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HEAD AND NECK BURNS. IMPLICATIONS ON VITAL AND FUNCTIONAL PROGNOSIS

PhD THESIS ABSTRACT

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INTRODUCTION

Severe burns, particularly those located in the cephalic region, remain among the most devastating forms of trauma, with profound consequences for patient survival, functionality, and socio-professional reintegration (1). Although advances in resuscitation, wound care, and specialized burn centre organization have significantly reduced mortality in many developed countries, this decline has been markedly slower in Eastern Europe, including Romania (2). This underscores the need for applied, locally adapted studies conducted in centers of excellence—such as the one in which this research was carried out. Therefore, the present study has not only scientific relevance but also the potential to directly improve the quality of care for severe burn injuries in our region. The multidisciplinary management of patients with severe burns—especially those with facial and cervical involvement—has become a strategic priority for improving both vital and functional outcomes (3).

Burns affecting the head and neck are frequently associated with inhalation injuries (4), nosocomial infections (5,6), severe respiratory complications (7), and long-term aesthetic and functional impairments (8). The face, neck, and airway are critical anatomical regions involved in respiration, speech, eating, and also in non-verbal communication, expressiveness, and personal identity. Any injury to these areas has major implications for the patient's quality of life and often requires specialized treatments, complex surgical interventions, and long-term psychological support (9). Moreover, the involvement of both upper and lower airways introduces additional challenges in the acute management of burn patients, with direct implications for survival (10).

In this context, the importance of conducting applied research on cephalic burns within a high-level reference centre such as the Burn Centre of the Emergency Clinical Hospital of Bucharest (SCUB) is indisputable. This is the only accredited advanced burn center in Romania and receives referrals nationwide, which allows for a statistically and clinically relevant analysis of facial, respiratory, and chemical burns.

This thesis brings together three complementary retrospective studies, each addressing a key dimension of cephalic burn pathology:

1. The first study examines the impact of facial and cervical burns on the incidence of respiratory complications and mortality, by comparing patients with and without injuries in these regions (11);

2. The second study focuses on inhalation injuries, evaluating correlations between burn severity, anatomical scoring systems (such as AIS), respiratory infections, and survival rates;
3. The third investigates the clinical and therapeutic characteristics of chemical facial burns (12)—a rare yet particularly debilitating condition with disproportionate functional and aesthetic consequences relative to the affected surface area (13).

The overarching goal of this thesis is to identify the factors that influence the clinical course of severely burned patients during the acute phase of hospitalization; the treatment of post-burn sequelae is not within the scope of this study.

Each research direction brings original contributions, based on real-world clinical data and validated against recent international literature. Thus, this study provides not only a snapshot of local clinical realities but also a bridge between Romanian medical practice and modern international standards, facilitating the integration of its findings into future national and regional clinical protocols.

The relevance of the topic addressed in this thesis is justified by the ongoing urgency and severity of cephalic burns. Despite notable progress in emergency medicine, intensive care, and plastic surgery, the management of patients with burns to the cephalic region remains a major challenge. Although care for major burns has improved—along with surgical techniques and supportive therapy—significant uncertainties remain regarding the early diagnosis and standardized treatment of airway injuries(14), as well as optimal reconstruction and rehabilitation strategies for facial and cervical burns(15). Additionally, the emergence of multidrug-resistant nosocomial infections and the diverse mechanisms of injury necessitate the continuous adaptation of treatment protocols to current clinical realities.

This research aims not only to enhance our understanding of the factors influencing the prognosis of patients with cephalic burns but also to generate practical recommendations applicable in everyday clinical settings. Furthermore, the data obtained can serve as a solid foundation for future research directions, including the use of inflammatory biomarkers, the implementation of artificial intelligence for triage and treatment algorithms, or the development of advanced dressing materials and dermal substitutes tailored for facial regions.

Ultimately, this thesis contributes to the body of knowledge in plastic surgery, intensive care, and infectious disease management and has the potential to improve the acute care of burn

patients during their initial hospitalization—both in Romania and in the broader context of Eastern Europe. At the same time, it marks a crucial step in aligning local medical practices with international standards by promoting a rigorous, patient-centered, and outcome-oriented scientific approach.

STUDY AIMS AND OBJECTIVES

The central hypothesis of this thesis is that a detailed review of the specialized literature, combined with rigorous retrospective studies, can contribute to a better understanding of the factors influencing the prognosis of patients with burns to the face and neck. The paper aims to optimize the therapeutic management of these injuries during the acute phase, without addressing the treatment of post-burn sequelae.

The research is based on the analysis of patients admitted to the Burn Center of the Emergency Clinical Hospital of Bucharest, with the goal of identifying key determinants of both vital and functional prognosis, as well as proposing improvements to current therapeutic protocols. The study focuses on monitoring the clinical course of patients with cephalic burns and evaluating the correlations between injury characteristics, the occurrence of complications, and clinical outcomes.

This approach is guided by a comprehensive analytical framework that considers the entire trajectory of the burn patient—from the mechanism of injury to post-traumatic recovery. Based on this model, the thesis has been structured around several lines of investigation:

- Epidemiological analysis of facial and cervical burns, including risk factors, morbidity, mortality, and socio-economic impact;
- Identification of the mechanisms of burn injury and their distribution across the studied cohorts;
- Evaluation of the clinical characteristics of the lesions and of established severity factors;
- Investigation of inhalation injuries, which are frequently associated with facial burns, and their influence on clinical evolution;

- Analysis of associated complications and hospitalization duration;
- Assessment of the etiological agent's impact on patient prognosis;
- Formulation of practical recommendations for improving diagnostic and therapeutic strategies in the management of severe cephalic burns.

Through this endeavour, the thesis aims to contribute to the optimization of burn patient care and to the updating of treatment guidelines in accordance with the clinical realities observed in medical practice in Romania.

MATERIALS AND METHODS

As part of the doctoral research, three retrospective clinical studies were conducted, focused on the analysis of the main complications observed in patients with severe burns over different time periods.

Descriptive Table of Clinical Studies Conducted During the Doctoral Research

Title	**Duration**	**No. of Patients**	**Description**
The impact of cephalic burns on respiratory complications and mortality	2 years (January 2022 – December 2023)	206 patients	Retrospective study
Airway burns – classification and location, and their influence on the vital and functional prognosis of burn patients	January 2018 – April 2021	62 patients	Retrospective study
Specific challenges in the treatment of chemical burns of the face and neck	8 years (May 2016 – April 2024)	33 patients	Retrospective study

All studies represent a retrospective analysis of the medical records of burn patients admitted to the Burn Center of the Emergency Clinical Hospital of Bucharest. For all studies, incomplete data in the observation charts represented an exclusion criterion. From the medical

documentation, various variables were extracted, depending on the specific focus of each study. All data collected during the research were analyzed using **IBM SPSS Statistics version 25**, and graphic representations were created using **Microsoft Office Excel/Word 2024**. For each study included in this thesis, the specific methodology is presented in detail and can be consulted in the corresponding chapters.

CLINICAL STUDY 1: The Impact of Cephalic Burns on Respiratory Complications and Mortality

The study conducted on burn patients admitted to the Burn Center of the Emergency Clinical Hospital Bucharest between 2022 and 2023 makes a significant contribution to understanding the impact of facial and cervical burns (FCB) on respiratory complications and mortality. Through a comparative analysis between patients with and without FCB, the study highlights clear differences in lesion severity, frequency of respiratory complications, and overall survival.

The results indicate a high prevalence of facial and cervical burns (65.6%) in the studied population—a proportion comparable to other international studies. Patients with FCB were significantly younger and presented, on average, with more extensive total body surface area (TBSA) burns (median TBSA = 20%) compared to those without FCB (median TBSA = 10%). This suggests that FCB often represents a manifestation of severe thermal trauma, and involvement of the head and neck regions may reflect widespread exposure to the causal agent—often open flame or explosion.

Although the differences in burn depth were not statistically significant between groups, patients with FCB had a higher rate of combined second- and third-degree burns, indicating a complex injury profile.

One of the most important findings of the study is the strong correlation between FCB and the incidence of inhalation injuries. Almost all cases of inhalation injury (47 out of 49) were identified in patients with FCB, and the presence of these injuries was associated with early orotracheal intubation and an increased risk of respiratory infection and mortality. The

data suggest that the presence of facial burns should be considered a major clinical indicator for prompt airway evaluation.

However, only a portion of the intubated patients had bronchoscopically confirmed injuries, raising concerns about potential overuse of intubation in the absence of strict objective criteria. The implementation of protocols such as the Denver Criteria could optimize the selection of patients requiring airway intervention.

The incidence of respiratory infections was significantly higher in patients with FCB (26.7%) compared to the control group (7%), and univariate analysis suggested that both FCB and TBSA were influential factors in their occurrence. However, in the multivariate regression model, only TBSA remained an independent predictor of respiratory infection. Thus, overall burn severity (as indicated by TBSA) appears to have a greater influence on infection risk than the anatomical location of the burn alone.

Patients with FCB frequently required mechanical ventilation, and respiratory pathogens isolated from secretions were specific to severe nosocomial infections (Pseudomonas aeruginosa, Acinetobacter baumannii, Klebsiella pneumoniae), suggesting a potential link with prolonged ventilation, repeated bronchoscopies, and aggressive empirical antibiotic therapy.

Survival data revealed a mortality rate more than double in patients with FCB compared to those without (31.1% vs. 12.7%), and median survival time was significantly shorter. However, in the multivariate analysis, FCB was no longer an independent predictor of mortality, indicating that this association is primarily influenced by other factors—particularly TBSA and advanced age. In essence, FCB acts as an indirect marker of trauma severity rather than a direct cause of death.

Each 1% increase in burned body surface area was associated with a 5.2% increase in the risk of death, while age over 65 years quadrupled the risk of mortality. These parameters remain crucial in the prognosis of severe burns and must be integrated into therapeutic decisions and triage.

The results support several important clinical recommendations:

- **Early evaluation of FCB:** The presence of facial burns should trigger prompt assessment of the airways and the risk of smoke inhalation using tools such as bronchoscopy or thoracic imaging.

- **Intubation standardization:** A reevaluation of intubation criteria in patients with FCB is necessary to avoid unnecessary procedures that may increase the risk of pulmonary infections.
- **Monitoring TBSA and age:** These should be considered key prognostic determinants and integrated into severity scoring systems and treatment guidelines.
- **Infection control:** The use of aggressive pulmonary hygiene protocols, culture-based targeted antibiotic therapy, and early de-escalation strategies are essential for reducing mortality.

Limitations and methodological considerations: As a retrospective study, this research is subject to inherent limitations, including potential unaccounted confounders and variability in the application of clinical protocols. The absence of detailed data regarding intubation timing relative to burn severity, antibiotic use, and respiratory function scores may affect the depth of causal analysis between FCB and pulmonary complications.

Furthermore, it is unclear to what extent the microbiological profile reflects true infections versus colonization—an essential consideration for the proper interpretation of culture results.

Although facial and cervical burns are significantly associated with increased lesion severity, respiratory complications, and higher mortality, the study demonstrates that these associations are primarily mediated by the extent of the burn and the patient's age. Therefore, anatomical location, though important, must be interpreted in the broader context of integrated burn patient evaluation.

Future directions include prospective studies with standardized evaluation and treatment protocols to refine intervention criteria and improve the complex management of patients with facial and neck burns.

CLINICAL STUDY 2: The Implications of Airway Burns, Their Severity and Location on the Vital and Functional Prognosis of Burn Patients

This study provides an in-depth analysis of the impact of airway burns on the survival of patients with severe burns, offering valuable insights into the complexity of these injuries within the context of major thermal trauma. The analysis integrated anatomical, functional, microbiological, and prognostic factors, aiming to validate existing classifications such as the Abbreviated Injury Score (AIS) and to propose additional stratification based on the anatomical location of the burns.

Patient cohort characteristics: The cohort included 62 patients admitted to the Burn Center of the Emergency Clinical Hospital Bucharest between January 1, 2018, and April 30, 2021. All patients had suspected airway burns and underwent at least one fiberoptic bronchoscopy. The mean age was 53.16 years (± 16.98), with a median of 50 years (IQR: 42–66.5), and most patients were male (64.5%). The average total body surface area (TBSA) burned was 41.68% (± 22.49), and 71% of patients had at least one area of third-degree burns.

The main mechanisms of injury were flame (58.1%) and explosion (32.3%). Inhalation injuries were confirmed by bronchoscopy in 61.3% of cases, with the most common distribution involving combined regions—the oral cavity, supraglottic, and subglottic areas (30.6%). According to the AIS, 46.9% of patients had grade II or higher injuries. Bronchopneumonia developed in 41.9% of cases during hospitalization, and the overall mortality rate was 54.8%, with a mean survival time of 51.91 days.

The mean age of deceased patients was significantly higher compared to survivors, and ROC analysis identified a threshold of 47.5 years with high sensitivity. This finding aligns with international data showing that elderly patients have diminished physiological reserves, exaggerated inflammatory responses, and reduced healing capacity. In addition to this physiological vulnerability, pre-existing comorbidities worsen outcomes in cases of severe burns. Therefore, age must be considered a fundamental parameter in any risk stratification algorithm and therapeutic resource allocation.

The extent of cutaneous injury emerged as the second strongest predictor of mortality. The threshold of 42.5% TBSA, identified as a tipping point in mortality risk prediction, reflects a level of tissue damage at which the systemic inflammatory response becomes overwhelming

and predisposes to multi-organ failure. The incremental rise in mortality risk with each additional percentage of burned surface confirms the importance of TBSA in prognostic scoring systems and in therapeutic planning, including decisions about burn center admission and aggressive treatment initiation.

One of the most notable findings of this study is the identification of bronchopneumonia as an independent risk factor for mortality. Its association with a nearly threefold increase in death risk underscores the critical role of pulmonary infections in the evolution of burn patients. Respiratory infections were frequently caused by multidrug-resistant nosocomial pathogens, especially *Pseudomonas aeruginosa* and *Acinetobacter spp.*, highlighting the need for strict protocols on prophylaxis, early diagnosis, and microbiologically guided antibiotic therapy. These infections, often aggravated by prolonged mechanical ventilation and burn-induced immunosuppression, contribute to the development of acute respiratory distress syndrome (ARDS) and multiple organ failure.

Although airway injuries were identified in over 60% of patients and classified by AIS and anatomical location, they did not independently predict mortality. This seemingly paradoxical result suggests that isolated morphological assessment of inhalation injuries, while useful, is insufficient for accurate prognosis. The AIS, although widely used, suffers from limitations in external validation and interobserver consistency. Moreover, the lack of associated pulmonary function scores limits the predictive ability of these classifications.

These findings support the need to revise airway burn assessment tools and to include additional biological and functional markers in severity scoring systems. Airway injury appears to become prognostically significant only when complicated by infections or systemic pulmonary damage, explaining the lack of a direct correlation with mortality in adjusted models.

Tracheostomy, although frequently used for airway protection, did not have a significant impact on overall survival. This could be because tracheostomy is often performed as a supportive measure in various clinical contexts rather than as an early life-saving intervention. Additionally, factors such as the burn mechanism, third- or fourth-degree injury depth, or airway injury location did not influence survival, suggesting these variables must always be interpreted in conjunction with other clinical factors.

The results strongly support the need for a multidimensional approach in assessing burn patients, especially those with suspected airway injuries. Evaluation must combine:

morphological data (location, AIS score), functional data (oxygen saturation, pulmonary capacity), global severity factors (TBSA, age), infectious parameters (bronchopneumonia, tracheal cultures).

The study firmly proposes the inclusion of bronchopneumonia in severity scoring systems and recommends its active monitoring as a prognostic marker and criterion for therapeutic escalation. It also highlights the need for clear protocols regarding the use of fiberoptic bronchoscopy, prophylactic intubation, and tracheostomy.

Despite the high prevalence of airway burns, their severity—when assessed in isolation—does not independently correlate with mortality. Instead, advanced age, extensive burn area, and especially bronchopneumonia are the most important predictors of death among severely burned patients. The modern management of burn victims must rely on a complex and integrative assessment that goes beyond simple morphological classification and incorporates functional, infectious, and systemic criteria. Only in this way can therapeutic strategies be optimized and survival outcomes improved for these critically ill patients.

CLINICAL STUDY 3: Specific Challenges in the Treatment of Facial and Cervical Chemical Burns

This study provides an overview of the clinical characteristics, complications, and therapeutic strategies associated with chemical burns, with a special focus on facial and cervical locations. The data collected over an eight-year period allow for the analysis of a relatively rare type of burn—chemical burns—yet one with major functional and aesthetic implications. The analysis highlights the unique features of these injuries and emphasizes the importance of rapid intervention, individualized treatment, and a multidisciplinary approach.

Out of the total number of patients admitted between 2016 and 2024, only 4.39% presented with chemical burns, confirming the rarity of this mechanism compared to other types of burns. However, the severity of the cases was considerable, with 76% of patients presenting with deep partial-thickness or full-thickness burns. Domestic accidents accounted for 73% of the cases, and the affected patients were predominantly male, with a mean age of 45.6 years. In most cases, the affected surface was under 10% of the total body surface area

(TBSA), but the type of chemical agent and the anatomical location involved necessitated complex treatments and prolonged care.

The calculated ABSI score indicated a high estimated survival rate for most patients, but severe cases were associated with major complications and a mortality rate of 9.09%. Notably, all deceased patients had deep burns, extensive involvement, were transferred from other facilities, and had been involved in workplace accidents.

The subgroup of patients with facial and cervical chemical burns presented distinct features: lower mean age (38.8 years), male predominance, and significant ocular involvement (over 50%). Despite the smaller TBSA in many cases, these injuries proved particularly severe due to the functional and aesthetic impact on exposed areas. Third-degree burns were present in nearly one-third of the cases, frequently requiring reconstructive surgical interventions.

Comorbidities were less frequent in this subgroup, but the severity of the chemical agents—especially strong alkalis, acids, or industrial paints—greatly influenced treatment complexity. Favorable outcomes, reflected in a mean hospitalization duration of 18.8 days and a low complication rate, can be attributed to early intervention and the implementation of a rigorous therapeutic protocol.

Most patients with partial-thickness burns were managed conservatively using modern dressings such as hydrogels, silver sulfadiazine, dermal matrices, or hydroactive dressings. These technologies proved effective in maintaining a moist healing environment, preventing infections, and reducing the risk of hypertrophic scarring. For full-thickness injuries, early excision followed by coverage with autografts and dermal substitutes was the standard of care. In some cases, flap reconstruction was necessary to restore function and achieve satisfactory aesthetic outcomes. The involvement of a multidisciplinary team—including plastic surgery, intensive care, ophthalmology, and psychiatry—was essential in achieving optimal results.

More than half of the patients in the study had positive microbiological cultures at admission, predominantly with staphylococcal species. Three deaths were caused by infectious complications, confirming the major impact of sepsis in the context of deep burns and associated comorbidities. These findings highlight the importance of implementing strict infectious disease prevention and treatment protocols, as well as continuous microbiological monitoring.

Chemical burns, especially those involving the facial and cervical regions, represent a high-risk entity that requires careful and individualized management. The results confirm the effectiveness of the therapeutic protocols used and underscore the importance of training medical teams in the early recognition and management of these injuries.

Chemical burns are rare but potentially devastating injuries, especially when involving the head and neck regions. Their severity is not determined solely by the surface area affected, but rather by the nature of the chemical agent and the location of the injury. Early intervention, the use of modern technologies, and personalized treatment have proven effective in reducing complications and improving prognosis. The therapeutic protocol applied in our center has proven efficient but also emphasizes the need for continuous improvement and expanded research in this specialized field of burn pathology.

CONCLUSIONS AND PERSONAL CONTRIBUTIONS

Both in Romania and internationally, burns involving the cephalic extremity remain a major therapeutic challenge. Burns of the head and neck are frequently associated with large total body surface area involvement and airway injuries. These lesions trigger a complex systemic response that requires an integrated, multidisciplinary approach within specialized centers dedicated to the care of critically burned patients. The research conducted within this thesis represents an original contribution to the study of severe burn injuries, with a special focus on facial and cervical burns, airway lesions, and chemical burns.

Through an extensive retrospective analysis of representative patient cohorts admitted to a national center of excellence—the Intensive Burn Care Unit of the Bucharest Emergency Clinical Hospital (later accredited as the National Burn Center, the only one of its kind in Romania)—the work highlights key determinants of morbidity and mortality and proposes directions for optimizing therapeutic protocols. This thesis specifically focuses on the emergency treatment during the initial hospitalization of patients with burns of the cephalic extremity; the management of post-burn sequelae was not within the scope of this research.

Despite the continuous improvement in the quality of care for critically burned patients, mortality and morbidity remain high for this type of trauma. When burns involve the head and neck, the risk of complications increases even further.

One of the novel elements of this research is that it represents the first large-scale national study on patients with burns of the cephalic extremity and airway injuries, providing a comprehensive view of the impact of these injuries on burn patients in Romania, while also contributing to the limited pool of international data in this field. Another key originality lies in the integrated, multidimensional approach to the critically burned patient, using clinical, anatomical, infectious, and imaging data to formulate conclusions that are both clinically and statistically valid.

This research is relevant from multiple perspectives. Firstly, it offers a robust dataset from a national reference center, contributing to a better understanding of Romania's epidemiological and therapeutic realities. Studies on airway or chemical burns are scarce in the Romanian medical literature, and this work addresses an important gap while providing meaningful comparisons with existing international data.

The study on facial and cervical burns (FCB) revealed, for the first time in a national context, a clear link between these lesions and the increased incidence of respiratory complications. This observation has direct clinical implications for the early triage of patients and prioritization of interventions.

The study on airway burns brought important clarifications regarding the relative utility of the AIS (Abbreviated Injury Score), demonstrating that while inhalation injuries are frequent, they do not independently predict mortality. A major contribution of this research was the use of both morphological and anatomical classifications (AIS and anatomical location) for airway burns, along with the identification of their limitations in predicting vital risk. An integrative clinical model was proposed, combining age, TBSA, infectious status, and respiratory indicators to guide the management of critically burned patients. The work provides strong support for revising and expanding current evaluation criteria for airway burns to include functional and infectious markers.

The study on chemical burns, due to the large volume of data collected over eight years, represents one of the most extensive national analyses on this topic. It confirmed the rarity of such injuries but also highlighted the complexity of required treatments, especially for facial involvement. The introduction and validation of modern therapeutic protocols—including the use of hydrogels, dermal substitutes, and staged reconstructions—reflect a significant contribution to current clinical practice.

I believe that the topic addressed is of major importance and high relevance in the management of critically burned patients, especially those with injuries of the cephalic extremity. The ultimate goal is to improve both the vital and functional prognosis of these patients. The limitations observed during this doctoral research can be addressed through modern research directions such as:

- Multicenter prospective validation of mortality prediction algorithms that integrate TBSA, age, infectious scores, and dynamic pulmonary function data;
- Development of personalized scoring systems for airway burns that include inflammatory biomarkers and continuously monitored respiratory parameters (e.g., PaO_2/FiO_2);
- Introduction and assessment of new dressing materials with controlled release of active agents for the treatment of facial chemical burns;
- Creation of a national chemical burns registry to enable longitudinal analysis of therapeutic efficacy, complication rates, and post-burn quality of life;
- Research into the psychosocial and aesthetic impact of facial burns and the development of integrative rehabilitation protocols, including psychological and personalized reconstructive interventions.

In conclusion, this research offers a valuable contribution to the field of severe burn pathology, underlining the need to update treatment protocols, reassess severity indicators, and develop integrated models for early prognosis and intervention. In a healthcare system under constant pressure from resource limitations and rising therapeutic demands, the early identification of risk factors for complications and mortality—especially in patients with cephalic burns—is essential. Integrating clinical, functional, and microbiological parameters into robust predictive models and standardizing the approach to airway and chemical injuries is not only a clinical necessity but also a strategic direction for improving both vital and functional outcomes. Furthermore, the current epidemiological context, marked by the increase in nosocomial infections with multidrug-resistant organisms and the need for personalized therapy, amplifies the relevance and practical applicability of the studied topic.

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