degree involvement, length of hospital stay, outcome at discharge (death or survival) and the ABSI score (Abbreviated Burn Severity Index).

Because the project focuses on functional areas, we recorded involvement of every such zone, detailing major joints by anatomical region and documenting the incidence of facial, hand, foot and perineal burns.

Given the study's strong surgical component, we logged the number, type and frequency of operative procedures. Recognising that outcomes are heavily influenced by the patient's biological status, we tracked serial laboratory values—haemoglobin, leukocyte count and serum

proteins—together with the presence or absence of wound contamination and any pre-existing medical conditions, adopting a holistic view of the major-burn patient.

Prognosis was assessed with the ABSI score, one of the most widely used tools for estimating mortality risk in burn patients.

I analyzed the particularities of patients admitted for burns to the Severe Burns Care Unit / Burn Center of the Bucharest Clinical Emergency Hospital, highlighting both the demographic characteristics and the burn-injury characteristics of these patients:

- The ages of the patients ranged from 18 to 98 years, with a mean of approximately 55 years (55.27 ± 18.55) and a median age of 54 years.
- The proportion of men was significantly higher (65.6 %) than that of women (34.4 %).
- A significant relationship was identified between male sex and the presence of functional-area involvement, with an odds ratio about twice as high as that of female sex.
- A significant relationship was identified between male sex and affected surface area, with an odds ratio about 1.5 times higher of having a larger TBSA.
- Regarding place of residence, the rural share was higher (53.8 %) than the urban share (46.2 %).
- Among injury mechanisms, flame burns predominated (54.9 %), followed by explosion (17.6 %) and hot liquid (17.2 %). Chemical, contact and electrical burns had very low proportions (2.5 – 4.8 %).
- High probabilities of death were found for explosion (46.8 %) and flame (44.5 %) compared with the overall death probability (37.1 %).
- The calculated mean surface area was 30.37 ± 24.36; two statistically significant correlations were found: facial involvement carried an odds ratio 5 times higher of having a larger surface area, and perineal involvement was a positive predictor with an odds ratio 12 times higher of having a larger surface area.
- With regard to burn depth, we reported high incidence rates—particularly for deep burns: grade IIA in 70 % of cases, grade IIB in 86.7 % of cases, grade III in 57.4 % of cases.

- Grade IIB was significantly more frequent in explosions (91.3 %) and hot-liquid burns (90.2 %) compared with the overall rate (86.8 %).
- Grade III was significantly more frequent in flame burns (62.4 %) and electrical burns (81.8 %) compared with the overall rate (57.3 %).
- A substantial number of upper-airway burns were noted—254 cases, representing 35.2 % of the 721 patients. This was significantly more frequent in explosions (66.7 %) and flames (39.9 %) than overall (35.7 %).
- Patients with facial involvement also had airway involvement, with an odds ratio 11 times higher than patients without facial burns.
- Regarding functional areas affected, 93.5 % of all patients had at least one such area burned. Further analysis showed high proportions for face (68.8 %) and hand (68.1 %), followed by neck (28.2 %), elbow (32.4 %) and shoulder (23.6 %). In the lower limbs, foot burns were present in 32.1 %, with associated areas: knee (26.5 %), hip (12.6 %) and perineum (19.2 %).
- No more than two areas were affected in a combined 47.5 % of cases—23.3 % with a single area, 24.2 % with two areas—followed by cases with three areas (16.3 %) or four areas (14.3 %).
- The ABSI score ranged from 2 to 17, with a mean of about 8 (7.84 ± 3.11) and a median of 7.
- Survivors had an ABSI no greater than severe ($ABSI \leq 7$) in a significantly higher proportion (76.7 %) than non-survivors (9.4 %). Non-survivors had about 9-fold higher odds of an $ABSI > 7$.
- We also noted that patients with facial burns had a significantly higher proportion of $ABSI > 10$ (36.7 %) than those without facial burns. Perineal involvement was a positive predictor, with odds 4 times higher of a high ABSI.
- Patients who died had a hospital stay of at most two weeks in a significantly higher proportion (57.8 %) than survivors discharged in that period (36.3 %). Survivors had about 1.7-times higher odds of a stay > 2 weeks than those who died.

- Mortality-increasing factors: each higher age category carried 2.3-times higher odds of death; upper-airway burns carried 3.4-times higher odds; the presence of grade III burns carried 1.9-times higher odds; each one-point increase in ABSI carried 3.1-times higher odds of death.
- As for surgical interventions, we tallied 437 operated patients. Of these, 16.5 % underwent procedures that did not involve functional areas, whereas the remaining 83.5 % required operations on functional areas.
- The functional areas most frequently operated on were, by far, the hands—231 cases (52.9 % of those operated), with roughly equal numbers for left hand versus right hand (48 vs 52) and 131 cases of bilateral involvement. Other joints also required surgery in descending order: elbow 116 (26.5 % of those operated), knee 94 (21.5 %), foot 73 (16.7 %), shoulder 56 (12.8 %), hip 37 (8.5 %).

Within the conclusions of this study we were able to describe the exceptional severity of burn patients, with functional-area involvement present in almost all cases (93.5 %). Beyond this very high incidence, burns of these areas have a major impact, severely influencing mortality, prolonging hospitalisation, increasing the number of operations and affecting the patient's overall status. The gravity of the burns was evident both from the strong effect exerted by involvement of each functional area and, even more, from their cumulative effect, as a considerable proportion of patients had multiple functional areas affected.

CLINICAL STUDY II: Our Experience and Clinical Findings in Perineal Burns: Implications for Patient Prognosis—A 3 Year Retrospective Study

We conducted a retrospective study that included 258 patients admitted to the Severe Burns Care Unit of the Bucharest Emergency Clinical Hospital between 1 June 2016 and 1 June 2019. From the total number of admitted patients, we analysed those who met the inclusion criteria: age ≥ 20 years and the presence of perineal burns. Patients aged ≥ 91 years and those transferred to other medical facilities were excluded.

The following demographic and clinical characteristics were collected for the included patients: age, sex, injury mechanism, percentage of total body surface area burned, presence of

third-degree burns, presence of upper-airway burns, transfer from another hospital, length of hospital stay and the surgical interventions performed.

We recorded the results of microbiological assessment. Microbiological screening was performed on admission and included: cultures from burn wounds, aerobic and anaerobic blood cultures, tracheal-aspirate cultures and urine cultures. In our burn centre, antibiotic therapy is not given routinely; antibiotic prophylaxis is limited to the peri-operative period. When infection is suspected clinically and paraclinically, empirical antibiotic therapy is initiated and later adjusted according to antibiogram results. We also performed weekly microbiological screening of burn patients to monitor changes in microbial flora, by sampling burned areas, including the regions under study. Outside this protocol, microbiological tests were carried out whenever infection was suspected. In cases of suspected sepsis, an extended set of investigations was performed, including tracheal aspirate, urine culture, burn-wound cultures and blood culture.

The mean total body surface area (TBSA) affected in the cohort of 49 patients was 64.9 %. Forty-five patients (91.8 %) had third-degree burns. Among patients without perineal involvement, the proportion of third-degree burns was about 60 % (62.1 %), a proportion that likewise shows no sex difference. Upper-airway injuries were identified in 34 patients (69.4 %).

Regarding the anatomical distribution of burns, 48 patients (97.9 %) with perineal burns also had burns of the thighs, with only one case (2.04 %) of isolated perineal burn. Another common association was anterior abdominal burns, identified in 25 patients (51 %).

The overall mortality of patients admitted during the three-year period was 55.87 %, whereas in patients with perineal burns mortality reached 77.5 % (38 out of a total of 49 patients). Statistical analysis revealed a higher mortality rate correlated with TBSA, the presence of third-degree lesions and a high ABSI score.

The mean length of hospital stay was 17.4 days, with 35 patients hospitalised for 14 days or fewer. For greater relevance, we calculated the mean length of stay for the 10 surviving patients, which was 46.9 days.

Associated comorbidities were also evaluated: five patients had arterial hypertension, four cardiovascular disease, five type II diabetes mellitus, two obese, two chronic obstructive pulmonary disease, one liver cirrhosis, one scrotal hernia and one inguinal hernia. One patient

also had traumatic splenic rupture. Neuro-psychiatric disorders were associated with traumatic injuries in six patients—four were chronic alcohol users and two had previously been diagnosed with Alzheimer's disease. Of the total cases, 11 % presented through a suicidal mechanism; all these patients had a burned surface area greater than 60 % TBSA.

With regard to infectious complications, both bacteria (33 patients, 67.4 %) and fungi (8 patients, 16.3 %) were identified in perineal wounds. Some patients had infections with three or four pathogens in the perineal lesions; their distribution is shown in Figure 2. Of all patients, 12 (24.5 %) had positive blood cultures, and 13 patients (26.5 %) had documented genitourinary infections.

Of the 49 patients studied, 39 required surgical treatment, including emergency escharotomies and staged excision and grafting of third-degree burns. Two patients required lower-limb amputations—one bilateral and one unilateral thigh amputation—and five patients required tracheostomy.

Of the 10 surviving patients, 7 cases required split-thickness skin grafting of the inguinal and genital regions, while one case required extensive grafting of the region. One patient required partial re-grafting of the scrotum because of poor positioning compliance and graft lysis. In two other cases, the lesions were partial-thickness burns and healed conservatively without complications or reported urinary dysfunction.

In the conclusions of this study, we were able to determine that perineal burns are among the least explored areas, although they are highly important because of their significant impact on mortality. The diagnosis of perineal burns is often associated with severity in extensive burn trauma, indicating a likely negative prognosis despite all necessary interventions. Being an anatomical region difficult to treat both surgically and in terms of associated infectious complications, prevention of perineal burns remains essential, and techniques aimed at reducing sequelae should be refined, with a strong emphasis on infection management and the challenges of surgical coverage of lesions in this area. An important conclusion emerging from this study is the increased mortality rate in patients with perineal burns, correlated with a heightened infectious potential. Advanced age, a high percentage of third-degree burns and an elevated ABSI score are all negative prognostic factors that reduce chances of survival. Proven to be a negative prognostic factor in burn patients, perineal lesions must be treated rigorously despite

their small surface area. Prevention of infection through strict hygiene protocols, avoidance of urinary and faecal contamination and removal of necrotic or devitalised tissue is mandatory. A standardised treatment protocol, adapted to burn depth, should be implemented in every burn-treatment unit. Post-operative care and patient positioning must be closely supervised.

CLINICAL STUDY III: Therapeutic management of burns affecting major joints of the limbs and the role of medical textiles in enhancing the rehabilitation process: 1 year retrospective study

We conducted a retrospective study that included patients admitted to the Severe Burns Care Unit (UIAG) of the Bucharest Emergency Clinical Hospital over a one-year period, between 1 January 2023 and 31 December 2023. The inclusion criteria were: age ≥ 18 years and the presence of burns involving the major limb joints, such as the shoulder, elbow, wrist, hip, knee and ankle joints. The exclusion criteria were: absence of articular burns, incomplete medical records and transfer to another medical facility. The collected data included: patients' age and sex, mechanism of injury, total body surface area burned, presence of third-degree burns, location of the affected joints, presence of inhalation injury, length of hospital stay, surgical and conservative treatments applied, and patient outcome. To assess prognosis, the ABSI score was calculated.

Most patients were male, totalling 82 individuals (73.2 % of the entire cohort). The mean patient age was 50.52 years, while the mean total body surface area burned was 24.7 %. A proportion of 36.6 % of patients had burns covering at most 10 % of the body surface, and 26.8 % of patients fell into the 11–20 % range. Third-degree burns were present in 69 patients (61.6 % of all cases).

Regarding the mechanism of burn injury, 82 of the 112 cases (73.2 % of patients) were attributed to flame burns, 23 cases (20.5 %) were caused by hot liquid, while 5 cases (4.5 %) resulted from electrocution and 2 cases (1.8 % of patients) were chemical burns. Upper-airway injuries were present in 30 cases, representing 26.8 % of the total.

An analysis of burn location revealed involvement of 146 major upper-limb joints, the most frequently affected being the wrist joint (80 cases), followed by the elbow joint (36 cases)

and the shoulder joint (30 cases). In the lower limbs, major joints were affected in 78 cases, with a higher incidence reported at distal joints—33 cases for the ankle, and 24 and 21 cases for the knee and hip, respectively.

Out of the total 112 patients, 79 patients (70.5 %) required surgical treatment for defect coverage. Concerning burn debridement, 75 patients underwent surgical excision, either tangential or fascial, depending on lesion severity, while enzymatic debridement with Bromelain was used in 4 cases. After debridement, these patients required definitive coverage with split-thickness skin autografts.

Of all cases, 7 patients had severe limb burns requiring amputations. Defect coverage with flaps was reserved mainly for sequelae cases and consisted of 3 Z-plasties, 1 random-pattern flap, 1 pedicled abdominal flap and 1 pedicled latissimus dorsi flap.

This study focused on burns involving the major limb joints, injuries that pose unique challenges for specialised surgical treatment both in the acute phase and throughout long-term recovery. Management of these cases requires an intensive and sustained rehabilitation programme to restore functionality and improve patient quality of life. The results highlight the importance of early intervention and individualised therapeutic strategies for burns affecting the joints. By implementing focused surgical and rehabilitation approaches, healthcare providers can address the complex pathophysiology of these injuries, reduce the risk of debilitating complications and optimise recovery outcomes for burn survivors. The importance of local treatment was demonstrated in the evolution of the burn patient, especially when treating functional areas.

CLINICAL STUDY IV: Surgical management of burns in functional areas: a 5-year retrospective study

Within this study a retrospective analysis of 481 patients admitted to the Severe Burns Unit of Bucharest Emergency Clinical Hospital between 1 January 2019 and 31 December 2023 was performed. From the total patient group we excluded those transferred out of our unit, as well as those for whom insufficient data were available.

We collected the following demographic and clinical characteristics: age, sex, percentage of total body surface area burned, burn depth and the presence of third-degree burns, mechanism of injury, presence of upper-airway burns, length of hospital stay and the surgical procedures performed. A major element in evaluating patient evolution was calculation of the ABSI score, used to predict mortality in burn cases.

Patient age ranged from 18 to 96 years, with a mean age of 55 years (54.49 ± 18.61). By sex, we identified a significantly higher number of male patients—306 (63.6 %)—compared with 175 female patients (36.4 %). With respect to place of origin, 248 patients (51.6 %) came from rural areas and 233 (48.4 %) from urban areas.

Analysing burn depth, we observed a high number of superficial partial-thickness burns—341 cases, an even greater number of deep partial-thickness burns—408 cases, and a substantial number of full-thickness burns—269 cases. A frequent association was identified between superficial partial-thickness and deep partial-thickness burns in 72.8 % of cases, as well as between superficial partial-thickness and full-thickness burns in 50.2 % of cases. Further analysis of severe burns showed that 59.3 % of patients with deep partial-thickness burns also had full-thickness burns, while 90 % of patients with third-degree burns likewise had deep partial-thickness burns. The mean percentage of total body surface area burned was 27.5 %, and the mean length of hospital stay was 24 days.

The most frequently affected functional areas were the head region and the hands. Among patients with head-region involvement, 98.1 % had facial burns and 53.9 % had burns in the cervical region. Analysing joint burns, we observed shoulder involvement in 41 % of cases, elbow in 62.9 %, hands in 63.6 %, hip in 27.1 %, knee in 53.3 % and ankle in 30.1 %. Associations were often found between head-region and hand burns (77.5 %), as well as between burns of certain joints and those of the head region (shoulder in 87.2 % and elbow in 84.1 %).

Of the total 481 patients, 137 died, representing 28.5 % of cases. Calculating the ABSI score yielded a mean value of 7 (7.31 ± 3.09); 50 % of patients had a score ≤ 7 and 25 % had a score ≥ 9. Values varied considerably between survivors—with a mean ABSI of 6.11 ± 2.00—and those who died, who had a mean score of 11.01 ± 2.54.

Of the 481 patients, 266 (55.3 %) required surgical interventions; 63.9 % of these had only one operation, whereas 93.2 % required up to three interventions. The most frequent

procedure was skin grafting, performed in 188 patients (37.38 %), followed by emergency fasciotomies for compartment-syndrome decompression in 103 patients (20.48 %). Sixteen patients (3.18 %) required amputations; in 19 cases (3.78 %) burn lesions were excised and sutured; 17 patients (3.38 %) required reconstruction with flaps; and 19 patients (3.78 %) required tracheostomy.

The conclusions of the study are highly relevant to the clinical approach to treatment because the order in which burns of different anatomical regions should be operated on remains intensely debated. Some authors recommend the priority treatment of functional areas, considering them “precious” and in need of protection, while other authors support covering extensive surfaces first to limit losses and stabilise the patient, with treatment of functional areas to follow. Regardless of the protocol chosen, it must be adapted to the particularities of each burn centre and its specific needs, varying from one centre to another. As a general rule, rapid coverage of extensive surfaces and limitation of losses to stabilise the patient should be a priority. Functional areas can then be treated, often using full-thickness skin grafts, frequently requiring additional interventions to improve functional outcome, but only after complete patient stabilisation and attainment of a favourable general status.

STUDY V: The Role of Skin Substitutes in the Therapeutical Management of Burns Affecting Functional Areas

Since in the main study we identified a significant number of exceptionally severe burns, we considered it necessary to explore in greater depth the methods that could aid healing and coverage of burn wounds—especially when functional areas are involved. The importance of these areas was highlighted, underlined, and their impact verified by the statistical data uncovered in the present study. Because they require special attention, we additionally evaluated the use of dermal substitutes in severe burns of functional zones. [10]

The primary role of these substitutes is to facilitate healing in deep burns, although they can also be beneficial in intermediate burns. Being three-dimensional structures, they must meet a series of criteria: protect against fluid and protein loss; trigger no immune response; be flexible and durable; prevent microbial and toxin infiltration from outside; and reduce pain while granting sufficient time for the donor site or burn wound to heal. [9, 11-13]

The study's conclusions described the fact that severe burns remain a notable clinical and socio-economic challenge—particularly when they affect functional and aesthetically sensitive areas—often exhausting the patient's limited available skin capital. In such situations, autografting becomes insufficient, and the use of modern dermal substitutes is required. These provide faster defect coverage, matrix-guided regeneration, malleability, and a scar quality superior to that of simple grafts. Research supports an anatomy-adapted protocol: thin, elastic substitutes for areas such as the face and neck; solid matrices with collagen and glycosaminoglycans for joints, hands, and weight-bearing soles; and fat-enriched or silicone-containing products for flexibility and cushioning.

Access is limited in low- and middle-income countries because of high costs and insufficient skin-bank infrastructure, even though these very regions bear the greatest burden of burns. Future progress depends on lowering manufacturing costs, simplifying application, and conducting organised multicentre studies—especially in resource-limited settings—with transparent reporting of functional outcomes, complications, and economic impact. Until then, optimal burn care remains a patient-specific algorithm that matches substitute properties to each individual wound, prioritises treatment of functional areas, and aligns with available resources to restore form and function while reducing global disparities.

CONCLUSIONS

The present research paper started from the premise of emphasising the importance of functional areas within another perpetually relevant topic – burns. In this regard, the study was carried out in the Severe Burns Care Unit / Burns Centre of the Bucharest Clinical Emergency Hospital.

Being the only nationally accredited unit and having the largest caseload, we gathered the present data and analysed them in comparison with data from other countries where national registries exist. Obviously, Romania likewise needs such a registry once several centres are accredited, so that multicentric, not only monocentric, studies can be performed. Because the hospital has an emergency profile, most patients stand out through procedures performed in the initial, urgent phase, where first-aid measures are given, patient re-equilibration is initiated and emergency surgery is carried out when the situation demands it. Thus, from a surgical standpoint

the patient profile is mainly acute: incisions and restoration of normal blood flow are performed, as well as reconstructive methods carried out chiefly in the earliest stages of burn disease to excise burn wounds and cover the resulting defects, limiting losses, re-equilibrating the burned patient and providing definitive coverage solutions. For this reason, sequela stages are less represented in our unit.

Being the only centre of this type, the exceptional severity of the burns we recorded was not at all surprising. Their profile involves an older age (an average of 55 versus 24.5 and 24.2 reported in other studies), with extensive burned body surfaces (an average of 30.37 in the present study versus 19.8 % in countries with a similar GDP) and with third-degree burns in 57.3 % of cases – unlike other studies describing 23.4 % in adults. Demographically, the burn profile resembles other studies initially through a higher representation of the male sex (linked to greater odds of functional-area injury and larger surface area), a predominantly rural provenance and, to some extent, similar aetiology. The major differences stem from the greater lesion severity we encountered; burns were often caused by flame or explosions, leading to significantly more severe trauma. Older age has been shown, both here and in the literature, to carry a higher risk of death, and provenance is a risk factor for higher mortality owing to poorer health-education levels, frequent negligence and harder access to specialised burn care of good quality.

Another extremely important component is the presence of upper-airway burns. Unlike literature values, the mean here is 35.7 % of all patients – more than double other reports. The high frequency of burns to the face, periorbital region, hands or shoulders and the frequent explosion or flame aetiology explain the large number of airway burns, since each has been shown to be more likely associated with them.

Older mean age, larger surface area, upper-airway injury and the presence of third-degree burns also explain the steep rise in ABSI score: we obtained a cohort mean of 8, without separating survivors from the deceased. Literature values are markedly lower, usually reporting a maximum ABSI of 7 (typical of ICU-only studies where case severity is intrinsically higher). The difference matters because an ABSI of 6–7 is classed as moderately severe (80–90 % survival), whereas 8 confers a high risk of death (only 50–70 % survival). Unsurprisingly, in this study survivors had ABSI ≤ 7 in 76.7 % of cases, while patients with ABSI > 7 had a nine-fold higher mortality.

Although mortality has declined continuously since 1970 through preventive and treatment measures, as a reference centre it is evident that the 36.8 % mortality recorded here is unsurprising and multicausal. Non-modifiable factors present at high levels in this study include advanced age, upper-airway burns and a high ABSI. With regard to mortality arising from each individual functional area, we described the risk odds linked to each joint or specific zone. Another contributor to exceptional severity is the frequent coexistence of multiple functional-area burns, so negative prognostic factors accumulate and the death risk rises sharply (especially when facial or perineal burns are combined). In extremely severe cases it becomes hard to judge which factor is decisive, but the association and cumulation of effects are certain. In this context the impact of each functional area is even harder to pin down, especially given the high mortality – 36.8 % – and the fact that most patients (93.5 %) had at least one functional area burned.

The hospital stay for patients with functional-area burns reflected case severity: a mean of 22.97 ± 22.51 days. Patients who died often stayed less than two weeks, whereas survivors were 1.7 times more likely to stay over two weeks. Statistically significant factors lengthening admission included burns of the face, perineum and a higher number of required surgical interventions.

Functional-area involvement was frequent, most often at the face and hands, as reported in the literature. We documented high incidences of burns to other functional zones – large joints or perineum – sometimes double the literature figures. We studied the major impact of each functional area both on the individual burn economy and in cumulative terms, and we sought to outline surgical and non-surgical care measures that complement their treatment.

The collected data demonstrate the severity of cases we treat, highlight how certain functional areas influence burn-survival prognosis and underscore the severe risk of sequelae when other functional areas are harmed. Severe cases call for quality care starting in the earliest stages: rapid fluid-and-electrolyte resuscitation plus supportive therapy, as well as the earliest possible excision and coverage of burn wounds to remove the offending factor, close the vicious circle and set the patient on a favourable course.

PERSONAL CONTRIBUTIONS

Being regarded as the fourth-most common cause of trauma, burns remain an exceptionally severe condition that still demands deeper understanding and investigation and that requires a complex, multidisciplinary approach delivered in dedicated centres. This doctoral research set out to explore in greater depth the problem of burns affecting functional areas in the context of major burns. The centre in which I conducted both my clinical activity and my scientific research has a number of distinctive features, being the only and the largest burn centre in the country. Consequently, the cases I recorded have specific characteristics and a severity seldom described in similar papers in the literature.

Drawing up national prevention and treatment protocols, as well as refining international ones, is vitally important. Because we treat exceptionally severe burns, the first stage that deserves future emphasis is prevention and the first-aid measures given to major-burn patients, so as to achieve better re-equilibration and stabilization before transfer to a hospital unit specifically dedicated to burn care. Until the number of such units grows, first aid becomes all the more important in order to lessen the impact of the acute phase of burn disease.

One of the novel and distinctive elements of this thesis is the development of a set of recommendations based on the experience of this center, correlated with the current specialty literature, that could serve as a treatment guide—assessing whether it is appropriate to prioritize functional areas in the earliest stages of burn disease or whether they should be treated later, and even establishing an order of treatment among functional areas when several of them are involved, a situation that is frequently encountered in major burns. Of course, any protocol must be adapted to each center, to its capabilities, strengths and limitations, socio-economic status and available staff.

When we face a patient profile such as that seen in this center—older age, deeper burns over large surfaces and the frequent presence of upper-airway burns—priority must be given to re-equilibrating the patient, limiting severe fluid, electrolyte and protein losses stemming from the magnitude of the trauma, while definitive coverage of the burn wounds parasitizing the major-burn patient becomes a priority. Thus, the entire effort of the multidisciplinary team ultimately converges on covering the burn wounds—the only definitive therapeutic action capable of breaking the vicious circle, whose impact is likewise severe on the evolution of burns

in functional areas. By applying the principle of early excision–grafting aimed at covering large surfaces as rapidly as possible, systemic inflammation and the metabolic rate are significantly reduced, thereby stabilizing the burned patient—especially if frail, elderly or multimorbid—and giving priority to vital over functional prognosis. Moreover, a lengthy hospital stay in which the patient is immobilized or inactive has been linked to a significant rise in the risk of severe arthroses and contracture scars, the incidence of which is directly proportional to the increased number of areas burned.

The approach is different for a patient with less severe trauma and a smaller affected surface in whom functional-area burns occur almost in isolation. When several areas are involved they must themselves be prioritized. Although facial and perineal burns have been shown to be particularly severe and to carry a high mortality rate, their treatment must be prioritized in survivors, as the vital importance of these zones is proven. For the remaining functional areas, prevention becomes especially important until they can be operated on, and physiokinesitherapy, early mobilization and positioning splints are crucial in preventing disabling contracture scars. From the study carried out, in situations where joint burns are treated and local full-thickness skin resources are limited, I propose a treatment sequence that begins with grafting the hands, then the elbow or the axilla—the former because of its incidence and major importance, the latter two because they have been shown to have the highest rate of scar-contracture formation. Knee, ankle and hip should then be staged sequentially as regards their coverage methods.

Efforts to limit the losses occurring in burn wounds can also be supported by temporary solutions such as skin banks or temporary skin substitutes. The importance of these in supporting treatment has been demonstrated, but unfortunately they are currently insufficiently available; greater availability could significantly influence the prognosis and trajectory of the major-burn patient.

Future research directions could include prospective studies assessing the consequences of functional-area involvement in the sequela stage, but the frequent rural origin of patients—who have limited access to the initial unit given their place of residence, modest financial means and poor medical knowledge—results in limited access to successive follow-up assessments. Because mortality is high, the cohort of survivors is greatly reduced, willingness to return for

successive evaluations is low, and the patients who have easy access and could be included in such a study may be only those satisfied with the progress made, thereby introducing a subjective element into the study.

I believe that the chosen research topic is timely and still insufficiently studied, even though the impact of each individual area is well known. This work aims to add to the body of knowledge in this field, and the study's limitations could be overcome in the future through an even stronger emphasis on preventive methods, by creating more specialized major-burn treatment centers, by developing a national registry and recording results in multicentric studies, and by more frequent use of supportive methods for covering skin defects.

REFERENCES FOR THESIS SUMMARY

1. Colohan SM. Predicting prognosis in thermal burns with associated inhalational injury: a systematic review of prognostic factors in adult burn victims. J Burn Care Res. 2010 Jul-Aug;31(4):529-39. doi: 10.1097/BCR.0b013e3181e4d680. PMID: 20523229.

2. Nielson CB, Duethman NC, Howard JM, Moncure M, Wood JG. Burns: Pathophysiology of Systemic Complications and Current Management. J Burn Care Res. 2017 Jan/Feb;38(1):e469-e481. doi: 10.1097/BCR.0000000000000355. PMID: 27183443; PMCID: PMC5214064.

3. Lotfi M, Mirza Aghazadeh A, Davami B, Khajehgoodari M, Aziz Karkan H, Khalilzad MA. Development of nursing care guideline for burned hands. Nurs Open. 2020 Mar 20;7(4):907-927. doi: 10.1002/nop2.475. PMID: 32587709; PMCID: PMC7308693.

4. Dehghani, M. , Hakimi, H. , Mousazadeh, S. , Zeynali, J. , & Samimian, S. (2014). The Relationship between Pain and Anxiety throughout dressing among burn patients. Journal of Holistic Nursing and Midwifery, 24(4), 30–37.

5. Vaghardoost R, Kazemzadeh J, Rabieepoor S. Epidemiology of burns during pregnancy in Tehran, Iran. Burns. 2016 May;42(3):663-7. doi: 10.1016/j.burns.2015.10.001. Epub 2015 Dec 12. PMID: 26691644.

6. World Health Organization. Burns. WHO. https://www.who.int/en/news-room/fact-sheets/detail/burns (WHO, 2018). (Accesat 12 Septembrie 2024)

7. Ministerul Sănătăţii – Situaţia actuală a îngrijirii pacienţilor cu arsuri în sistemul public de sănătate. https://ms.ro/media (Accesat 15 Septembrie 2024).

8. Bazzi A, Ghazanfari MJ, Norouzi M, Mobayen M, Jafaraghaee F, Emami Zeydi A, Osuji J, Karkhah S. Adherence to Referral Criteria for Burn Patients; a Systematic Review. Arch Acad Emerg Med. 2022 Jun 2;10(1):e43. doi: 10.22037/aaem.v10i1.1534. PMID: 35765610; PMCID: PMC9206830.

9. Clark RA, Ghosh K, Tonnesen MG. Tissue engineering for cutaneous wounds. J Invest Dermatol. 2007 May;127(5):1018-29. doi: 10.1038/sj.jid.5700715. PMID: 17435787.

10. Iordache M, Avram L, Lascar I, Frunza A. The Role of Skin Substitutes in the Therapeutical Management of Burns Affecting Functional Areas. Medicina. 2025; 61(6):947. https://doi.org/10.3390/medicina61060947

11. Middelkoop, E.; Sheridan, R.L. Skin Substitutes and “the next level”. In Total Burn Care, 5th ed.; Herndon, D.N., Ed.; Elsevier: Amsterdam, The Netherlands , 2018; pp. 167–173 .

12. Pruitt, B.A.; Levine, N.S., Jr. Characteristics and uses of biologic dressings and skin substitutes. Arch. Surg. 1984, 119, 312–322. https://doi.org/10.1001/archsurg.1984.01390150050013.

13. Sheridan, R.L.; Tompkins, R.G. Skin substitutes in burns. Burns 1999, 25, 97–103. https://doi.org/10.1016/s0305-4179(98)00176-4.

SCIENTIFIC PAPERS PUBLISHED

1. **Iordache M**, Bordeanu-Diaconescu E-M, Grosu-Bularda A, Andrei M-C, Frunză A, Grama S, Costache R, Neagu T-P, Lascăr I, Hariga C-S. Our Experience and Clinical Findings in Perineal Burns: Implications for Patient Prognosis—A 3 Year Retrospective Study. Medicina. 2024; 60(12):2009. - https://doi.org/10.3390/medicina60122009
2. **Iordache, M.**, Grosu-Bularda A., Bordeanu-Diaconescu E.-M., Frunză A., Andrei M.-C., Grama S., Costache R.-A., Neagu T-.P., Lascar I., Chiotoroiu A.L., Chiotoroiu S.M., Dondea M.-F., Therapeutic management of burns affecting major joints of the limbs and the role of medical textiles in enhancing the rehabilitation process: 1 year retrospective study, In: Industria Textila, 2025, 76, 1, 131–143, http://doi.org/10.35530/IT.076.01.2023144
3. **Iordache M**, Bordeanu-Diaconescu E-M, Grosu-Bularda A, Andrei M-C, Frunză A, Grama S, Costache R, Neagu T-P, Lascăr I, Hariga C-S. Surgical management of burns in functional areas: a 5-year retrospective study. In: Journal of Medicine and Life, 2025;18(4):292-298. doi:10.25122/jml-2025-0077-
4. **Iordache M**, Avram L, Lascăr I, Frunză A. The Role of Skin Substitutes in the Therapeutical Management of Burns Affecting Functional Areas. Medicina. 2025; 61(6):947. https://doi.org/10.3390/medicina61060947