

Understanding Burn Injuries: From Epidemiology to Rehabilitation and Psychometric Evaluation

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Abstract

Burn injuries have long been recognized as one of the most severe traumas, posing significant challenges to both physical and psychological well-being. This comprehensive review explores various aspects of burn injury, including epidemiology, mechanisms of injury, advancements in contemporary treatment, rehabilitation, health status assessment methods, the impact of preexisting psychiatric conditions, personality assessment, and coping strategies. Globally, burn injuries rank among the leading causes of trauma-related deaths, with factors such as burn depth, extent of injury, age, and associated conditions influencing outcomes. Advancements in treatment, including surgical techniques and skin substitutes, have significantly improved survival rates. Rehabilitation plays a crucial role in maximizing patients' ability to adapt to life after burn injury, addressing both physical and psychological aspects. Health status assessment methods encompass a range of measures, from general health indices to disease-specific scales. Preexisting psychiatric conditions, personality traits, and coping strategies also play significant roles in post-burn adaptation and recovery. Developing burn-specific coping scales could enhance our understanding of the unique stressors faced by burn patients and improve patient outcomes. This review highlights the interdisciplinary nature of burn care and the importance of addressing physical, psychological, and social aspects in the treatment and rehabilitation of burn survivors.

Introduction to Burn Injury

Throughout history and literature, the profound impact of fire on both humanity and property has instilled a mixture of fear and reverence for this element, and with good reason. Among the most severe traumas a person can endure is a major burn injury, which wreaks havoc on the skin, the body's largest organ. The skin ordinarily serves as a barrier against microbial invasion, prevents fluid loss, and regulates body temperature. However, these protective functions are compromised following a burn injury, and without proper treatment, extensive burns often lead to poor outcomes due to burn shock, organ failure, and sepsis. Globally, burn injuries rank among the leading causes of trauma-related deaths and are among the top thirty contributors to both premature mortality and years lived with disability, as measured by Disability Adjusted Life Years (DALYs). The severity of a burn injury is influenced by various factors, including the percentage of total body surface area (TBSA) burned, the depth of the burn, the age of the victim, associated injuries or illnesses, and to some extent, the location of the injury.

Burn-specific factors impacting morbidity and mortality include:

A. The extent of the burn injury, expressed as a percentage of total body surface area (TBSA).

B. The depth of the burn, ranging from superficial burns affecting the epidermis or superficial dermal layers (1st and superficial 2nd degree burns) to deeper injuries penetrating into the deep dermal skin layers (deep 2nd degree burns) or through all skin layers down into subcutaneous tissue as full-thickness or subdermal injuries (3rd degree burns). Severe burns can also damage muscular or skeletal structures.

Advanced age exacerbates the severity of burn injuries, and concurrent inhalation injuries significantly increase both mortality and morbidity rates.

Deeper burns (deep dermal, full thickness, and subdermal) necessitate surgical excision and skin grafting, leading to prolonged healing times and an elevated risk of wound infection and sepsis during the recovery phase. Conversely, superficial burns (epidermal and superficial dermal) typically heal spontaneously within one to three weeks. Thus, severe burn injuries pose a significant threat not only to physical health but also to psychological and social well-being.

Epidemiologys

The incidence of burn injuries exhibits significant variation across different regions and countries worldwide, influenced by economic and social factors. Burn-related challenges in third-world nations are more prevalent and distinct from those encountered in Western societies. In the United States and Canada, the estimated incidence of burns requiring hospitalization ranges from 19 to 26 admissions per 100,000 inhabitants. Finland reported a figure of 35 per 100,000 inhabitants in the 1970s, while Italy, Britain, and New Zealand reported figures of 31, 29, and 25 per 100,000 respectively. Sweden's reported incidence of 17 admissions per 100,000 inhabitants per year is comparatively low, resulting in approximately 1500 hospitalizations annually. Several factors may account for Sweden's lower rate, including early recognition of preventive measures through extensive legislation, a greater focus on outpatient treatment, and a primary healthcare system emphasizing preventive measures.

Mechanisms of burn injuries also vary widely among countries and communities due to differences in food preparation methods, heating systems, industrial environments, and general living conditions. Specific product usage or cultural habits may contribute to the prevalence of certain types of burns in particular regions. For instance, the widespread introduction of water heaters led to a significant increase in scald injuries among children before safety modifications were implemented.

Males are disproportionately represented in burn statistics globally, with the exception of India, and men face the highest risk of burn injury and mortality due to such injuries. Children are also at significant risk in both developed and developing countries.

Advancements in Contemporary Burn Treatment

During the early decades of the twentieth century, individuals with extensive burns faced grim survival prospects. Surgical advancements of the time did not benefit burn patients, resulting in high mortality rates primarily attributed to severe fluid shifts leading to burn shock or sepsis. However, the advent of modern antibiotics and aseptic techniques in the 1950s and 1960s marked a turning point, significantly reducing mortality rates associated with wound infections and sepsis. Subsequent advancements in intensive care during the 1960s and 1970s, including more effective ventilators, vasoactive medications, and invasive monitoring, further contributed to improved outcomes. Throughout this period, burn shock, inhalation injuries, sepsis, and hypermetabolism gained recognition, prompting partial mitigation efforts.

The complexity of burn injuries prompted the establishment of centralised, specialised burn centers staffed by multidisciplinary teams, enhancing care for severely burned patients. The pivotal introduction of tangential primary excision of necrotic tissue by Janzekovic in 1970 marked a significant surgical breakthrough. This approach aimed to promptly remove non-viable tissue, minimizing the risk of infection and improving long-term outcomes by reducing scarring and chronic wounds. Subsequent refinements in anesthesia, surgical techniques, and knowledge facilitated early excision of necrotic skin, often followed by immediate wound coverage using autografts from the patient or homografts from tissue banks.

Technological progress over the past decade has further enhanced treatment options, particularly with the development of skin substitutes like cultured epithelial keratinocytes and artificial dermal substitutes. These innovations play a crucial role in reducing long-term scar contracture, disfigurement, and hospitalisation duration.

These advancements have significantly improved survival rates following major burn injuries. Fifty years ago, adults aged 15 to 44 faced a 50% chance of survival with burns covering 46% of their total body surface area, while children had a similar survival rate with burns covering 49%. In modern burn units, adults now have a 50% chance of survival even with burns exceeding 70% of their body surface area. Remarkably, young adults now report 50% survival rates despite burns covering between 80% and, in some cases, up to 98% of a child's body.

Post-Burn Injury Rehabilitation

The rehabilitation process for patients with extensive burns begins immediately following the injury, even for those requiring ventilator support. It involves joint positioning with splints, early physiotherapy, and providing information and support to the patient's family. However, for severely injured individuals, this marks just the initial stage of a lengthy journey toward adapting to life after a burn injury. The physical and psychological impact of such injuries can be profound, and the recovery or adjustment process varies depending on individual and situational factors.

The goal of rehabilitation is to maximize the patient's ability to resume a life that is minimally affected by the physical and psychological consequences of the burn injury. This entails addressing a range of issues related to reduced physical function due to skin complications such as scar contractures, as well as providing support for various psychosocial challenges. Early identification and treatment of common coexisting conditions like posttraumatic stress disorder (PTSD) and depression are crucial. Given the complexity and variability of burn sequelae and the diverse backgrounds of patients in terms of preexisting mental health conditions, social support networks, and coping mechanisms, a multidisciplinary approach to burn rehabilitation is essential.

In modern burn units, a team of specialists including burn surgeons, anesthesiologists, infectious disease specialists, burn nurses, psychiatrists, psychologists, physiotherapists, and vocational therapists collaborate continuously to assess and support the patient's progress both during hospitalization and in outpatient settings.

Numerous studies suggest that adaptation and psychological adjustment following a burn injury are influenced by factors beyond the severity of the burn itself, such as preexisting personality traits, coping strategies, gender, visibility of scars, and employment status. However, research on adaptation after burn injuries often faces methodological challenges such as small and non-representative sample sizes and high rates of participant attrition, primarily due to the relatively low incidence of severe burn injuries and the centralized nature of care.

Health status and outcome

During the 1950s and 1960s, death rates emerged as crucial indicators of outcomes in burn care, as well as in other areas of healthcare, particularly when mortality remained significant even in cases of moderate injuries. The introduction of expressing burn size as a percentage of total body surface area enabled the development of initial trauma indices that could be compared across different burn populations. While demographic and socioeconomic data provided insights into population needs, they lacked the ability to generate valid measures of morbidity.

As mortality rates declined in the late 1960s and 1970s, the utility of death rates for assessing improvements in patient care and informing healthcare planning and research diminished. Instead, there was a growing reliance on measures of morbidity in health status assessments. Despite the collection of vast amounts of information from various surveys, there was a lack of unified measures to aggregate the data.

Moriyama identified a significant challenge in developing aggregated measures due to the absence of a clear conceptual definition of health that could be translated into suitable operational definitions. Health, well-being, and quality of life are complex concepts with variable definitions. While the World Health Organization's definition of health emphasizes positive aspects, most health measures used in surveys tend to focus on negative aspects.

According to WHO definitions, impaired function occurs at the organ level, such as reduced range of motion due to scar contracture, while disability refers to disturbances at the individual level, such as reduced walking capacity. Handicap, on the other hand, refers to the disadvantage experienced by individuals due to impairments and disabilities. The importance of incorporating surveys of mental and social health alongside assessments of physical functioning is evident in the WHO's definition of health. However, researchers often prioritize clinical measurements of physical impact when evaluating outcomes after trauma, possibly due to the complexity of the interplay between physical, mental, and social health variables on outcomes.

Varieties of Health Assessment Methods

Various methods are utilized to gauge health status, ranging from instruments focused on specific physical functioning to questionnaires covering a wide array of psychological, social, and physical aspects. Ideally, health status measurements should differentiate between individuals and groups, forecast outcomes, and track changes over time. Donovan identified seven fundamental categories of health status:

1. General health measures provide comprehensive snapshots of well-being, encompassing social, emotional, and functional aspects. Common instruments in this category include the Sickness Impact Profile (SIP), Nottingham Health Profile (NHP), General Well-Being Schedule, EuroQol, and Medical Outcomes Study Instrument (MOSI), with the SF 36 being one variant of the latter.
2. Physical function measures assess disability, impairment, and physical function, focusing on activities of daily living. Examples include the Lambeth Disability Screening Questionnaire, Barthel Index, and Index of Activities of Daily Living (IADL), alongside group-specific measures like the Pulse Profile for the elderly.
3. Pain measures evaluate pain intensity using tools such as the McGill Pain Questionnaire and Visual Analogue Scale (VAS).
4. Social health measures gauge the strength of social support networks, employing instruments like the Social Health Battery.

5. Psychological measures appraise psychological or psychiatric morbidity, utilizing tools such as the General Health Questionnaire and Psychological Adjustment to Illness Scale (PAIS). Disease-specific instruments include the Hospital Anxiety and Depression Scale (HADS), Montgomery Åsberg Depression Rating Scale (MADRS), and Impact of Event Scale (IES).
6. Quality of life measures, like the Quality of Life Index and Four Single Items of Well-Being, assess overall life satisfaction and well-being.
7. Specific disease measures address concerns pertinent to patients with specific diagnoses, typified by instruments like the Arthritis Impact Measurement Scales (AIMS), Oswestry low back pain disability questionnaire, and Burn Specific Health Scale.

These measurements typically comprise closed sets of questions presented in a defined order with limited response options. They are administered via self-report questionnaires or, less commonly, through interviews.

Such health measures elucidate subjective or perceived facets of health, in contrast to clinical examinations or laboratory tests, which are deemed to yield more objective data. Nonetheless, an individual's perception of treatment effects and final outcomes can only be fully evaluated from the patient's perspective.

Psychometric principles

Psychometric theory involves the scientific principles governing the definition, measurement, and scaling of abstract phenomena such as personality traits, coping mechanisms, depression, and anxiety. It can be characterized as an approach to constructing and evaluating measures based on statistical associations between items and scales, with validity and reliability serving as fundamental concepts in psychometric theory.

Validity and Reliability

Validity, often considered the most crucial aspect, pertains to the extent to which an instrument accurately measures what it intends to measure. Three types of validity measures are typically examined: content, criterion, and construct validity. Content validity assesses whether items in a measure adequately represent the entire scope of the construct being measured, usually established through expert and population assessments. Criterion validity evaluates the measure's correlation with an external "gold standard" measure of the same construct, although such standards are seldom clearly defined in psychosocial science. Construct validity examines the relationship between theoretical constructs and the measure, relying on a robust theoretical foundation.

Reliability refers to the consistency of measurement, or the extent to which an instrument yields consistent results when used repeatedly under the same conditions. Reliability estimation typically involves internal consistency and test-retest methods. Internal consistency assesses the reliability of grouping questions in a questionnaire that measure the same concept, often computed using Cronbach's α . Test-retest reliability measures consistency by correlating scores from the same individuals across two different administrations of the same test.

Multivariate techniques

In analyzing complex relationships like outcomes after burn injuries, multivariate techniques are essential for assessing and analyzing numerous variables and observations. These techniques extend beyond univariate and bivariate statistics to measure, explain, and predict relationships among multiple variables.

Factor analysis identifies underlying patterns or relationships among numerous variables, simplifying the intercorrelation matrix into common factors to classify variables and reduce their number. Multiple regression techniques assess the effect of relationships between several independent variables on one dependent variable, often used in logistic regression when the dependent variable is binary.

The goal of multivariate analysis is to identify the most fitting and biologically plausible model for describing the relationship between outcomes and a set of explanatory variables.

Evaluation of Health Status Specific to Burns

The conventional approach to measuring health status historically involved the use of both generic and disease-specific health scales. However, it wasn't until 1979 that Blades et al. pioneered the development of a burn-specific health scale. This scale aimed to assess the clinical impact of a wide range of burn-related issues and quantify the effects of multidisciplinary burn care, acknowledging the unique challenges faced by burn survivors that affect both psychosocial and physical adjustment.

The development process involved compiling a comprehensive pool of items from three commonly used generic measures and input from burn center staff and patients, resulting in a total of 369 items. A panel of professionals in burn treatment and rehabilitation, along with former patients, rated the relevance of each item regarding a burn survivor's quality of life. The items with the highest median scores were retained, leading to the creation of the Burn Specific Health Scale (BSHS) comprising 114 items. This scale was subsequently refined by Munster et al. in 1987, resulting in the 80-item abbreviated Burn Specific Health Scale (BSHS-A) with four main domains and seven subdomains: Physical Functioning (Mobility, Self-Care, Hand Function, Role Activities), Mental Functioning (Body Image, Affective), Social Functioning (Family/Friends, Sexual Activity), and General Functioning.

Although the BSHS-A showed promise, its length hindered widespread clinical use. Furthermore, a lack of factor analysis and high correlation among subscales raised concerns about discriminant validity. To address these issues, Blalock et al. conducted a content validity study in 1992, interviewing individuals previously hospitalized for burn injuries. This led to the addition of 29 items and the development of the revised Burn Specific Health Scale (BSHS-R), consisting of 31 items. The BSHS-R demonstrated high internal consistency and factorial validity across five domains: Simple Functional Abilities, Work, Interpersonal Relationships, Heat Sensitivity, and Treatment Regimens. However, it was unable to differentiate between the domains of Affect and Body Image, and certain domains from the BSHS-A were excluded for unclear reasons.

Burn Injuries and Preexisting Psychiatric Conditions

Pre-existing psychiatric conditions are commonly found in the medical backgrounds of burn patients, often playing a significant role in the injury's causation. Estimating the incidence of prior psychiatric illness has proven challenging, with reports ranging widely from 23% to 75%. Frequently encountered preexisting conditions include substance abuse issues, organic brain dysfunction, depression, and personality disorders. Self-inflicted burns account for up to ten percent of cases, typically associated with complex premorbid psychiatric conditions. Additionally, burn patients with any history of psychiatric disorders are more prone to sustaining preventable injuries, requiring extended hospital stays, and facing early recovery adjustment difficulties.

Personality and Assessment of Personality Traits

Assessing various facets of personality has gained increasing significance, given recent research indicating that personality traits can be crucial predictors of health outcomes and treatment efficacy. According to the World Health Organization (WHO), personality is defined as "the ingrained patterns of thought, feeling, and behaviour characterising an individual's unique lifestyle and mode of adaptation, resulting from constitutional factors, development, and social experience." The term "personality trait" was introduced by Allport, who defined it as "a generalized and focalized neuropsychic system (peculiar to the individual), with the capacity to render many stimuli functionally equivalent, and to initiate and guide consistent forms of adaptive and expressive behaviour."

A fundamental assumption in personality research is the stability of basic personality traits over time in adulthood, supported by empirical evidence showing substantial rank-order stability and minimal changes in mean levels over time across various personality inventories and cohorts.

Biologically oriented personality theories typically adopt a dimensional approach to classify and explain human behaviour. The three-dimensional personality model by Eysenck and the five-factor structure, exemplified by the NEO Personality Inventory Revised, are prominent examples. The five-factor model includes Neuroticism, Extraversion, Agreeableness, Conscientiousness, and Openness, aiming to be comprehensive in describing broad dimensions of personality.

Sjöbring proposed a different conceptualization of personality, positing three basic bipolar dimensions—Validity, Solidity, and Stability—and included an additional measure of intelligence called Capacity. The Karolinska Scales of Personality (KSP), developed by Schalling, drew inspiration from Sjöbring's theories and other biologically based dimensions of personality. The KSP was designed to study vulnerability aspects of personality, focusing on associations between personality traits and biological markers, as well as personality predispositions to health and disease. The KSP underwent revision and development, leading to the creation of the Swedish universities Scales of Personality (SSP).

Personality traits also play a significant role in the context of burn trauma. Traits such as high neuroticism and high extraversion are linked to increased susceptibility to trauma exposure, and individuals affected by burn injuries tend to exhibit these personality traits more than a normative sample. Additionally, personality traits are implicated in long-term adjustment, with high neuroticism and low extraversion negatively affecting coping and positively correlating with post-traumatic stress disorder (PTSD) symptoms after burn injuries. Hence, understanding personality is crucial when evaluating factors contributing to perceived health status following burn injuries.

Coping strategies

Coping strategies play a crucial role in how individuals adapt to stressful life events. While stress itself may have less impact on health status and well-being than the individual's appraisal and coping mechanisms, coping strategies encompass the behavioral and cognitive efforts employed to manage, endure, reduce, or mitigate stressors. In individuals facing impairments or disabilities, coping encompasses all activities aimed at preserving psychological and physical integrity, regardless of the reversibility of these conditions.

The effectiveness of coping strategies can be influenced by various factors, including the nature of the problem, personality traits, and cultural influences. However, there is no consensus on which coping strategies are most effective for resolving problems, preventing future difficulties, or alleviating emotional distress. Coping strategies can generally be categorized as attempts to either avoid or confront a problem

or stressor, with individuals often oscillating between these approaches following traumatic events. Common coping strategies after burn injury include self-distraction, avoidance, and wishful thinking. Acceptance has been identified as a beneficial coping strategy for adaptation three months post-burn injury, but coping strategies may evolve over time.

Coping strategies can be assessed using standardized self-evaluation instruments, interviews, or experimental and observational techniques. While various measures exist, two widely used instruments are the Ways of Coping Questionnaire (WCQ) and the COPE. Although these instruments have been applied to evaluate burn patients, no coping scale has been specifically tailored to study coping strategies after severe burn injury. Generic scales may lack sensitivity to the specific stressors faced by burn patients, potentially leading to high attrition rates in studies. Developing a burn-specific coping scale could enhance compliance and motivation among participants.”

Conclusion

Burn injuries represent a significant public health concern globally, with profound implications for both individual health and societal well-being. From the historical reverence and fear of fire to the modern advancements in burn treatment, the understanding and management of burn injuries have evolved significantly over time.

The epidemiology of burn injuries reveals a complex interplay of factors influenced by socioeconomic conditions, cultural practices, and technological advancements. Disparities in burn incidence and mechanisms highlight the need for tailored preventive strategies and targeted interventions to mitigate the burden of burn injuries across diverse populations.

Advancements in contemporary burn treatment have revolutionized patient outcomes, leading to substantial improvements in survival rates and long-term functional outcomes. Multidisciplinary approaches, specialized burn centers, and innovative surgical techniques have contributed to enhanced care and rehabilitation for burn survivors.

Assessment of health status and outcomes following burn injuries is integral to evaluating treatment efficacy and guiding rehabilitation efforts. From traditional mortality rates to comprehensive health status measures, the evolution of assessment methods underscores the multifaceted nature of burn injury outcomes. Psychometric principles provide a framework for developing valid and reliable instruments tailored to the unique challenges faced by burn survivors.

Understanding the role of preexisting psychiatric conditions, personality traits, and coping strategies is essential for comprehensive burn care. These individual factors influence adaptation, recovery, and long-term adjustment following burn injuries, highlighting the importance of holistic, patient-centered approaches to rehabilitation.

In conclusion, while significant strides have been made in burn care, ongoing research and innovation are needed to address the complex physical, psychological, and social dimensions of burn injuries. By advancing our understanding of burn trauma and optimizing treatment approaches, we can improve outcomes and enhance the quality of life for burn survivors worldwide.

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