Best Practice Recommendations For Skin Health and Wound Management 2025

CHAPTER 8

Prevention and Management of Burns

David Wallace MD MSc FRCSC
Stephanie Chadwick RN NP-PHC MClSc-WH BScN NSWOC WOCC(c)
Jack Rasmussen MD FRCS(C)
Marc Jeschke MD PhD FACS FCCM FRCS(C)
Crystal McCallum RN MClSc
Matthew Godleski MD
Shahriar Shahrokhi MD FRCSC FACS
Louise Forest-Lalande RN MEd NSWOC
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INTRODUCTION

Burns are injuries to the skin that occur when the skin or other tissues are damaged by contact with heat from, "friction, cold [frostbite], heat, radiation, chemicals or electrical sources, but the majority of burn injuries are caused by heat from hot liquids, solids or fire."[1]

Burn injuries can be devastating and, without appropriate treatment, can result in slow healing, infection, scar formation and disfigurement, contractures, joint dysfunction, pain, as well as poorer mental health, well-being and quality of life (QoL).[2] Burn victims may have to have multiple surgeries, undergo grafting, wear compression garments for several years and live with physical disability, body image disturbance, disfigurement and emotional and employment (schooling, training) challenges. Infants and children are increasingly vulnerable as they are growing, and the burn scarring and skin contracture lead to long-term care needs.[3]

Worldwide, burns are among the leading causes of death of young people. In 2023 the World Health Organization (WHO) listed fire-related burns as more common in adult women and the fifth most common cause of non-fatal injuries in childhood, often linked to lack of adult supervision and child maltreatment.[4] Globally, most children with burns are boys, who also have a higher mortality rate related to burn injuries. The WHO links the risk of death from injuries such as burns with poverty, noting a pattern of injury-related deaths in many low- and lower middle-income countries.[5] The reasons for this include unsafe living and working conditions, lack of focus on prevention efforts and poor access to high-quality emergency trauma care and rehabilitation services.[4]

In 2021, Statistics Canada explored the mortality and morbidity related to fire, burns and carbon monoxide poisoning among First Nations, Métis and Inuit people using findings from the 2011 Canadian Census Health and Environment Cohort.[6,7] They reported higher rates among First Nation people than non-Indigenous persons, confirming previous reports. In Canada, this is reflected in the disproportionate age-standardized rate (2001–2006) of hospitalizations for fire-related injuries (excluding Quebec, population aged 0–19) in areas where at least 33% of the population reported a First Nations or Métis identity, especially First Nations and Métis children aged 0–9 and First Nations children aged 10–19.[8]

Although the age-standardized rate of emergency room visits and hospitalizations related to fire/burn injuries in Canada has declined over time, burn injuries continue to be a concern. In Canada, from 2011 to 2020 there were approximately 220 fire-related deaths reported each year,[6] slightly less than the 234 deaths reported in 2010 (See Table 1). More research is needed on persons who sustain burns related to substance use (alcohol, cocaine, marijuana), when judgment and decision making may be altered or impaired. Williams et al. report these patients (n=3,476) experience increased length of hospitalization and use of intensive care services.[9]

Table 1: Fire/Burn Injury Morbidity/Mortality in Canada, 2022[10]
https://parachute.ca/en/professional-resource/cost-of-injury-in-canada/the-human-cost-of-injury/

Description (Cases)	Deaths	Hospitaliza-tions	Emergency Room Visits	Disability (all ages)
Fire/Burn Injuries	162	2,193	51,904	386
Total Injuries	17,475	231,530	4,555,865	61,400
Percentage	0.93	0.94	1.14	0.63

In 2017, a search of the electronic Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) database for emergency department visits revealed that just over half the burns sustained in 2013 were scalds (52.3%), followed by contact with hot objects (29.9%), fire, flames, smoke (11%), electrical (4.7%), electrical (1.4%), and sun (0.7%) (See Figure 1).[11]

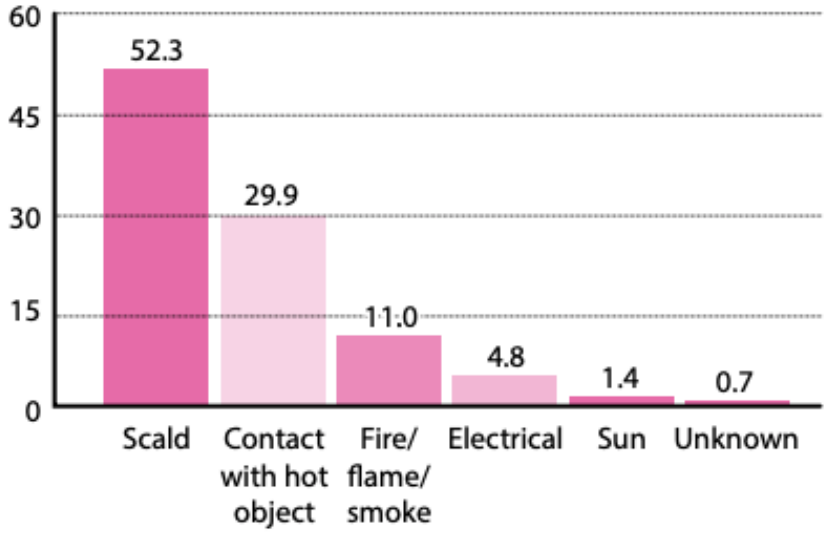


Figure 1: Distribution (Percentage) of Burn Injuries by Cause, 2013

While the overall proportion of burns was slightly higher among females, with females experiencing scald-related burns more often than males, males experienced burns from hot objects, fire/flame/smoke, electricity and the sun slightly more frequently than females (See Figure 2).[11]

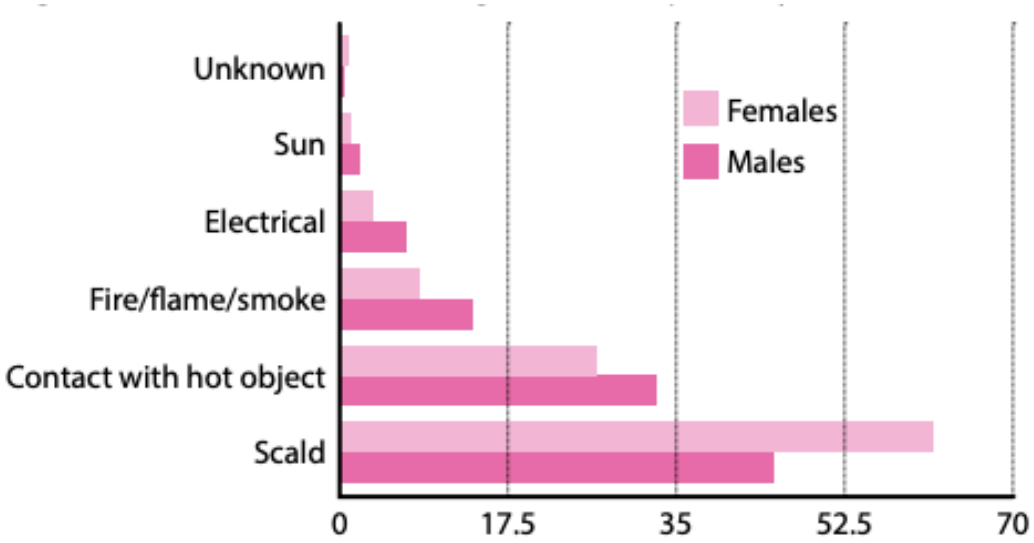


Figure 2: Distribution (Percentage) of Burn Injuries by Cause and Sex, 2013[11]

Residential fires, recorded and analyzed in the Canadian National Fire Information Database, are one cause of heat-related burns. Between 2005 and 2015 there were approximately 7,130 residential fires per year in Canada, with a total of 830 non-firefighter deaths and 4,656 injuries.[12] Of these fires, just over two-thirds had no present and/or functioning life-safety system (e.g., smoke alarm and/or sprinkler protection); these fires resulted in 80% of deaths. Residential fire deaths most often involve persons who are males, older adults, children under the age of five and Indigenous individuals.

In Canada, burns are the fifth leading cause of serious work injury. In 2013, 5.7% of people aged 15–74 who experienced a serious injury at work sustained a burn, scald or chemical burn.[13]

A retrospective study of 1,427 patients admitted to a regional burn centre at a university teaching hospital in Ontario, Canada, reported that, of the 23% admitted between January 2001 and December 2010 for work-related burns, the mean age was 40.5 + 11.9 years, 95% were males, and 69% were from the immediate urban area. Work-related burns in this study also predominantly affected the upper extremities, head and neck, with the most common causes being flame (32.7%), electrical (27%) and scald (19.7%), and the most common groups affected being manual labourers (44.5%) and electricians (13%). The most severe burns were associated with truck drivers, who, because of motor vehicle accidents, sustained flame or tar burns.[14]

Burn injuries are not only a burden in Canada due to mortality and morbidity, they also place a strain on health-care resources (acute, rehabilitation and community). In 2018, the total injury costs related to fire/burns in Canada was $299 million, with the direct costs (health-care costs) being $201 million and the indirect costs $89 million (costs related to reduced productivity, disability and premature death).[10] (See Table 2)

Table 2: Total costs of burns in Canada in 2018 by age category, both sexes[10]

Age Category	Total costs in millions
Children 0–14	$54
Youth/ young adults (15–24)	$43
Adults (25–64)	$164
Seniors (+65)	$37

This document is written with the intent to encompass the quintuple aim for health care improvement. This is to enhance the patient experience, reduce costs, improve population health, improve the clinician experience and enhance equity. This equity piece is particularly important for patients living with skin issues, wounds and specifically burn injury. Ensuring all patients receive care, supplies and ongoing preventative strategies needs to be recognized and communicated to policy makers (See Table 3).[15]

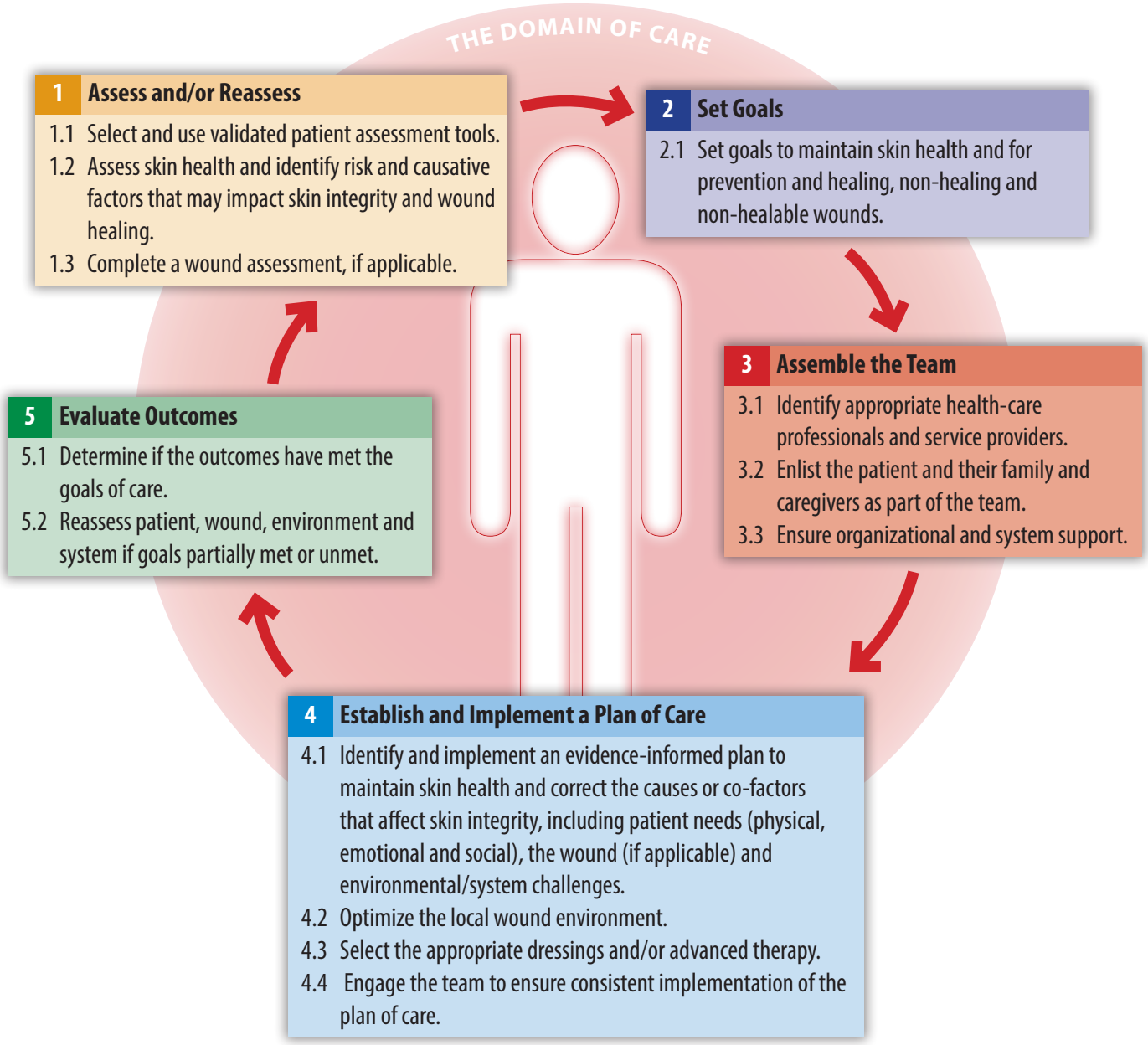
Table 3: Quintuple Aim and Management of Burn Injury

5 Components	Applied to Burn Injury
Improving population health	Through prevention, education and self-management strategies
Reducing costs	Application of best practice to ensure most effective treatment Appropriate use of resources - prevention strategies in homes, workplace and community; screening, burn prevention, dressings, compression garments
Advancing health equity	Application of principles to all those at risk for, or affected by, a burn injury
Care team well-being	Providing clinically usable information for front line clinicians
Enhancing the patient experience	Providing a supportive process of care for all those living with a burn injury

THE WOUND PREVENTION AND MANAGEMENT CYCLE

This chapter offers a practical, easy-to-follow guide that incorporates the best available evidence. It outlines a process, or series of consecutive steps, that supports patient-centred care using the Wound Prevention and Management Cycle (See Figure 3), which guides the clinician through a logical and systematic method for developing a customized plan for the prevention and management of burn injuries, from the initial assessment to a sustainable plan targeting self-management for the patient.

Figure 3: The Wound Prevention and Management Cycle



The recommendations in this chapter are based on the best available evidence and are intended to support the clinician, the patient, care partners, their family and the health-care team in planning and delivering the best clinical practice. Two foundational chapters supplement this chapter with additional evidence-informed information and recommendations that are general to all wound types: Chapter 3: Skin: Anatomy, Physiology and Wound Healing[17] and Chapter 4: Best Practice Recommendations for the Prevention and Management of Wounds: An Overview.[16]

There are three guiding principles within the best practice recommendations (BPRs) that support effective prevention and management of skin breakdown:

1. The use of the Wound Prevention and Management Cycle, regardless of the specifics, to prevent and manage skin breakdown,
2. The constant, accurate and multidirectional flow of meaningful information within the team and across all care settings, and
3. The patient as the core of all decision making.

Step 1: Assess and/or Reassess

Recommendations
1.1 Select and use validated patient assessment tools

The use of validated and standardized patient and risk assessment tools is essential for identifying factors that may impede healing and quality of life and for providing direction for preventative care or management.[17] Most existing validated tools are for use with the adult population.

Discussion:
Burn size: The total burn area is expressed as a percentage of the total body surface area (TBSA). The most common methods used to estimate the TBSA involved in a burn injury include palmar surface, the Lund and Browder chart and the Wallace Rule of Nines. These tools are further discussed in Recommendation 1.3.

Hand burn severity: Although the surface area of the hand is relatively small compared with total body surface area, the functionality of the hand is significantly important in the completion of activities of daily living, and thus hand burns are considered major. The importance of the hand was demonstrated when the universal Hand Burn Severity (HABS) score was devised and validated to quickly describe the severity of a hand burn injury.[18]

Mortality risk assessment: Prediction of mortality secondary to burn injury is useful, as knowing a patient's projected mortality may improve triage and help to identify the most appropriate plan of care. The FLAMES score is an example of a validated tool that can predict burn-injury-related mortality of patient populations of similar characteristics, e.g., age or sex.[19,20] Frailty is also a predictor of adverse outcomes for patients with burns.[21]

Anxiety assessment: Anxiety experienced by burn patients is often related to pain-producing situations, such as confrontation with wounds, dressing changes and surgical procedures.[22] The Burns Specific Pain Anxiety Scale is a valid and reliable tool that provides a standardized assessment for identifying burn patients with feelings of anticipatory anxiety and worry who require further assessment and intervention.[23] In a recent review, researchers discuss the role of massage therapy in pain and anxiety reduction.[24]

Quality-of-life assessment: Burn injuries that are extensive, slow healing, disfiguring, painful or that result in contractures and/or joint dysfunction may cause psychological stress and significantly impact the patient's quality of life.[22] Use of a validated quality-of-life (QoL) assessment tool may be beneficial to identify potential barriers and patient lifestyle issues that may interfere with positive participation in the plan of care. Examples of validated tools to assess burn-injury-related QoL in adults include the following:

- Burn Specific Health Scale—Abbreviated,
- Burn Specific Health Scale—Revised, and
- Burn Specific Health Scale—Brief (BSHS-B).[25]

For the pediatric population, burn-related QoL tools include the range of age-specific Burn Outcomes Questionnaires[25-27] and the series of Health Outcomes Burn Questionnaires (for children aged 0–5 years and 6–17 years).[27,28]

Coping assessment: Burn patients undergo extreme physical and psychological stress. Bosmans et al. (2015) state burn survivours live with symptoms of, "acute stress disorder (ASD), post-traumatic stress disorder (PTSD), anxiety, depression, as well as delirium and problems with sleeping, and frequent nightmares are commonly experienced."[29] To promote recovery after hospital discharge, patients must be equipped with productive coping skills. The Coping with Burns Questionnaire was developed to measure coping (re-evaluation/adjustment, avoidance, emotional support, optimism/problem-solving, self-control and instrumental action) of adult burn patients after discharge.

Empowerment: Empowerment is an important aspect of emotional care. Shorke et al. (2024) in a large study with 80 adult burn survivours that were, "randomly divided into an intervention group, receiving the psychosocial empowerment program, and a control group, continuing standard care". The program used various tools to measure a range of elements, such as satisfaction with appearance, coping abilities and symptoms of post-traumatic stress disorder (PTSD). "The intervention focused on enhancing resilience, self-efficacy, and adaptive coping, through targeted skill building in stress management, adaptability to coping, social reintegration, emotion regulation, and problem-solving. Participants in the intervention group demonstrated significant improvements in body image satisfaction, coping abilities, and symptoms of PTSD compared to the control group."[30]

Scar assessment: Scar assessment scales provide a systematic approach for assessing and documenting scar quality and evolution and are valuable instruments in the clinical evaluation and follow-up of scars. Examples of validated scar assessment scales include the following:

- Matching Assessment of Scars and Photographs,[31]
- Patient and Observer Scar Assessment Scale,[32]
- Satisfaction with Appearance Scale[33] and
- Vancouver Burn Scar Assessment Scale.[34]

Wound assessment tools: Assessment of any wound and documentation of findings also requires a standardized approach using a comprehensive, validated and reliable wound assessment tool. Such tools not only provide a baseline of wound characteristics, but also identify wound change over time, which helps determine if a wound is progressing toward closure or is deteriorating. Currently, there are no burn-specific wound assessment tools.

Pain assessment: Pain assessment tools provide a systematic approach for assessing and documenting pain as well as the factors that are causing or exacerbating wound-related pain. The accurate assessment of pain is essential to ensure patients experience effective pain management. Currently, there are no burn-injury–specific pain assessment tools. Examples of validated pain assessment tools that could be used to assess for burn-injury pain include the visual analogue scale, the numeric rating scale, the verbal rating scale, the Brief Pain Inventory and the McGill pain questionnaire.[35]

Nutrition screening: Nutritional screening tools provide a standardized approach for identifying patients who are at risk of compromised nutrition and who require further nutritional assessment and intervention. Currently, there are no burn-injury-specific nutritional screening tools. Examples of validated nutritional screening tools that could be considered for use with patients with burn injury include the following:

- Subjective Global Assessment,
- Malnutrition Screening Tool,
- Nutrition Risk Screening-2002,
- Malnutrition Universal Screening Tool,
- Subjective Nutrition Assessment Questionnaire and
- Canadian Nutrition Screening Tool.[36,37]

Wound and pain assessment and nutrition screening tools are discussed in detail in
Chapter 4: Best Practice Recommendations for the Prevention and Management of Wounds: An Overview.

1.2 Assess skin health and identify risk and causative factors that may impact skin integrity and wound healing

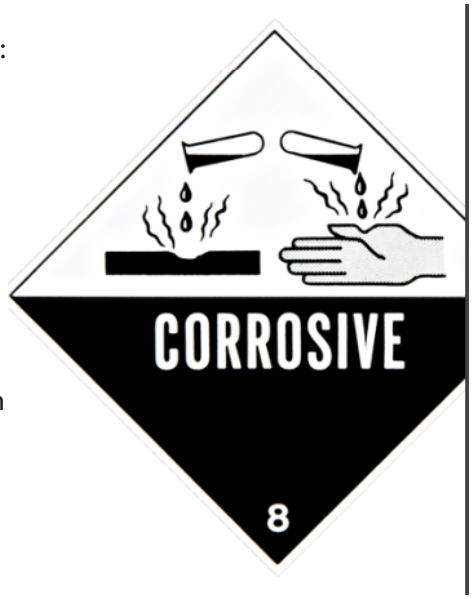
Discussion:
Risk assessment: Different populations have statistically higher or lower risk for different types of burn injuries. Table 4 reflects the highest proportion of burn injuries by age, sex and cause in 2013. Injury statistics were obtained from the database of the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP), Public Health Agency of Canada.[11]

Table 4: Highest Risk for Burn Type by Age and Sex[11]

Burns Cause	Most at Risk (by Age and Sex)
Scalds: Includes contact with hot water, steam, food, oil, grease, liquid glue or liquid wax	Children under 1 year
Fire, flame, smoke (highest proportion)	Males aged 50–64 Females aged 20–29
Fire, flame, smoke (highest count)	Males aged 15–19
Sunburns (highest proportions)	Males/females aged 20–29
Electrical (highest proportion)	Males under 1 year Males 20–29 years
Electrical (highest count)	Males aged 2–4 years

The CHIRPP database revealed the two most common overall causes of burn injuries are:

Scalds: hot beverages (34.1%) and hot water (not tap water) (28.9%) and
Contact burns: stoves/ovens (22%) and fireplaces/accessories (19.6%).



Common causes of electrical burns (tissue damage caused by the heat energy of an electrical current flowing through the body) in children are electrical and extension cords and wall outlets. Adults most often experience electrical burns both at home and at work caused by electronically powered devices.

Most chemical burns result from workplace-related injuries; however, those that occur in the home are most often the result of exposure to corrosive agents. Common alkali substances in the home that may cause burn injury include: cleaning products (ammonia), drain cleaners (caustic soda), oven cleaners,plaster or cement (lime) and fertilizers. Common acidic substances in the home that may cause chemical burns include: glass polish (hydrofluoric acid), vinegar (acetic acid) and nail polish remover (acetic acid).

Patients using home oxygen therapy and smoking cigarettes are at a higher risk of inhalation injury and longer hospitalizations.[38] Recent rises in substance use have increased risks of burn complications, length of hospital stay and use of critical care services.[39-41] As well, the medical equipment (polyvinyl chloride products in nasal cannulas) contribute to intense flames in the facial area. Therefore, home safety education is essential.[42]

For children, most burn injuries occur in the home, whereas adults most commonly experience burns in the home, outdoors or in the workplace. In addition, although children and the elderly are most vulnerable to burn injury, those who cannot recognize or react to a dangerous burn-risk situation are at increased risk for burn injury, including persons with:

- Cognitive or mental impairment,
- Impaired mobility and sensation and
- Musculoskeletal or nervous system disorders.[43]

People with mental illness are also vulnerable to burn injury. In their retrospective study of patients 16 years and older admitted to hospital in Ontario, Canada, and treated for a major burn injury (April 2003 to March 2011), Mason et al. observed that in a three-month period immediately preceding the burn there was a greater number of emergencies related to mental health issues.[44] These authors further stated that, "mental illness is an independent risk factor for unintentional injury and injury recidivism"... "the treatment of mental illness might be an important target for burn prevention efforts".[44]

Although there is no comprehensive tool available to assess one's general risk of burn injury, the statistics noted could aid one in developing a prevention plan (individual, community) based on age, sex and environment.

1.2.1 Patient: Physical, emotional and lifestyle

Discussion: Assessment – Primary Survey: All people with burn injuries requiring or receiving assessment by a health-care professional should be evaluated first using the ABCDEF mnemonic, listed in the order of priority, to identify any life-threatening injuries.

Airway: Assess for airway obstruction and for injuries that are physically restricting breathing, e.g., a burn or fracture to the jaw area, a circumferential burn around the chest or a lung penetration injury secondary to an explosion.

Breathing: Evaluate breathing and ventilation. Watch for chest movement, auscultate and percuss to detect any conditions impeding ventilation, e.g., hemothorax, pneumothorax or flail chest. Observe for the signs of smoke inhalation, including facial burns and swelling, singed nasal hairs, blackened sputum, hoarseness of voice and respiratory distress. Romanowski, et al. (2016) reported that more than one-third of intubations in patients then transferred to burn centres were unnecessary.[45] More research is needed to determine when intubation is needed. Ching et al. stated that singed nasal hair, carbonaceous sputum and facial burns were not automatic predictors of the need for intubation.[46] Again, more research is needed. In a recent study, Flinn et al. (2023) recommend repeated assessment of respiratory status.[47] PF ratio and bronchoscopy are the only modalities that can determine severity of inhalation injury.[48]

Upper Gastrointestinal Burns: Ingestion of caustic materials may cause chemical burns to the oropharynx, tongue, esophagus, stomach and duodenum. Laryngeal edema may occur, producing upper airway obstructions.

Circulation: Assess for signs of bleeding, hypovolemia and burn shock, e.g., low blood pressure and body temperature, rapid/weak/thready pulse, rapid breathing, cool/clammy/pale skin, confusion/anxiety/weakness and unconsciousness. Pulse oximetry can be used to quickly measure oxygenation of hemoglobin. If burn shock is suspected or the burn is of an electrical origin, consider the need for a 12-lead electrocardiogram, cardiac enzymes and continuous cardiac monitoring. In hospital, burn shock can be further evaluated using blood work (complete blood count, packed cell volume, urea and electrolyte concentration, clotting screen, arterial blood gases, blood group and save or crossmatch serum), echocardiogram, endoscopy, urinary catheterization (to measure output) and cardiac catheterization depending on the suspected severity of the burn injury. Chest, pelvic and lateral cervical spine x-rays, ultrasounds and CT scans may also assist with identification of injury secondary to blunt trauma.

Disability: Complete a neurological assessment to establish the patient's level of consciousness (using a valid and reliable tool like the Glasgow Coma Scale), pupil size/symmetry/ reaction and evidence of spinal cord injury or compartment syndrome. Symptoms of acute compartment syndrome include a new and persistent deep ache in a limb, numbness/ tingling/ electricity-like pain in a limb, swelling, tightness and bruising. Abdominal compartment syndrome may present as a tense, distended abdomen, low blood pressure, poor or absent urine output and abdominal pain with palpation. Blood work, ultrasound and use of a pressure monitor can help confirm the diagnosis.

Exposure: Expose the patient's skin to determine the area of burn injury more accurately (this will be discussed in the secondary survey). All clothing and jewellery (especially rings, watches and bracelets with hand/arm burns) must be carefully removed to visualize the burned area and avoid the 'tourniquet-like' effect of constricting items left in place when the resulting tissue edema increases.

Fluid resuscitation (to be discussed in Step 4: Establish and Implement a Plan of Care).

Assessment – Secondary Survey: Once the primary survey has been completed and resuscitation is successfully underway, the secondary survey should begin. The secondary survey consists of:

- A head-to-toe examination to rule out secondary injuries,
- A systematic and detailed history of the patient's general health,
- Identification of specific issues related to the burn injury and
- A wound (burn injury) assessment (first responders should avoid putting any products on the burn before the medical assessment is completed).

Minor Burn Assessment: Not all burns require assessment by a health-care professional. If a person has experienced a small (e.g., less than [<] 1% TBSA) minor superficial burn, e.g., a sunburn, or superficial partial-thickness burn that does not involve the face, eyes, ears, hands or perineum, that does not impede joint function, that is not caused by electricity or chemicals and that does not involve an inhalation injury, self-management may be appropriate. Those who are immunocompromised or medically complex, who cannot identify infection and complications and those who do not know when to seek medical attention, or do not have the physical ability to self-treat, should seek assessment by a health-care professional.

Common secondary injuries that may present as the result of a major burn include:

- Upper gastrointestinal (GI) erosions and ulcers/Curling's ulcer (which usually present clinically with painless GI hemorrhage),
- Myoglobinuria and acute renal failure (manifested by an elevated serum creatinine and a fall in creatinine clearance),
- Sepsis,
- Venous thromboembolism and
- Microangiopathic hemolytic anemia.

If the patient has experienced a chemical burn, it is important to consider the systemic effects of the absorption of the chemical product.

Heterotopic ossification is a less common burn injury complication, associated with larger burns located (most often) adjacent to the elbow joint. While rare, the rehabilitation implications of heterotopic ossification can be severe and should be considered in situations of increased pain and range of motion losses.[49]

As previously mentioned, patients with burns that are the result of fire or flame may have an associated inhalation injury and/or carbon monoxide poisoning, which must be assessed for. Cyanide toxicity is also a systemic sequelae of inhalation injury.[50] Patients presenting with electrical burns may also have bone fractures, spinal cord injury, peripheral nerve injury, neurophysical complications, electrocardiographic alterations, amputation and or visceral injuries.[51] Peripheral nerve injuries (commonly affecting the median, ulnar and peroneal nerves) are associated not only with electrical burns, but with large, major burns, and in patients who are on mechanical ventilation or in hospital for longer periods of time, or who have increased surgical requirements.[52] Peripheral nerve injuries can happen acutely, but also often develop in the first weeks post-injury. Serial screening for sensory or motor changes, especially in higher risk patients (as previously noted), should be considered.

A detailed patient history should identify comorbidities that may interfere with healing and/or impair immunity, including diabetes mellitus, peripheral arterial disease, collagen vascular diseases, organ transplants, cancer and psychological factors. Choice of treatment may also be dependent on comorbidities, such as choice of oxygen therapy concentration in patients with chronic obstructive pulmonary disease. In their assessment clinicians also need to gather information on known allergies, current medications (prescription and non-prescription), lifestyle choices (e.g., smoking, substance use, level of physical activity, participation in high-risk activities), vocation and avocation, level of physical functioning (including mobility, gait, fatigue, eyesight, hearing, activities of daily living and use of assistive devices), hydration and nutrition, spiritual health and psychological functioning (e.g., behavioural conditions, cognitive ability).

In addition to a nutrition-related blood screen, validated nutritional screening tools, such as those noted in Recommendation 1.1, provide a standardized approach for identifying patients who are at nutrition risk and who require further nutritional assessment and intervention.

The secondary survey should also identify the events preceding the burn injury. Circumstances of the injury should be explored, as care and outcomes can be influenced by the timing and mechanism of injury, duration of exposure to the burn agent and first-aid measures provided. Non-accidental injuries must be considered when the patient's history does not match with the observed injury or if there are inconsistencies with the history provided. Young children,[53] the elderly and people with cognitive impairment are at risk for non-intentional burn injuries.[54]

If non-accidental injury is suspected, health-care providers are mandated to report to the appropriate authority, e.g., children's aid societies, provincial/ territorial ministries of health, retirement home regulatory authorities, police.[55] Note that comorbid conditions may have contributed to the burn injury—for example a person having a stroke while boiling hot water. Social workers may play a role in the investigation, and clinicians need to be aware of the reporting of abuse in the health system in which they are employed.

The mnemonic AMPLE can be used as a reminder of pertinent patient history information that must be collected during the secondary survey.

Allergies
Medications
Previous illness, past medical history, illness/pregnancy
Last meal or fluid intake
Events preceding injury (such as exposure to chemicals, toxins or radiation because, "exposure to chemical agents can cause pulmonary, cardiac and other internal organ dysfunction, or hazardous environment can pose a threat to the health".[56]

Pain assessment: Burn-injury-related pain involves both peripheral and central processes and may present with the combined features of acute nociceptive and inflammatory pain (presenting as sharp, aching or throbbing sensations) and neuropathic pain (initially presenting as shooting, lancing, burning, electric shock, squeezing, throbbing, and knife-like sensations and allodynia, and later presenting as numbness, tingling and prickling sensations).[57] The background burn pain experience, which may fluctuate, is not only dependent on the mechanism of the burn injury, burn depth and burn size, but may be influenced by the presence of inflammation and/or infection.

Patients with burns may also suffer from incident, procedural or operative wound pain. Incident pain may occur during the normal day-to-day activities of the patient and may result from otherwise benign activities like standing or sitting, turning, walking, coughing or laughing. Procedural pain is pain experienced during procedures, such as dressing changes, wound debridement and other wound treatments. Like procedural pain, operative pain is the result of procedures complex enough to require anesthesia, such as major burn injury dressing changes. The burn injury-related pain experience is also influenced by biologic, psychosocial, spiritual and environmental factors, which must be assessed for, and that may include:

- Biological factors: genetics, sex and endogenous pain control,
- Psychosocial factors: anxiety, stress, depression, coping skills, behaviour and cognitive status and spiritual resources and
- Environmental factors: lifestyle, employment type, socialization, cultural background and life traumas.

Validated pain assessment tools, such as those noted in Recommendation 1.1, provide a standardized approach for identifying, assessing and documenting the factors that are causing or exacerbating burn-injury-related pain, so that appropriate interventions can be implemented to ensure patients experience effective pain management.

Quality-of-life (QoL) assessment: Burn injuries may have profound physical/aesthetic, psychological, social and vocational (schooling) and/or employment consequences. Individuals with burn injuries may have to cope with itching, tightness to skin and changes to functional ability. To optimize the rehabilitation of a patient with a burn, it is important to assess the predictors of health-related quality of life (HRQL). A recent systematic review (2018) found the following poor HRQL predictors related to burn injuries: burn severity (greater length of hospital stays, burn size, depth of injury and number of surgeries), post-burn depression, post-traumatic stress symptoms, avoidance coping, less emotional or social support, higher levels of neuroticism as well as unemployment post-burn injury. Additionally, weaker predictors of poor HRQL related to burn injuries include pain, a post-burn substance use disorder, and being female.[58]

Validated burn-injury-related anxiety scales, QoL assessment tools and coping questionnaires, such as those noted in Recommendation 1.1, provide a standardized approach for identifying potential barriers and patient lifestyle factors that may interfere with positive participation in the plan of care and identify patients in need of extra rehabilitation care.

1.2.2 Environmental: Socio-economic, care setting, potential for self-management

Discussion: Closely linked to the quality-of-life assessment, an environmental assessment that incorporates an assessment of the social determinants of health is essential in determining if the patient has the care partner and/or family and socio-economic support needed to meet any goals of care that may be considered. Determinants that should be assessed include income, employment and working conditions, food security, environment and housing, early childhood development, education and literacy, social support and connectedness, health behaviours and access to health care. For example, a study of the global burden of child burn injuries showed that most preventable burn injuries occur in low-income countries (in part due to open-fire cooking), and that low income was associated with higher mortality and morbidity rates, noting barriers such as limited knowledge of first aid for burns, availability of transportation to specialized burn care centres, and limited supplies, beds and staff at specialized burn care centres. Furthermore, the study suggested that improving the wealth of poor households may lead to better living conditions, nutrition and access to medical services, thus reducing burn injury risk and outcomes.[59]

1.2.3 Systems: Health-care support and communication

Discussion: A systems assessment takes into consideration the patient's access to emergency services, funding, availability of support services and wound-related products, devices, diagnostic services, service delivery personnel and co-ordination of care, all of which vary widely from province/ territory and from one interprovincial/ interterritorial region to another. Health-care support and communication can even vary from one service delivery site to another.

When setting patient goals and developing a plan of care, early communication with the care partner and/or family, clinicians must take into consideration the patient's access to health-care supports, as an organized, interprofessional and collaborative approach to care is critical to improving burn-injury-related outcomes.

1.3 Complete a wound assessment, if applicable

Discussion:

Burn injury assessment: When assessing a burn injury, it is important to determine the underlying cause or mechanism of the injury—this is key as the cause influences the pathophysiology of the injury and its management—burn depth and size, and severity of the burn injury (See Figure 4). Assessment of the burn can help the team to determine the ability of the person to heal their burn injury, plan treatment, facilitate communication, monitor treatment and predict and verify outcomes.

Figure 4: Burn Classification

Used with permission of Mölnlycke.

Mechanism of Injury

Heat-related burn injuries vary in depth and size and are caused by scalds from liquids spilled or liquid immersion, grease or steam; contact burns and fire, flash or flame. The severity of the injury is related to the rate at which the heat is transferred from the heating agent to the skin, which depends on the heat capacity and temperature of the agent, duration of contact with the agent, transfer coefficient, and heat and conductivity of the local tissue.

Scalds tend to be superficial partial-thickness tissue damage and may involve a large area of skin. Scalds with viscous liquids like oil, grease, liquid glue or liquid wax that are splashed on a person's skin tend to cause more severe burn injuries than scalds from liquids with greater fluidity, like hot water. Fluids that are more viscous tend to roll off a person's skin at a slower rate or cling to a person's skin, increasing the duration of exposure. Scald burns may present as a first degree burn on initial assessment but may develop into a superficial partial-thickness (second degree) burn within 24 hours. Blisters that were not present initially may develop within the first 24 hours.

Immersion scalds can result in more severe burn injuries because of the increased duration of contact between the heat agent and the skin. Such burns can cover a large skin area.

Contact burns tend to cause deep partial-thickness or full-thickness tissue damage and involve less skin area than other types of burns.

Flame injuries are of various depths (superficial partial-thickness to full-thickness) and cover varied amounts of skin.

Cold-related burns may occur through exposure to extreme cold. Across the spectrum of tissue damage patients may experience a freezing injury (FI) from frostnip, to superficial injury, to deep tissue freezing caused by crystallization of water in the cells, which may cause ischemia, leading to skin necrosis and damage to the deeper tissues.[60] The Hennepin Score may be used to quantify injury and tissue loss of frostbite injury, similar to TBSA calculators in burn patients.[61]

Electrical burns outwardly may not reflect the true extent of the injury, as internal tissue and organ damage may have ensued.[62] The extent of electrical burns is related to the voltage of the current. With low-voltage electrical burns, small, deep burns are seen at the contact points. Assessing the contact points help to determine the probable path of the electrical current and thus the potential areas of injury is required. High-voltage burns (greater than 1,000 volts) may cause extensive deep tissue damage, limb loss and death. Electrical current takes the path of least resistance through the body, allowing for the electrical energy to be transformed to heat, damaging the tissue it contacts. Least resistance is offered by nerves and blood vessels, whereas bone and fat offer the most resistance. If major body organs, such as the heart, brain or kidneys are involved, the damage can be profound. Because much of the damage is below the skin at the level of muscle, fat and bone, the severity of the injury can be difficult to determine (the 'iceberg' effect). High voltage flash burns occur when electrical current does not actually enter the body; rather, the person is exposed to an arc of high-voltage current. The resulting burns may manifest as superficial partial-thickness damage to body parts exposed to the arc. If clothing ignites, deeper burns may result.[62]

Radiation burns are injuries to the skin or tissue caused by exposure to ultraviolet rays (sunburn), radiation therapy for cancer treatment and, in rarer instances, nuclear emissions or explosions. The effect of radiation reactions is dependent on the type of radiation, its energy, penetration and ionization power, total dose, fractionation and overall exposure/treatment time.[63] Radiation-induced skin injury ranges from erythema (redness) to dry or moist desquamation, skin necrosis, ulceration and death.[63]

The extent and depth of a **chemical burn** is directly proportional to the amount, type and strength of the agent, its concentration, extent of penetration, mechanism of action and length of contact time with the skin/tissue. Chemicals will continue to destroy tissue until inactivated by reaction with tissues, neutralized, brushed off (powders), or diluted with the appropriate neutralizing agent (it is important to note that, in some cases, water may favour skin disruption*). Therefore, it is essential for the health-care provider to find out the chemicals involved in the injury. The burning process may continue for variable and often prolonged periods of time, e.g., up to 72 hours, after the initial contact with the chemical agent. Acids, in general, cause coagulation necrosis with protein precipitation. Alkalis produce liquefaction necrosis, which allows the alkali to diffuse more deeply into the tissues. Therefore, on a volume-to-volume basis, alkaline material can produce far more tissue damage than acids.

*Safety data sheets (SDS) in workplaces provide first aid measures information which describes actions to be taken immediately in case of chemical exposure. The purpose of first aid is to minimize injury and future disability.[64]

Regardless of the mechanism of injury, the pathophysiology of a full-thickness burn wound involves a local and systemic response. Locally, a burn may be divided into three zones.

1. Zone of Coagulation
- Centre of the wound – the area that had the most contact with the burn source
- Irreversible full-thickness tissue damage with no tissue perfusion
- Tissue appears white or charred and will not recover.

2. Zone of Stasis
- Surrounds the zone of coagulation
- Deep partial-thickness injury with decreased tissue perfusion
- Tissue appears red initially and later turns white and may blanche with pressure. Petechial hemorrhages may be present
- With good management, tissue will likely recover.

3. Zone of Hyperemia
- At the periphery of the wound
- Superficial partial-thickness injury with good tissue perfusion
- Tissue appears red, blanches with pressure and will likely recover.[65]

In complex burns, there is also a systemic response secondary to the systemic release of cytokines and other inflammatory mediators, catecholamines, vasopressin and angiotensin. This can result in hypovolemia, systemic hypotension, increased vascular permeability and compromised organ perfusion, bronchoconstriction, hypothermia, hemolysis (requiring blood transfusions), an increased basal metabolic rate (which can impede wound healing, increase infection risk and impede physical rehabilitation) and a reduced immune response.[66]

Burn Depth

Burn depth is subjectively determined based on the characteristics of the burn wound (See Table 5) and is key to informing the plan of care.

Table 5: Characteristics of Burn Types According to Depth

Classification	Depth of Injury	Appearance	Sensation	Most Common Cause of Injury
Superficial (first degree)	Epidermis	• Intact skin (red, shiny) • Blanchable erythema and mild edema • Brisk capillary refill • No blisters • May scar[60]	Tactile and pain sensation intact Pain ranging from itching to sharp[67]	• Scalds from spilled liquids (low viscosity) • Electrical flash • Sunburn
Superficial partial thickness (second degree)	Epidermis with partial-thickness loss of dermis Dermal appendages intact	• Blanchable erythema • Brisk capillary refill • Intact or ruptured thin-walled serum-filled blisters (blisters may increase in size) • If blisters ruptured, tissue is pink or red and moist • Mild to moderate edema[67]	Sharp pain. Potential residual sensitivity to sun, cold, friction, months after healing. Possible residual pruritus[67]	• Scalds from spilled liquids (low viscosity) or steam • Electrical flash • Brief exposure to flame • Brief contact with hot object • Sunburn

Deep partial thickness (deep second degree)	Epidermis with deep partial-thickness, loss of dermis Underlying structures are not exposed. Some dermal appendages intact	• Non-blanchable erythema • Sluggish capillary refill • Intact or ruptured thick-walled serum-filled blisters (blisters may increase in size) • If blisters ruptured, tissue is blotchy/mottled, cherry red/blanched white and dry (plaque like) • Will scar and may require surgery[60]	Deep pressure sensation intact Pinprick sensation absent Variable pain sensation	• Scalds from spilled liquids (low and high viscosity) or steam • Exposure to flame • Contact with hot object
Full-thickness (fourth degree)	Full- thickness skin/tissue loss Exposed or directly palpable underlying structures (muscles, fat, bones, tendons) Dermal appendages destroyed	• Non-blanchable • Tissue leathery, pale, mottled, red/ brown/ white in colour and dry • Eschar may be present • Thrombosed vessels visible (dry, carbonization, no blisters) • Involves deeper tissues, and frequently leads to loss of the burned part[60]	Insensitive to pain and pressure; pain may be present at the periphery, and absent at the level of the burn	• Prolonged liquid immersion scald • Prolonged contact with hot flame, hot objects, or chemicals • Electricity

Adapted from the Ross Tilley Burn Centre[57,60]

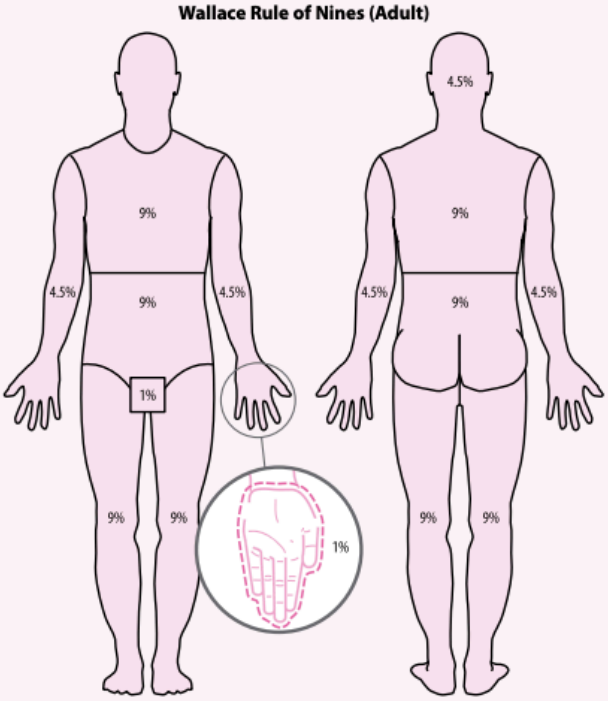
Assessment of burn depth can be precarious even for experts in the field. Given that burn experts are only 64–76% accurate in determining burn depth,[68] there has been a push to develop more objective methods to determine burn depth. Therefore, technologies have been and continue to be developed and utilized in this field.[69] These include biopsy and histology, thermography, photometry, pulse-echo and Doppler ultrasound, laser Doppler imaging, nuclear imaging, liquid crystal film, and use of radioactive isotopes and non-fluorescent and fluorescent dyes. Laser Doppler imaging (LDI) is the most accurate and validated technology in determining burn dept.[70,71] These methods, however, are either invasive, and/or require expensive equipment and/or access to expert technicians and are, therefore, limited to use on specialist burn units and in research.

Burns are dynamic: Burn depth may increase over time. Therefore, reassessment after 24–72 hours is important in establishing accurate burn depth.

Burn Size

In addition to accurate estimation of the burn depth, determining burn size (surface area) is essential to inform the plan of care. The total burn area is expressed as a percentage of the total body surface area (TBSA). The most common methods used to estimate the TBSA involved in a burn injury include palmar surface, the Lund and Browder chart, and the Wallace Rule of Nines (See Figure 5).

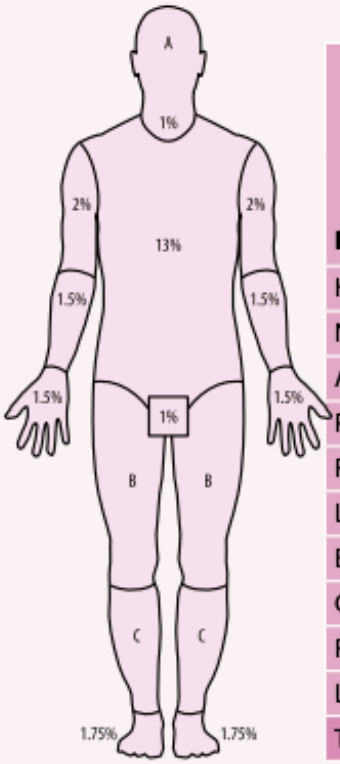
Figure 5: Common Methods to Estimate Burn Surface Area



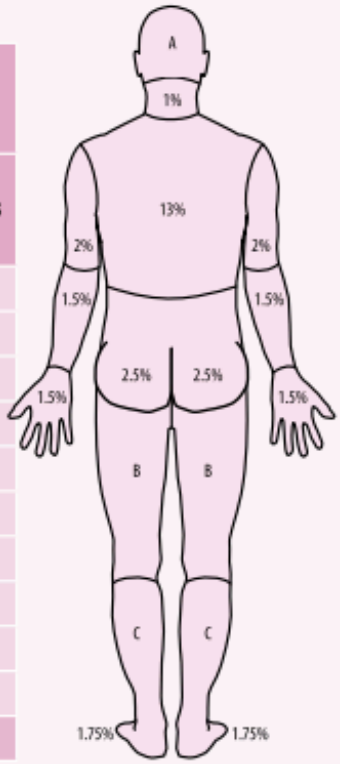
Palmar Surface: This is the simplest and quickest method that requires the least amount of training.[72] This method involves estimating the TBSA involved in a burn injury using the palm and fingers of the patient's hand as ruler. The patient's hand area (inclusive of the palm and fingers) represents approximately 1% of their TBSA. The palmar surface method is more accurate in estimating the size of small and large burns than it is for medium-sized burns.

Lund and Browder: The Lund and Browder chart, considered the gold standard due to its high validity and ease of comparison during subsequent treatment, is used across age groups, as it takes into consideration the variations in TBSA as a person grows. Modified versions are available for children under age 15 to correct for the smaller surface area of the lower extremities. Weaknesses of the Lund and Browder chart include difficulties in assessing lateral burns, the lack of anatomical landmarks for reference and the inability to accurately represent obese or female patients, which can make calculation of the TBSA in a burn injury more difficult and time consuming.[73,74]

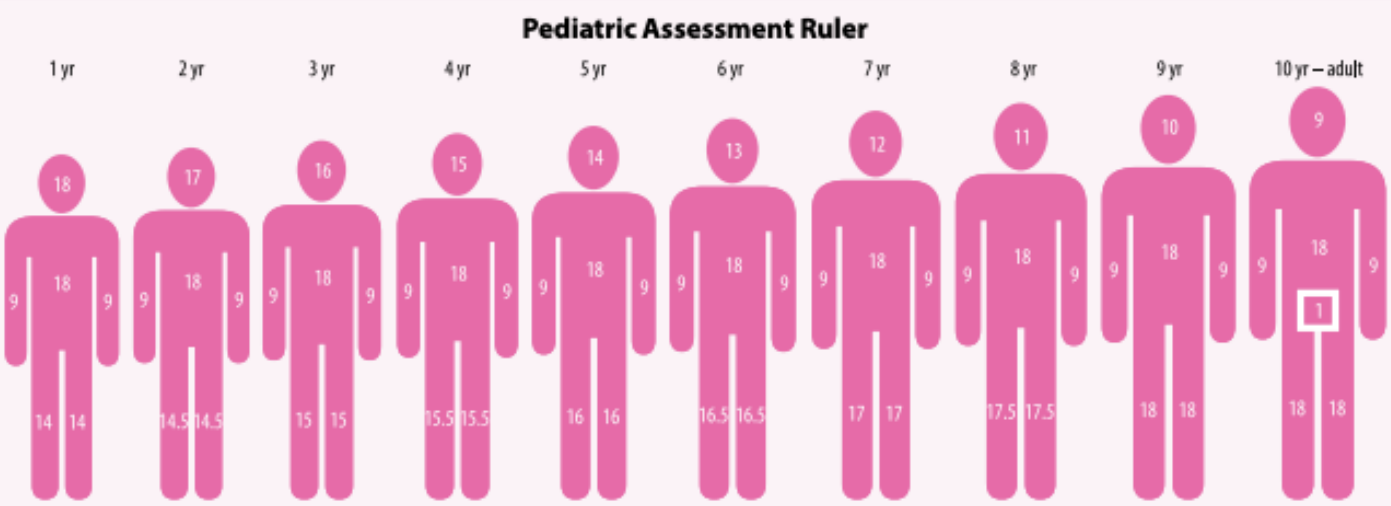
Lund and Browder Chart



Region	% of total body area surface burn	
	Partial Thickness Loss	Full Thickness Loss
Head		
Neck		
Ant. Trunk		
Post. Trunk		
Right Arm		
Left Arm		
Buttocks		
Genitalia		
Right Leg		
Left Leg		
Total Burn		



Area	Age					
	0	1	5	10	15	Adult
A = 1/2 of head	9.5	8.5	6.5	5.5	4.5	3.5
B = 1/2 of one thigh	2.75	3.25	4	4.5	4.5	4.75
C = 1/2 of one lower leg	2.5	2.5	2.75	3	3.25	3.5



Body surface area percentiles for each age group. Select the patient's age to determine the body surface area ratio for each body area to calculate the burn size.

Adapted from Victoria Burns Service www.vicburns.org.au.

Wallace Rule of Nines: The rule of nines is another means of estimating TBSA involved in a burn injury in adults. With this tool, the TBSA is divided into major anatomic regions divisible by nine (portrayed on a standardized chart). The TBSA is calculated by estimation using the chart. Pediatric versions of this tool for children under age 10 have been created to account for the variations in TBSA in childhood.[72,74] This tool has been shown to be a quick, simple, familiar and reasonably accurate method of assessing TBSA in burn injury.

Note: SUPERFICIAL (FIRST DEGREE) BURNS ARE NOT INCLUDED IN THE CALCULATION OF BURN SIZE (SURFACE AREA)

Like burn depth, assessment of burn size can be precarious for even the most skilled clinician. Given that burn size is only ever estimated correctly one third of the time,[75] there has been increased interest in developing technologies to improve accuracy. These include mobile software applications that use 1D, 2D or 3D modelling or imaging, and 3D scanners.

Severity of Burn Injury

Once burn depth and area have been estimated (and taking into consideration the cause of the burn, presence or absence of inhalation injury and comorbidities of the patient), the severity of the burn injury can be determined.

As with all wounds, burn injuries must be assessed for:

- Tissue types and amounts, e.g., epithelium, granulation, slough or eschar,
- Bacterial balance, e.g., localized, spreading or systemic infection,
- Exudate type and amount, e.g., none, scant, small, moderate, large, copious, colour, e.g., serous, serous-sanguineous, sanguineous, or purulent,
- The presence or absence of odour,
- The type of wound edge, e.g., attached, unattached, rolled and
- Periwound tissue appearance, e.g., intact, reddened, indurated, macerated, excoriated.

These considerations are elaborated on in Chapter 4: Best Practice Recommendations for the Prevention and Management of Wounds,[17] which also provides information on wound assessment tools.

American Burn Association's (ABA) Proposed Indicators for Sepsis in Burns[76]

The leading cause of death in burns is sepsis.[77,78] As major burns typically present with signs of systemic inflammation, diagnosing infection can be a challenge. The ABA suggests that if a patient with a burn injury presents with three or more of the following findings, sepsis should be suspected, and the underlying cause investigated and treated:

- Temperature >39° C or <36.5° C
- Progressive tachypnea (>25 breaths/min if not ventilated or >12 L/min if ventilated)
- Progressive tachycardia (>110 beats/min)
- Thrombocytopenia (<100 000/uL; applied only after day 3 post-resuscitation)
- Hyperglycemia (untreated glucose >200 mg/dL, >7 units/hour insulin infusion, or >25% increase in insulin dosing over 24 hours)
- Enteral feeding intolerance (abdominal distention, residuals over twice the feeding rate, or diarrhea >2500 mL/24 hours).

Step 2: Set Goals

Recommendations
2.1 Set goals to maintain skin health and for prevention and healing, non-healing and non-healable wounds

Discussion: Burn injury prevention should be considered a primary safety goal for all people and in all employment, home and social settings. The CHIRPP database revealed the populations at greatest risk for burn injuries in Canada (See Recommendation 1.2).[11]

Research has also shown that the social determinants of health impact one's risk of burn injury (See Recommendation 1.2.2). Despite knowing such information, ultimately all people are at risk for experiencing a burn injury in their lifetime. When related to health issues such as radiation therapy, preventative measures should be implemented. Knowing one's personalized risk factors can help to tailor prevention strategies.

The following are examples of community-based, provincial and national burn prevention programs and organizations which aim to identify risk factors, educate and heighten awareness of individual risk, and encourage people to practice strategies to decrease their level of burn injury risk:

Canadian Fire Safety Association: https://canadianfiresafety.com/
Public Services Health & Safety Association: https://www.pshsa.ca/
National Fire Protection Association: https://www.nfpa.org/
Canadian Burn Survivors Community: https://www.canadianburnsurvivors.ca/
Parachute Canada: https://parachute.ca/en/injury-topic/burns-and-scalds/
Workplace Safety and Prevention Services: https://www.wsps.ca/ and
WorkSafe (provinces and territories have their own sites).

2.1.1 Identify goals based on prevention or healabilty of wounds

Discussion: Where a burn injury has already occurred, goals must be set to reflect the overall healing ability of the wound (healing, non-healing or non-healable). This decision is made based on identified risk factors and a comprehensive patient, wound, environment and systems assessment. Goals must be developed according to the SMART principle,[79] in collaboration with the patient, family and or care partner, and adjusted accordingly, as goals can change over time, e.g., wound closure as evidenced by complete wound re-epithelialization and absence of drainage within 12 weeks.

Starting points for common goals related to the overall healing ability of burn injuries include:

- Prevent further progression of burn depth using cool water for for 20 minutes,[80] once the causal agent has been identified,
- Wound closure, stabilization or prevention of deterioration,
- Reduction in the amount of necrotic tissue,
- Reduced bacterial burden or prevention of increased bacterial burden,
- Establishment or maintenance of an appropriate amount of wound moisture,
- Decreased number of dressing changes,
- Prevention of scarring or improved scar quality,
- Limb preservation,
- Improved nutrition and hydration and
- Mental health and well-being, and spiritual care

2.1.2 Identify quality-of-life and symptom-control goals

Discussion: A comprehensive patient, wound, environment and systems assessment will also allow for the development of goals related to the impact of the burn injury on the patient's daily life. Such goals may include:

- Pain reduction and management,
- Reduction and management of wound-related itch,
- Maintaining or improving joint range of motion and function of the burn-injured area,
- Contracture reduction,
- Restoration of independence,
- Return to work, home, school or leisure activities,
- Reduced anxiety and/or psychological stress and
- Improved coping mechanisms and supported spirituality.

Step 3: Assemble the Team

Discussion: Prevention, assessment and management of burn injuries require an integrated team to optimize the patient's overall health and well-being. The team must work closely and collaboratively with the care partners and family to address the complex physical, emotional and social impacts of surviving a burn injury. All team members must work together to create and implement a sustainable plan of care based on the identified goals.

Recommendations
3.1 Identify appropriate health-care professionals and service providers

Discussion: Health-care professionals working with patients with burn injuries need to be trained to do so, through organizations such as the American Burn Association, which offers advanced burn life support education for providers.[81] Advanced Burn Life Support (ABLS) educational programs and conferences are available across Canada.[82] Caring for patients with burn injuries requires that clinicians have the knowledge, skills and judgement to assess the severity of the burn injury; achieve hemodynamic stability and end-organ perfusion; identify and treat inhalation injury; maintain thermoregulation; identify and manage compartment syndrome; recognize non-accidental injuries; provide physiologic support for all body systems; deploy therapeutic burn wound treatments; provide support and resources for the unique emotional, spiritual, cultural and social needs of burn patients, their family and care partners; develop individualized rehabilitation care plans to maximize return to function, and more, depending on their professional role.

Ideally the professional members of the team, except first responders, will be in one location, which is often the case with specialized burn centres in large urban areas. Outside of such centres, however, this may not be the case and will necessitate the establishment of a clear, comprehensive communication plan. For community, rural and remote care, burn assessments and reassessment may be completed via telemedicine or web-based platforms.[83]

In any case, effective communication among team members is essential for supporting the short- and long-term management of the patients' needs. Table 6 lists some of the potential interprofessional burn injury team members and their roles. The selection of team members is based on the comprehensive assessment of the patient with the burn, their wound, environment and systems and the established goals. Not every burn patient requires involvement of all team members listed. This is especially true of patients with minor burns that are treated on an outpatient/clinic basis. Other service providers on the team may include shoe fitters, meal delivery services, homemakers, garment fitters and transportation providers, among others.

Burn team members are a specialized community of practice. It is important to note that burn rehabilitation team members in acute and critical care are connected to community-based prevention strategies/programs, post-acute teams, ambulatory care, community clinics, rehabilitation and home care programs. Specifically, burn rehabilitation physiatrists may work with patients in critical care and continue to support them in settings such as inpatient rehabilitation, out-patient/clinics and community care.

Table 6: Team Members and their Roles in the Management of a Patient with a Burn Injury

Team Member	Roles
Anesthesiologist	• Optimize mechanical ventilation, fluid management and circulatory support • Assist with pain management
Nurse practitioner	• Assessment and treatment of burn • Assist with evaluation of care plan, pain and patient outcomes[84,85,86]

Burn nurse	• Co-ordinate inpatient care and patient discharge • Provide daily care, positioning, edema care and complete/assist with dressing changes • Manage fluid resuscitation • Administer medication and enteral nutrition, provide health teaching and monitoring • Provide palliative care • Deliver patient, care partner and family education
Burn surgeon	• Prescribe medications, order tests, provide referrals • Oversee medical management • Perform surgical intervention, grafts and flaps, amputations • Provide burn debridement and blister management
Critical care specialists and post-critical care physicians	• Provide care based on their specialty (e.g., nephrology, rehabilitation, orthopedics, emergency) according to the needs of the patient and the resources of the care centre.
Physiatrists (burn rehabilitation speciality)	• Focus on physical medicine and rehabilitation post-burn[87,88] • Support rehabilitation to reduce length of stay (acute) and readmission • Monitor rehabilitation progress and transitions of care: critical care, inpatient rehabilitation and home and community care
Physician assistants	• History taking, assessment/physical exam, treatment plans, education with patient and or care partners[84,89]
Emergency room clinician	• Initiate fluid resuscitation and treat burn shock • Assess and treat smoke inhalation, hypothermia and any other secondary injuries • Determine the burn severity and decide if the patient needs to be transferred to a specialized burn centre • Assess and manage pain
First responder	• Stop the burning process, and cool and cover the burn • Establish an airway and provide cervical spine control • Attempt resuscitation • Control hemorrhage and assess for and treat burn shock • Transport to hospital for assessment
Occupational therapist (OT)/ Occupational therapist assistant (OTA)	• Provide scar management • Prescribe adaptive devices and manufacture splints to prevent contractures • Perform activities of daily living assessment • Support vocational/employment goals and activities • Provide cognitive and psychosocial assessments, support and counselling with family members
Pharmacist	• Assist with management of pain, infection • Provide medication reconciliation, information, education or teaching, monitoring for medication interactions • Communicate with family members and provide education
Physiotherapist (PT) Physiotherapy assistant (PTA)	• Assess functional status and provide training • Prescribe and facilitate exercise and movement • Evaluate strength and administer treatment • Prescribe gait aides • Apply biophysical agents • Communicate with care partners and provide education
Registered dietitian	• Monitor dietary needs and provide nutritional recommendations • Provide nutritional education • Communicate with family members and provide education

Respiratory therapist	• Assess pulmonary mechanics • Enhance patient ventilation by assisting with airway management and diagnostic bronchoscopy, assess arterial blood gas, optimize mechanical ventilator settings and chest physiotherapy • Provide education
Counsellor, social worker psychologist, psychiatrist	• Address anxiety and or psychological stress • Contribute to understanding cause of burn (e.g., abuse, neglect) • Improve coping mechanisms • Support communication with team and care partners/family members • Assist with social and financial supports • Link to peer supports • Provide palliative support
Speech and language pathologist	• Assess and recommend strategies for improving swallowing and communication • Evaluate and treat microstomia • Assist with head/ neck burn scar management
Spiritual care professional	• Support and counsel those with slow-to-heal, non-healing and non-healable burn injuries • Support links to patients' spiritual, faith or religious community • Provide palliative support
Vocational/ Educational professional[60]	• Support return, adaptation to school, employment/work (paid, unpaid, volunteer), sport, activity • Collaborate with school teachers, counsellors, therapists to support educative and employment (role in society), leisure or sport • Coach and mentor • Peer support partners

3.2 Enlist the patient and their family and care partners as part of the team

Discussion: The success of a plan of care for the prevention and management of burn injuries relies on the collaboration of the person with the burn injury (or at risk), their support system(s) and communication among the team involved in the development of the plan of care.[90] For pediatric patients, parents or legal guardians need to be part of the care-planning team, and for those with cognitive impairment, the person(s) who has/have been assigned their Power of Attorney for Personal Care must be involved. To be effective team members, the person with the burn injury and their support system must have the motivation, capacity, ability and commitment to act, as well as the personal ability to interact effectively with each other.

Ideally, the patients with the burn injury and their care partners will be willing and able to work with the rest of the team to set goals and participate in the development, implementation and evaluation of the plan of care. Every attempt should be made to have meaningful and culturally and age-appropriate communication with the patient and family regarding interventions that will result in the best possible long-term outcomes.[91] Communication must consider the patient's literacy level, language ability, cultural background, and learning style and abilities.

To help ensure active participation, patients with burn injuries and their care partners and families should be offered timely, consistent information that is tailored to enhance self-care strategies and management practices and behaviours.

3.3 Ensure organizational and system support

Discussion: Successful burn injury programs are designed and evaluated in collaboration with clinical practice leaders, educators, researchers, policy makers and administrators at a local, regional, provincial, territorial and national level.[92] Organization and system support is required to ensure that patients receive a coordinated transition of care through community and health-care agencies. This level of collaboration and co-operation is essential as patient's have needs that will be ever changing, specifically as they gain community-level functioning, improved quality of life,[93,94] and return to work and engagement in life.[60]

Organizations must support the education of staff members so they may obtain and maintain the required knowledge and skills to be effective members of the burn care team. For OTs and PTs, core competencies (knowledge, skills, attitudes) have been developed to effectively care for the multiple complex issues related to burn injuries.[95,96] In 2017, the Burn Rehabilitation Therapists Competency Tool (Version 2), was expanded to include therapists in long-term rehabilitation and outpatient care.[97] Routine educational needs assessment should be undertaken to identify knowledge gaps in team members. Education should address the identified short and long-term gaps and be provided using the principles of adult learning.

Step 4: Establish and Implement a Plan of Care

Discussion: The development and implementation of a sustainable plan of care must be based on the identified goals and be collaboratively created with the patient, their family and care partners, and relevant health-care team members.

Recommendations

4.1 Identify and implement an evidence-informed plan to support healthy skin, to correct the causes or co-factors that affect skin integrity, including patient needs (physical, emotional and social), the wound (if applicable) and environmental/system challenges

Discussion: Prevention of burns occurs through public awareness programs and education initiatives. Prevention includes recognition of at risk homes, schools and workplaces and in the community. Each province, territory or First Nation offers programs throughout the year.[4,10]

The management of patients with burn injuries may require only pre-hospital care; however, it may include transportation to the closest emergency department for assessment based on the Advanced Trauma Life Support and Advanced Burn Life Support[98] guidelines, as well as the following:

- Discharge to outpatient/community-based services for treatment for minor (non-complex) burns,
- Admission to hospital for care of moderate burns and
- Transfer to a specialized burn centre for treatment of major (complex) burns.[98]

The decision to transfer to a specialized burn centre is made by the physician and team (See Table 7). This requires, in part, consideration of the updated American Burn Association (2022) Burn Patient Referral criteria: https://ameriburn.org/aba-releases-new-guidelines-for-burn-patient-referral/

Table 7: Criteria for Transfer to a Burn Unit[98]

	Immediate Consultation with Consideration for Transfer	Consultation Recommendation
Thermal burns	• Full-thickness burns • Partial thickness ≥ 10% TBSA • Any deep partial- or full-thickness burns involving the face, hands, genitalia, feet, perineum or over any joints • Patients with burns and other comorbidities • Patients with concomitant traumatic injuries • Poorly controlled pain	• Partial-thickness burns <10% TBSA • All potentially deep burns of any size
Inhalation injury	• All patient with suspected inhalation injury	• Patient with signs of potential inhalation such as facial flash burns, singed facial hairs or smoke exposure
Pediatrics (less than or equal to 14 years or <30 kg)	• All pediatric burns may benefit from burn centre referral due to pain, dressing change needs, rehabilitation, patient/caregiver needs or non-accidental trauma	

Chemical injuries	• All chemical injuries	
Electrical injuries	• All high-voltage (≥1,000 volts) electrical injuries • Lightning injury	• Low-voltage (<1,000 volts) electrical injuries should receive consultation and consideration for follow-up in a burn centre to screen for delayed symptom onset and vision problems

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Management – Primary Survey: After ensuring personal safety, it is critical to remove the source of the burn injury. This means removing the heat source for patients who have experienced a thermal injury, turning off the electricity supply for those with electrical burns, brushing off dry chemicals or diluting liquid chemicals (*depending on the chemical)* with water for those who have experienced chemical burns, or removing the patient from the source of radiation for those with radiation burns. In conjunction with the treatment of life-threatening injuries, most burn wounds need to be cooled.

Thermal burns should be cooled with clean, tepid running water or wet towels and compresses to stop the burning process, limit tissue damage, minimize swelling, cleanse the wound and aid in pain control. Very cold water and ice should not be used to cool burn injuries, as these can cause local vasoconstriction, which can increase tissue damage and may contribute to hypothermia.

For freezing injuries, moist rewarming, possible thrombolysis and watchful waiting[60] are recommended. Organizations should have frostbite protocols in place for providers and regular education should be available.

- Once the initial treatment phase has passed in severely affected or symptomatic individuals or those at risk for re-injury, consider an assessment of quantitative peripheral sensory testing, using a tool such as Semmes-Weinstein monofilament.
- Freezing injuries, like other cold injuries, should be treated as an acute traumatic injury.
- Rewarm actively and rapidly in a water bath (40–42°C).
- Passive rewarming is only acceptable when the first option is unavailable.
- Have the patient avoid nicotine or other vasoconstrictors during the period of rewarming.
- Provide thrombolytic therapy to identified candidate patients but only in an appropriate medical setting.
- Debride necrotic tissue, if necessary, at a later stage and only after completion of the rewarming cycle.
- Provide supportive care of post-injury nerve and skin damage.
- Educate patients to prevent repeat injury.[32,99]

Chemical burns require copious irrigation with tepid water or an appropriate antidote to remove the corrosive agent and stop the burning process. This irrigation process may be lengthy, e.g., 15–120 minutes, and should continue until the patient stops complaining of discomfort and the tissue pH normalizes. Electrical burns should not be irrigated.[100]

Rogers et al. (2022) also remind health-care providers involved in burn care, their patients, care partners and family members, about the importance of adopting the Choosing Wisely recommendations regarding the overuse of unnecessary procedures and investigations.[101]

Eleven recommendations were developed to reduce the costs and adverse effects of "unnecessary therapeutic and diagnostic procedures, while still maintaining high standards of evidence-based burn care."[101] For more on the recommendations, please visit Choosing Wisely Canada: https://choosingwiselycanada.org/recommendation/burns/

All individuals with burn injuries who require a health professional's care should then be treated using the ABCDEF mnemonic, listed below in the order of priority, to treat any life-threatening injuries.

The ACBDEF mnemonic includes:

Airway: If the patient has an airway obstruction or an injury that is physically restricting breathing, attain and maintain a patent airway. Depending on the type and severity of injury, this may require administration of beta agonists to prevent or treat bronchospasm, intubation, tracheostomy and/or an escharotomy for deep dermal or full-thickness circumferential neck and/or chest burns. This step also includes the provision of cervical spine control prior to transport to hospital (especially in instances of high-voltage electrical burns or falls), unless spinal injury is not suspected.

- In a recent review, researchers noted that, "unnecessary endotracheal intubation was performed in 28% to 53% of transfers."[102]

Breathing: If the patient is not breathing, immediately initiate cardiopulmonary resuscitation (CPR). In addition, treat any conditions impeding ventilation, such as hemothorax, pneumothorax, flail chest, smoke inhalation, carbon monoxide poisoning and cyanide toxicity. Depending on the type and severity of injury, interventions may include needle aspiration or chest tube insertion to treat hemothorax or pneumothorax, mechanical ventilation for flail chest, mechanical ventilation and aggressive pulmonary toilet to manage inhalation injury.[101] "Do not recommend the administration of hydroxycobalamin (Vitamin B-12A or 'cyanokit') to patients prior to assessment in the burn centre, unless the history and investigations strongly support its use."[101]

- Position the patient in a semi-Fowler's or Fowler's position to decrease facial/airway edema. Reassess respiratory status at regular intervals.

Note: All patients with burn injuries should be administered 100% oxygen through a humidified non-rebreathing mask on presentation; 100% F_iO_2 should be administered until normal blood carboxyhemoglobin level return, monitored by blood gasses for high-risk cases.

Circulation: If the patient is bleeding or has hypovolemia or burn shock, treat accordingly. Depending on the type and severity of injury, interventions may include:

- immobilization,
- the application of pressure dressings or tourniquets and surgical interventions to stop bleeding,
- intravenous access with two large bore cannulas (preferably placed through unburned tissue) and fluid resuscitation for patients who have a burn injury of >20% TBSA (some sources reference >10% in children and adults greater than 50 or 60 years of age),
- the insertion of a Foley catheter (to monitor urine output) to treat hypovolemia and burn shock,
- use of vasopressors/ inotropes and thermoregulation to treat shock and
- hydrocortisone to treat adrenal insufficiency (secondary to refractory shock). Expected urine output is 0.5ml/ kilogram (kg) per hour for adults and 1ml/kg/hour for children.[103]

Rogers et al. (2022) state: "do not transfuse red blood cells to patients with burn injuries who have haemoglobin levels greater than 70 g/l, unless active haemorrhage or myocardial ischaemia is present."[101]

Disability: If the patient presents with an altered level of consciousness, it is imperative to treat the underlying cause, e.g., hypoxia secondary to carboxyhemoglobin level or hypovolemia.

Exposure: Removing clothing and jewellery from the area of a burn injury or close to, and/or distal to a burn injury allows for accurate determination of the area of burn injury and prevention of the 'tourniquet-like' effect of constricting items left in place when the resulting tissue edema increases. Clothing that has stuck to the burn injury must carefully be removed by soaking the material off. Patients should be covered and warmed as soon as possible to prevent hypothermia, as this can lead to hypoperfusion and deepening of the burn wounds.

Fluid resuscitation: For patients with major (complex) burns (e.g., adults TBSA greater than 20%; children under 10 years and adults over 50 years, with TBSA greater than 10%), fluid resuscitation is key to combating the profound loss of intravascular fluid into the interstitial space, which can lead to organ dysfunction and death, and should be initiated as soon as possible after injury (ideally pre-hospitalization). Several fluid formulas and protocols have been proposed for resuscitation, each requiring crystalloid infusion with or without the addition of colloids. It is important to note that there is no absolute consensus on fluid type or fluid formulas.

Fluid formulas are guidelines, and the calculation needs to include the patient's mental status, level of consciousness, vital signs (heart rate, blood pressure, pulse pressure, distal pulses, capillary refill) turgor of injured skin, blood gasses and urine output. Lactated Ringer's or other balanced salt solutions will be used. It is important to monitor fluid status continuously. Fluid resuscitation should be guided by physiological parameters and laboratory findings to prevent under- or over-resuscitation. The goal of resuscitation is restoration of intravascular volume and maintenance of organ perfusion and function while preventing burn wound conversion. "Burn conversion refers to the phenomena whereby superficial burns that appear to retain the ability to spontaneously heal, convert to deep wounds in need of excision."[104]

Traditionally, the endpoints of resuscitation of a thermally injured patient have been determined via physiological parameters, but the use of global end organ functions such as urinary output, heart rate and blood pressure is inadequate in determining the adequacy of resuscitation.[105] While the addition of measurements of base deficit and lactate have become commonplace as markers of adequate resuscitation, it is difficult to ascertain their importance as markers of burn resuscitation, as there are multiple episodes of ischemia and reperfusion injury with fluctuation in serum lactate and base deficit level.[106] In some studies, it appears that elevated lactate and base deficit levels on admission do correlate with overall organ dysfunction and mortality. However, there is no absolute number or threshold that determines non-survivability.[107-109]

Moreover, further studies have concluded that elevated lactate levels are an independent risk factor for mortality.[110] Since there is no ideal method at this juncture for determining the endpoints of resuscitation, some researchers have begun to adopt new techniques. Light et al. demonstrated the use of tissue pCO_2 monitoring to better correlate with tissue perfusion; however, its use is not yet commonplace.[106] Clinical assessment is outdated, the use of resuscitation markers is flawed, but there is some correlation with overall risk of organ dysfunction and mortality. Newer techniques are under examination but have not gained broad acceptance for use. Until a widely accepted method has been validated, care must be taken and as many tools as possible used to determine adequate resuscitation.

Management– Secondary Survey: The secondary survey should commence to diagnose any other injuries from head to toe, including the depth and extent of burn injuries. Once this thorough survey has been performed, appropriate and targeted treatment and management can begin.

This includes correcting any modifiable comorbidities assessed during the detailed patient history that may negatively impact wound healing and general burn injury recovery. In addition, depending on the severity of the burn injury, interventions may need to be put into place to address specific related issues such as upper gastrointestinal erosions and ulcers, such as Curling's ulcer (e.g., through the use of proton pump inhibitors and H2-receptor antagonists), and acute renal failure (e.g., adequate fluid resuscitation), treatment of any infections and, in severe situations, renal replacement therapy, sepsis (e.g., appropriate systemic treatment of burn wound infections and other infections that may be present or occur, like pneumonia; antibiotic prophylaxis is not advised), venous thromboembolism (e.g., prophylactic treatment), microangiopathic hemolytic anemia, bone fractures, spinal cord injury, peripheral nerve injury, neurophysical complications, amputation and/or visceral injuries.[111]

In addition, a fasciotomy may be required to treat compartment syndrome affecting a limb. Abdominal compartment syndrome may require mechanical ventilation, vasopressors, dialysis and surgery such as escharotomy and/or laboratory tests.

A Word on Escharotomies:[112-115]

All deep circumferential burns to the extremities have the potential to cause neurovascular compromise and therefore benefit from escharotomies. Early assessment and, "recognition of the need for escharotomy and other decompressive therapies is imperative for experienced burn providers, as to avoid reversible tissue ischemia and necrosis."[116] The typical clinical signs of impaired perfusion in the burned extremity/hand include cool temperature, decreased or absent capillary refill and tense compartments with the hand held in the claw position. The absence of pulses is a late sign. On occasion, non-circumferential deep burns or circumferential partial-thickness burns might require a prophylactic escharotomy as the patient might need large resuscitation volumes due to overall injury or the inability to perform serial reassessments. Escharotomies of the extremities are performed along the medial and lateral lines, with the extremity held in the anatomic position. For the hand, the escharotomy is performed along the 2nd and 4th metacarpals, and for the fingers care is taken to prevent any neurovascular damage. Therefore, escharotomies are typically not performed along the ulnar aspect of the thumb, the radial aspect of the index finger or ulnar border of the small finger.

Pain management: The intensity and impact of pain on a person's quality of life, including their emotional, physical, psychological well being, must be taken into consideration when creating a personalized plan of care. Patient's perception of pain is individual and varies throughout the healing process.[117] Pain management is a challenge and a foundation of care from the time of injury, through acute, rehabilitation and community care. Table 8 summarizes some common pain management strategies used in Denmark, Sweden, New Zealand and the United States, based on a review of four clinical guidelines.[118]

Table 8: Management of Burn Pain

Cause of Pain	Management Strategies
Background pain	Acetaminophen, non-steroid anti-inflammatory drugs (NSAIDs), opioids
Procedural pain	Opioids, transmucosal fentanyl, anxiolytics and general anesthesia for initial wound care Ketamine and potentially inhaled nitrous oxide
Post-operative pain	Acetaminophen, non-steroid anti-inflammatory drugs (NSAIDs), opioids, nitrous oxide, ketamine, transmucosal fentanyl, peripheral blocks, patient-controlled analgesia
Neuropathic pain	Nortriptyline, gabapentinoids

Non-pharmacological interventions include the development of coping skills via referrals to psychology, therapeutic touch, cognitive enhancement, hypnotherapy, visualization and virtual reality. Massage and distraction may also be of benefit.[119-121] In children (0.5 to 19 years) pain intensity has been shown to have been reduced with non-pharmacologic interventions (e.g., aromatherapy, music therapy, hypnosis, and auditory and visual stimulation).[122]

Regarding the management of neuropathic pain post burn injury, a systematic review suggested that pregabalin has been demonstrated to be effective, whereas gabapentin has not. The review further stated that the use of tricyclic antidepressants and anticonvulsants, which are common in treating neuropathies of other origins, have not been systematically investigated in the burn population.[123] Additionally, pregabalin (and gabapentin) are effective in relieving pruritus associated with burn injuries.[124]

A structured approach to pain management, such as the World Health Organization's Pain Relief Ladder, should be considered (in addition to non-pharmacological methods of pain control) when developing an individualized pain management plan.[125]

Quality of life (QoL): Once psychosocial issues, such as anxiety, depression and post-traumatic stress disorder, are identified, appropriate interventions, referrals and education need to be provided. Treatment and intervention options may include: coping self-efficacy,[29] cognitive behavioural therapy and medications to treat anxiety and depression.

Greenhalgh states that faces are a part of the body that cannot be hidden; therefore strategies must reduce scarring and optimize healing.[126] Peer support is critical to recovery; support groups include the:

- Canadian Burn Survivors Community www.canadianburnsurvivors.ca,
- Camp Bucko www.campbucko.ca,
- Saskatchewan Burn Support Network https://www.canadianburnsurvivors.ca/saskatchewan-burn-support-network,
- Camp Phoenix https://www.burnedchildrenrecovery.org/camp-phoenix
- Entraide Grands Brûlés https://www.entraidegb.org/ and
- Life After Burns (virtual peer support group) https://www.lifeafterburns.ca/peer-support-groups.

Nutrition: Metabolic and nutritional management play a vital role in the management of burn injuries.[127,128,129] Proportionate to the severity of the injury, patients with major burn injuries often experience oxidative stress, intense inflammatory response, and a long hypermetabolic and catabolic response.[60] A burn >40% TBSA is considered a severe burn.[129]

Nutritional requirements must be assessed regularly, individualized and continually modified throughout care in partnership with the registered dietitian, taking into consideration cultural perspectives and patient preferences. Individuals who are malnourished, underweight and/or older adults are at greater risk of delayed wound healing and require long-term monitoring of nutritional status, often up to several years.[130]

For persons not intubated, a regular non-restricted diet is recommended.[131] For those who are not able to meet their nutritional requirements with volitional oral intake (e.g., intubated, altered level of consciousness, poor appetite), nutrition support should be initiated early, preferably by the enteral route.[129,132] Nutrition should be started as early as possible (four to six hours) after burn injury, ideally within 24 hours of injury and, at most, 48 hours after injury.[129,133,134] Enteral nutrition solutions should be polymeric and high nitrogen.[132,135]

Energy: Calorie requirements increase as the size of the burn increases.[129] As patients with major burns have significantly higher energy needs, indirect calorimetry (IC) should be used to assess for energy requirements.[129,132,134] When possible, resting energy expenditure should be measured using IC within a week of admission to hospital.[136] If IC is not available or suitable, the Xie, Zawacki, or Milner equations should be employed for adult burn patients.[137,138] For children, the Schofield or Galveston equation for children are appropriate.[135,139] (See Table 9 and Table 10).

Table 9: Mathematical Calculation to Estimate Energy Needs after Burns

Zawacki	1440 kcal/m2/day
Xie	(100 kcal/m2/day) plus (25 x BSAB)
Harris Benedict (BEE)	Men: [66.47 + (13.75 x W) + (5 x H) – (6.76 x A)] x AF x IF Women: [655.1 + (9.56 x W) + (1.85 x H) – (4.68 x A)] x AF x IF AF: Bed Rest 1.2, Ambulatory 1.3, Sepsis 1.5 IF: Minor surgery 1.2, Skeletal Trauma 1.35, Severe Burns 2.1
Calories per Kilogram	Non-obese population: 25-35 kcal/kg body weight
	Obese, critically ill population: 21 kcal/kg body weight
Curreri	(25x W) + (40 x % TBSA burn)

Key:
BSA = body surface area in m^2 = [ht (cm) + wt (kg) – 60]/100
BSAB = % body surface area burn; W = weight in kilograms
H = height in centimeters; A = age in years ; AF = activity factor
IF = injury factor; TBSA = total body surface area burned

Body Surface Area (BSA) method – m^2 x 1600 ml = maintenance fluid requirement

Table 10: Common Formulas Used to Estimate Calorie Needs in Burnt Children[139]

Formula	Calories per day
Curreri junior (year): Commonly overestimates caloric needs	
Less than 1 year	Basal requirement + 15 kcal% TBSA
1 to 3	Basal requirement + 25 kcal% TBSA
4-15	Basal requirement + 40 kcal% TBSA
Galveston: Focuses on maintaining body weight	
Less than 1 year	2,100 kcal/m2 BSA + 1,000 kcal/m2 TBSA
1-11	1,800 kcal/m2 BSA + 1,300 kcal/m2 TBSA
≥ 12	1,500 kcal/m2 BSA + 1,500 kcal/m2 TBSA
WHO	
Male (year)	
0-3	(60.9 x weight in kg) - 54
3-10	(22.7 x weight in kg) + 495
10-18	(17.5 x weight in kg) + 651
Female (year)	
0-3	(60.0 x weight in kg) - 51
3-10	(22.5 x weight in kg) + 499
10-18	(12.2 x weight in kg) + 746
Mayes	
Male (year)	
3-10	(19.6 x weight in kg) + 1.033 x height in cm) + 414.9
10-18	(19.25 x weight in kg) + 1.372 x height in cm) + 515.5
Female (year)	
3-10	(19.97 x weight in kg) + 1.618 x height in cm) + 371.2
10-18	(8.365 x weight in kg) + 4.65 x height in cm) + 200
TBSA, total burned surface area; BSA, body surface area	

Protein: Increased protein turnover is common post major burn injury and can contribute to the loss of lean body mass.[60] Adults and children should be assessed for optimal amount of protein based on current recommendations.[129,140] Hampton et al. state more research is needed to determine optimal protein intakes to improve clinical outcomes and nutritional status for patients with burns.[131] Glutamine supplementation should also be considered,[132] with the exception of patients with multi-organ failure.[141]

Carbohydrates: Hyperglycemia and insulin resistance are not uncommon post major burn injury. Interventions should aim for moderate glycemic control based on current guidelines and status of the patient.[132,142]

Lipids: Fats are required to prevent essential fatty acid deficiency. Total fat delivery should be monitored, and energy from fat should be less than 30% of the total energy intake[129] for adults and 35% for children.[139] More research is needed on the role of omega-3 fatty acids (fish oils) for burn patients.[143]

Fluids: Fluid intake supports skin turgor and promotes tissue oxygenation/perfusion. Daily intake is determined in consultation with the team and burn healing state.

Micronutrients: Supplementation of zinc, copper and selenium (which enhance the immune defence and wound healing) and vitamins B1 (normalizes lactate and pyruvate metabolism), A (wound healing, immunity, epithelial cell differentiation), C and E (reduce oxidative stress and enhances wound healing), and D (prevents post-discharge fracture and osteoporosis) are suggested.[132,135]

Non-nutritional strategies: Non-nutritional strategies should be considered to address hypermetabolism and hypercatabolism, including maintenance of a warm room temperature (28–30 degrees celsius), early excision and surgical coverage of wounds and administration of medications that stimulate protein synthesis (e.g., non-selective beta-blockers). In addition, administration of recombinant human growth hormone (rhGH) to children with burns with TBSA greater than 60% should also be considered to prevent growth deficit, reduce hypermetabolism and enhance wound healing.

Rehabilitation: Therapeutic exercise-based interventions for burn survivors should be goal-oriented and include care partners and family in partnership with the team.[144] Activities should be directed at promoting mobilization, maintaining or improving function and strength and elongating scar tissue. Rehabilitative exercise, therefore, should include stretching, strengthening, cardiovascular training and functional activities.[145,146] Stretching can include passive activities, such as splinting (single or multiple joints) along with gentle sustained single joint stretches. These activities should continue until full range of motion (ROM) is achieved. Progression to active-assisted and active exercises is desirable to maintain ROM and prevent contraction of scar tissue. The burn therapist, PT or clinical exercise physiologists can use their clinical judgement along with consultation from the burn surgeon/ physiatrist as to when ROM and mobilization activities can begin. These should be done as early as possible after the burn injury and incorporate normal movement patterns that are tailored to the individual and continue long-term.[147,148]

Strengthening activities, including resistance training, are recommended after burn injury. Procter and colleagues suggest that the stress response in severely burned individuals includes hypermetabolism, muscle wasting and insulin resistance, which result in significant cachexia that can last for several years post burn.[147] They did show a benefit to children participating in a 12-week strengthening regimen instituted six months after a burn injury. Gittings et al. (2017) performed a systematic review and meta-analysis of resistance training (RT) for adults post burn injury and concluded that low-quality evidence is suggestive of some positive effects on muscle strength and psychological well-being after burn injury.[150] They recommend more research more research is needed in this area. Practice recommendations concluded that:

- "Burn survivors' strength and cardiovascular endurance should be evaluated in individuals seven years of age and older. Those who test below normal levels should be prescribed a supervised resistance and/or aerobic exercise program."
- "Exercise programs may begin as early as post discharge from acute care and as late as 14 years after burn."
- "Exercise programs should last six to 12 weeks for adults and up to 12 weeks for children".[151,152]

Palackic et al. recommend rehabilitation exercise training (RET) be established as part of care several years post burn injury. The RET approach, "is a proven effective treatment to restore lean body mass, glucose and protein metabolism, cardiorespiratory fitness, and muscle strength in burn survivors".[153]

Cardiovascular conditioning post burn injury has also been recommended.[149] Severe burn injuries are often associated with inhalation injuries, especially if the patient was involved in a flame-related burn. Thus, damage to the pulmonary system is often a component of a major burn injury and can be long-lasting, depending on the severity. Therefore, aerobic conditioning should be considered in rehabilitation after burn injury. In a study of pediatric patients with severe burns, Suman and colleagues found that a 12-week regimen of both aerobic and resistance training improved peak oxygen uptake in this population.[154]

Focused pulmonary rehabilitation should also be considered. Won et al. (2020) completed a prospective randomized single-blind study (n=120) and reported that patients with major burns and smoke inhalation benefited from focused pulmonary rehabilitation.[155] A literature review by Barnat and Mysliwiec explored physiotherapeutic methods used in the rehabilitation of children post burns (46 studies). They state scar massage and myofascial manual lymphatic drainage improves scar quality; scar cosmesis is improved with physical interventions based on exposure to light; splints prevent contractures; aerobic and resistance exercises strengthen muscles and improve pre-burn fitness levels; yoga and virtual reality support exercise; and neither music or hypnosis are confirmed to reduce pain (more research is needed).[156]

With all these exercise activities, patients should have or be directed toward some functional activity or goal. The burn therapist should consult with the rest of the integrated team to help confirm activities and identify new goals with function in mind. The OT may also help to identify activities of daily living that require specific strength or cardiovascular training to improve. Serghiou et al. suggest that a pre-exercise evaluation be undertaken to identify any underlying medical conditions, as well as any interests or goals the individual may have.[145] This will help the burn therapist to formulate a program that is challenging, fun, safe and effective, and meaningful to the patient's goals.

Return to Work (RTW). Rehabilitation also includes the patient's return or reintegration to school, family and social activities and work. Mason et al. stated that approximately 28% of patients with burns never return to any form of employment.[157] An individual's RTW can be challenging for complex reasons and may take longer than initial estimates.[158] As well, patients may return to paid or unpaid roles depending on the community in which they live.[60] Katsu and colleagues conducted a review n=6 studies focused on adult participation in return to employment. Limited information is available on the experience of adults with burn injuries, many of whom must overcome physical, psychological, social, economic and environmental barriers. The findings discuss patients consistently overcoming barriers, new or renewed vocational/ occupational/volunteer goals, knowledge and skill of health-care providers across the spectrum of care (acute to rehabilitation) and support from family, friends, and communities.[159] Finally, Van Bentum et al. state team members should address the burn complexity and its impact on the patient's present employment/role in society, and the need to identify the importance of trusted, personal supports. Meaningful activity other than paid employment must also be considered. The importance of long-term support, psychological support and social support are key to improving outcomes. More research is recommended.[160]

Positioning and splinting of the burn patient becomes increasingly important as the TBSA increases. Larger TBSA burns will require specialized sleep surfaces (pressure redistribution) along with positioning devices within the patient's bed environment. Minor burn injuries may simply require a supportive splint for the affected area. Splinting and positioning should be designed to:[145]

- Allow for edema reduction,
- Maintain joint alignment,
- Maintain tissue elongation,
- Promote wound healing,
- Relieve pressure points,
- Protect operative sites (new skin flaps or grafts),
- Assist in functional activity,
- Be pain free,
- Be lightweight (breathable, manage moisture) and
- Be easy to don and doff.[152]

Serghiou et al. in the *Clinical Practice Recommendations for Positioning of the Burn Patient,* provides detailed information on this subject.[152] Splinting and positioning are typically within the scope of practice of the OT, but strong communication with the rest of the team members will help patients and staff adhere to the plan of care and achieve optimal results. The OT will be able to provide specific positions for each area of the body to help prevent contracture. The PT may be required to apply compression wraps to assist in ambulation after skin grafting to the lower extremity (after a vascular assessment to rule out arterial insufficiency). Serial casting, skeletal traction and even amputation may be required in severe burn injuries.[161]

Orthoses

Orthoses are rigid or semi-rigid devices that play a significant role in burn rehabilitation alongside a prosthetist or orthotist. Parry et al. evaluated the evidence for the use of orthoses with persons who have burns. They recommended that ready-made or customized orthotic devices, such as casts, masks or positioning devices be considered to improve range of motion, protect against injury, reduce contractures and assist function as well as promote healing in adults with a burn injury[162] (See Table 11 for more on orthotic devices).

Table 11	Orthosis Types
Static orthosis	An orthosis that immobilizes joint(s) or tissue(s) surrounding a joint or articulating surfaces and is designed to maintain tissue length, rest injured or inflamed tissue, stabilize injured structures, promote healing, improve function, correct joint instability, prevent deformity and/or enhance joint alignment
Serial-static orthosis	An orthosis that immobilizes joint(s) or tissue(s) at maximal length to increase range of motion and/or tissue elongation and is designed to be modified or remolded serially to accommodate tissue changes for correction of a contracture
Static progressive orthosis	An orthosis that mobilizes joint(s) or tissue(s) in an elongated position utilizing adjustable, non-elastic components to apply low load and prolonged forces to mitigate or correct contracture
Dynamic orthosis	An orthosis that uses energy-storing components to provide controlled mobilization forces in one direction while permitting active motion in the opposite direction to correct contracture, promote tissue elongation, provide support to tissue or assist with weak motor function

Scar Prevention and Management

Cutaneous scar management and prevention of hypertrophic scar and keloid development are important components of burn care. Scars develop in approximately 70% of patients with burns, within four to eight weeks after injury. They mature and gradually flatten over two years. Keloids develop months and years after the injury and may spread beyond the wound edges.[130]

Burn scar contractures are a condition caused by, "the replacement of skin with pathological scar tissue of insufficient extensibility and length resulting in a loss of motion or tissue alignment of an associated joint or anatomical structure."[162] Scarring may contribute to social and emotional issues, physical limitations, neuropathic pain, irregular skin surfaces, stiffness and contractures that can be debilitating.[130] Approaches, or combinations of non-surgical treatments, include compression therapy, laser therapy, steroid injections, each with benefits and limitations.[130] Examples of therapy approaches include:

- **laser therapy:** increased pliability of scar, reduced scar height, reduced pain and improved colour and texture (e.g., pulsed dye lasers, carbon dioxide laser);
- **compression therapy:** reduced blood flow and effect on collagen remodelling, which may lead to smaller scars;
- **scar massage**: uses compressed air: focused on reducing pain and itching;
- **pressure garments therapy**: use of compression, custom fabricated garments reduce blood flow and effect on collagen remodelling, which may lead to smaller scars.[30] Includes wearing garments for up to 23 hours a day. Garments are produced from elasticized fabrics; the amount of pressure applied (5-40 mmHg) varies and is individualized based on needs[83,163] and
- **injection of fat**: reduces scar height, increases scar flexibility, improves wound closure.

More research is recommended for each.

Research on management of novel approaches to scar tissue is underway in Canada. Amini-Nik et al. focus on scar treatments that aim to improve patient-centred outcomes and quality of life. For example, new therapies are focused on, "drug delivery that targets the molecular cascades of wound healing to attenuate or prevent hypertrophic scarring is a promising approach."[130]

4.2 Optimize the local wound environment

Discussion: Local wound management strategies should be part of the plan of care and fit within the context of the overall healability of the burn injury. To optimize the local wound environment, clinicians must consider wound cleansing and debridement, management of bacterial burden and moisture control.

4.2.1 Cleansing

Discussion: To aid in minimizing the bacterial burden of a burn injury, wound cleansing is required to flush away surface microbes and foreign bodies, soluble debris and non-viable tissue. The challenge is in selecting the appropriate type of solution and application method. Cleansing solutions commonly used in wound management include sterile normal saline, sterile water, potable tap water, commercial wound cleansers and liquid antiseptics.[17] Such cleansing solutions may be appropriate in the management of burn injuries depending on the goals of care.

Expert opinion recommends that sterile solutions be used for acute burn injury management and in situations where underlying structures are exposed, to cleanse tunnels or sinuses, where the patient is immune-compromised or is suffering from a current wound infection (or has a history of recurrent wound infections), or in situations where potable tap water is inaccessible or the environment in which the wound is being cleansed is less than hygienic.

The Wounds Canada Skin and Wound Clean-up Product Picker: https://www.woundscanada.ca/dhfy-doc-man/public/health-care-professional/1307-product-picker-skin-and-wound-clean-ip/file is a useful tool to help clinicians choose the most appropriate type of wound cleanser. Regardless of the type of cleanser chosen, solutions should be applied in copious amounts at body temperature. Regarding the application method, safe irrigation (4–15 psi) is preferred to help flush away surface microbes, foreign bodies, soluble debris and non- viable tissue.

Chemical Burns of the Eye: Chemical burns to the eye require copious flushing and an ophthalmology consult upon arrival at the hospital. Late complications such as corneal ulceration, secondary glaucoma and cataracts are common and require follow-up. A Morgan Lens is used for emergency hand-free ocular irrigation and for multiple uses (e.g., acid burns [solvents, gasoline, detergent], alkali burns, non-embedded foreign bodies, foreign body sensation with no visible body, eyelid surgery and severe infection). Instructions for use are available at https://www.morganlens.com/media/1202/mortan_lens_instructions-2019v3.pdf.

4.2.2 Debriding

Discussion: Debridement serves to remove microbes, foreign bodies, debris and non-viable tissue from a wound to promote wound closure. As with wound cleansing, the appropriate method of debridement should be determined based on the needs of the patient and their wound, the environment, available resources and the scope of practice of the health-care clinician completing the debridement. Biological, mechanical, hydro surgical, chemical, autolytic and enzymatic debridement methods have all been reported in the literature as effective options for burn injuries to various degrees, although most research focuses on surgical debridement (either using xenografts, allografts, autografts or skin substitutes).

The Wounds Canada Skin and Wound Clean-up Product Picker is a useful tool to help clinicians choose the most appropriate form of wound debridement Hyperlink https://www.woundscanada.ca/dhfy-doc-man/public/health-care-professional/1307-product-picker-skin-and-wound-clean-ip/file and more information on debridement is available in Chapter 4: Best Practice Recommendations for the Prevention and Management of Wounds: An Overview.[16]

Debriding Blisters: If blisters are greater than 1 cm^2, are filled with cloudy serous fluid or blood, are in an area where they are prone to break with routine activities or are impeding joint function they should be deroofed. All blisters secondary to chemical burns should be deroofed. Areas that are difficult to debride include the interweb spaces of the feet and hands, thin areas on the face and dorsum of the hands and areas that are edematous secondary to fluid resuscitation.[164]

4.2.3 Managing Bacterial Balance

Discussion: Acute burn injury infections are one of the most serious complications.[165] Infections contribute significantly to burn morbidity and mortality.[166] Infections are the result of the interruption in the skin's barrier, immune dysfunction and from invasive procedures. Management must focus on optimizing the host response, reducing the number or virulence of microorganisms in the wound and optimizing the wound environment.[17] Jeschke et al. discuss

the importance of topical antimicrobials as the mainstay of non-surgical burn treatment; no one dressing or agent is superior, and antimicrobial choice is often determined by the burn unit product/dressing availability, the preference of the staff and historical experience. Strategies to manage bacterial burden at the surface of the burn wound include prophylactic and therapeutic use of topical antiseptics and antimicrobials (See Table 12).

The Wounds Canada Wound Dressing Formulary and Wound Dressing Selection Guide https://www.woundscanada.ca/docman/public/health-care-professional/1114-product-picker-2017-selection-guide-1/file product pickers are useful tools that can help clinicians choose the most appropriate antimicrobial dressing.

In the presence of spreading or systemic infection, systemic antimicrobials are indicated and are selected based on the results of a wound swab (obtained using the Levine technique) or tissue biopsy and histopathology. Common organisms in critically ill burn injured patients with bacteremia include: *Staphylococcus aureus, Pseudomonas aeruginosa, Klebsiella, Escherichia coli, Enterococcus* and *Acinetobacter* species.[167,168] Such infections typically require surgical interventions such as debridement of the involved tissue in conjunction with systemic broad-spectrum antimicrobials.[169] The International Wound Infection Institute has created several enablers for optimal infection management that can be useful tools for clinicians. Their resources can be found at www.woundinfection-institute.com

Table 12: Common Topical Antimicrobials Used in Burn Management

Agent	Description
Silver dressings*	• Silver-containing calcium alginates, foams, gels, gelling fibres and non-adherent synthetic contact layers • Some formulations kill bacteria within the dressing, others release silver into the wound bed itself • Broad-spectrum coverage • May be toxic in high concentrations to fibroblasts and keratinocytes or if not delivered in a sustained release manner • Most require less frequent dressing changes (except for the silver gel)
Honey (medical grade)	• Leptospermum honey-containing calcium alginates, gels and pastes • Biocidal effect is multifactorial • Broad-spectrum coverage • Low toxicity • Most require less frequent applications (except for the gel and paste) • Promotes autolytic debridement
PMHB (Polyhexa-methylene biguanide)	• Polyhexamethylene biguanide (PHMB)-containing ribbon gauze, gauze squares, transfer foam, foam, gel and non-adherent synthetic contact layer • Bacteria kill occurs largely in/on the dressing • Broad-spectrum coverage • Low toxicity • Most require less frequent dressing changes (except for the PMHB gel)
Gentian Violet/ Methylene Blue	• Gentian violet- and methylene blue-containing polyvinyl alcohol or polyurethane foam • Biocidal effect is multifactorial • Broad spectrum coverage • Non-cytotoxic • Require less frequent dressing changes
Hypochlorous acid (NaOCL/ HOCL)[170]	• Broad spectrum coverage • Used for multi-drug resistant organisms (MDRO) • Penetrates biofilm rapidly, killing formations from within; does not promote resistant bacteria strains

OCT (Octenidine Dihydro-chloride)[165]	• Broad spectrum coverage • Eradicates bacterial biofilm for up to 72 hours • Gel, irrigation and surfactant preparations • Does not promote bacterial resistance • Good tissue tolerability, not shown to disrupt healing • Anaphylaxis and allergic response rarely observed
PVP-I (Iodophors (Poly-vinyl alcohol)	• Knitted viscose fabric impregnated with polyethylene glycol containing 1% povidone iodine • Biocidal • Broad spectrum coverage • Require less frequent dressing changes • Used specifically for prevention of infection in minor burns
Silver sulfadiazine (SSD) cream	• Topical, water-soluble cream containing 1% silver sulfadiazine • Bacteriostatic • Broad-spectrum, but lacks fungal and vancomycin-resistant enterococci activity • Has cytotoxic effects on fibroblasts and keratinocytes and may delay healing of superficial burns[71] • May create a pseudo eschar • Once-daily dressing change versus twice daily[171] • Avoid in patients with sulfonamide allergies (sulfa) • Avoid applying to the face as in rare cases localized argyria may develop[172-174]

Adapted from: International Wounds Infection Institute, 2022.[165]

***A Note on Silver Dressings**
The 2018 International Society for Burn Injuries (ISBI) Practice Guidelines for Burn Care made the following recommendations for the use of silver as a topical agent: "Silver-containing compounds and dressings are effective topical antimicrobial agents. However, silver also has cytotoxic effects which may delay wound healing. Silver-based topical agents are appropriate for deeper burns (essentially those awaiting surgery)".[166] (ISBI 2018).

4.2.4 Managing Moisture Balance

Discussion: In addition to strategies noted in Recommendation 4.1 to improve the overall hydration status of a patient with a burn injury (such as fluid resuscitation and nutrition interventions), moisture balance within the wound base can be achieved through appropriate dressing selection and dressing change frequency. Planning dressing changes can be done in partnership with the OT/PT mobilization activities (mobilization allows prone areas like the back and posterior legs to be exposed to the air and dry out).

4.3 Select the appropriate dressings and/or advanced therapy

Discussion: A good burn injury dressing has the following characteristics (where indicated):[175]

- Promotes autolytic debridement of non-viable tissue,
- Protects against infection and environmental contamination/ trauma,
- Maintains a moist wound environment while containing or wicking away excess moisture,
- Reduces evaporative losses,
- Is non-adherent to protect delicate skin,
- Contours easily and conforms to the wound bed,
- Aids with splinting or immobilization,
- Is aesthetically pleasing,
- Is easy to apply and remove,
- Is painless on application, with wear and on removal and
- Is cost-effective (including the cost of the product, frequency of dressing change and the cost of health-care professional time).

The Wounds Canada Wound Dressing Formulary and Wound Dressing Selection Guide https://www.woundscanada.ca/docman/public/health-care-professional/1114-product-picker-2017-selection-guide-1/file product pickers are useful tools that can help clinicians choose the most appropriate wound dressing. Table 13 lists the common dressings that meet the characteristics noted above and that are commonly used on burn injuries. This table does not reference antimicrobial dressings, which were discussed in Recommendation 4.2.3.

Table 13: Common Dressings Used in Burn Injury Management

Dressing Category	Indication (based on a review of manufacturer dressing indications)
Acrylic dressings	Superficial partial-thickness burns, donor sites
Calcium alginates	Superficial partial-thickness and deep partial-thickness burns, donor sites
Film/ membranes	Superficial partial-thickness burns
Foams	Superficial partial-thickness and deep partial-thickness burns, donor sites
Gelling fibres	Superficial partial-thickness and deep partial-thickness burns, donor sites
Hydrocolloids	Superficial partial-thickness burns, donor sites
Hydrogels	Superficial partial-thickness burns
Non-adherent contact layers	Superficial partial-thickness and deep partial-thickness burns, grafts
Pain controlling dressings	Superficial partial-thickness burns, donor sites

A Cochrane review of dressings for superficial and partial-thickness burns conducted in 2013 revealed that, "silver sulphadiazine was consistently associated with poorer healing outcomes than biosynthetic, silicon-coated and silver dressings, whilst hydrogel-treated burns had better healing outcomes than those treated with usual care."[176] The authors noted, however, that there was a lack of high-quality evidence from which to draw conclusions.

Advanced therapies: In the absence of robust evidence, expert opinion suggests that the use of common advanced therapies, such as electrical stimulation therapy, low-level laser therapy, negative pressure wound therapy, therapeutic pulsed ultrasound and ultraviolet C light therapy is not appropriate in the treatment of acute burn wounds. Such therapies activate healing by stimulating inflammatory processes (growth factor release) and proliferation, and, in an acute burn situation, may result in excessive tissue growth and scarring. The same may not be applicable for chronic burn injuries; however, evidence supporting the use of common advanced therapies in such situations is also lacking. As previously mentioned, xenografts, allografts, autografts or skin substitutes are commonplace in the management of major burns, used to facilitate early wound coverage and reconstruction.[60] Once the thermally injured patient has been admitted, resuscitated, and all wounds have been assessed and managed appropriately with escharotomy and dressing, the surgeons need to determine the most efficient course of action regarding excision of burn and coverage. This should be undertaken as soon as the patient is resuscitated, usually within 24–48 hours post-injury. There is also emerging experimental data that supports cell salvage in burn injuries using non-ionic surfactants such as poloxamers, poloxamines and plurogel micelle matrix.[177]

4.4 Engage the team to ensure consistent implementation of the plan of care

Discussion: To ensure the best experiences and outcomes for patients with burn injuries, it is imperative that health-care professionals involved in the care of people with burns keep abreast of current research and innovations in burn wound management. This may be challenging for teams working in, "resource-challenged or austere environments (RAEs) where even basic burn care may not be available".[60] Whether it be developments in burn injury prevention, assessment or management knowledge and/or skills, all professional members of rescue teams, emergency services, community-based, acute and rehabilitation health care providers have an obligation to remain up-to-date and to share information on the latest evidence, practice and self-management strategies. Burn care team members also must focus on collaborative, timely communication through web-based, charting, verbal and written approaches. Team cohesion, trust and education remain foundational to burn management success.[178]

Step 5: Evaluate Outcomes

Recommendations
5.1 Determine if the outcomes have met the goals of care

Discussion: Routine reassessment using validated tools helps clinicians determine if the goals of the prevention and/or treatment plan have been met. If the person with the burn injury:

- Is progressing in a timely manner toward the achievement of their goals, carry on with the plan of care
- Is not progressing in a timely manner toward the achievement of their goals, return to Step 1 of the Wound Prevention and Management Cycle and reassess the patient, their wound and the environment and system factors
- Has met their goals, plan for discharge by reviewing self-management strategies.

Common expected outcomes for people with burn injuries by depth are noted in Table 14.

Table 14: Common Expected Burn Outcomes by Burn Depth

Classification	Expected Outcomes
Superficial (first degree)	Healing within 3–5 days* No scarring
Superficial partial-thickness (second degree)	Healing within 14–21 days* No scarring
Deep partial-thickness (deep second degree)	Prolonged healing (may require skin grafting) Minimal scarring and contractures
Full-thickness (third degree)	Prolonged healing (will require skin grafting) Moderate to considerable scarring and contractures
Full-thickness (fourth degree)	Prolonged healing (amputation possible and will require skin grafting) Moderate to severe scarring and contractures

*These times may vary based on a patient's pre-existing comorbidities.

5.2 Reassess patient, wound, environment and system if goals are partially met or unmet

Discussion: When the goals of care have not been met in a timely manner (See Table 11), it is imperative to go back to Step 1 of the Wound Prevention and Management Cycle: Assess and/or Reassess. Careful reassessment of the patient, their wound and environment and systems factors will most often reveal modifiable factors that need to be addressed.

5.3 Ensure sustainability to support prevention and reduce risk of recurrence

Discussion: At transitions of care (from acute to rehabilitation to community care), people with, or at risk for, burn injuries and their care partners, require relevant, focused information regarding the cause and risk factors for burn injuries, as well as their risk for re-injury. Both formal and informal educational methods are beneficial, including the use of standardized patient-education materials, as well as individualized demonstration and review of prevention and management techniques. Burn management should focus on skin care, scar/keloid management, and reduction of itch and complications. Therefore, specific teaching relevant to a newly closed burn injury includes the following.

Skin care: For at least 12 months (or longer) post closure, burn-injured skin requires daily (or more frequent) cleansing and moisturizing (using an emollient). Products that are pH-balanced, non-scented and non-sensitizing are preferred. The fragile tissue should also be protected from the sun during this period, as it is more prone to sunburn, and sun exposure may cause further pigmentation changes.

Burn itch: Itchiness at the site of the burn injury is common post wound closure and can be worsened by heat, stress and physical activity. Keeping the tissue moisturized as noted above, keeping the area cool, employing techniques such as relaxation and distraction, and using pressure garments are some non-pharmacological techniques effective in reducing itch. Topical and oral antihistamines may also be required.

Hypertrophic scarring: Burn wounds, like all wounds, heal with the formation of scar tissue. For infants and children, parents and care partners play a key role in scar management.[179] The amount of scar produced generally relates to the depth of the injury sustained. If not managed appropriately, scars can become hypertrophic, and if they happen to cross one joint or more, can cause contracture and, as a result, decreased function of the area. The length of time for a burn scar to mature can be two years or more.[145] Treatment of hypertrophic burn scars involves several different modalities. Monstrey et al. suggest that pressure and silicone therapy should be applied in burn wounds that take longer than two to three weeks to close or after skin grafting.[180] Nedelec et al. support the use of non-silicone and silicone gels and gel sheeting after burn injury.[181] Pressure is strongly recommended to decrease scar erythema and scar height.[182]

Pressure is applied in the form of pressure garments—often custom measured and fit for each patient—as soon as possible after wound healing.[83] It is important that the rationale for using compression be regularly discussed with the patient.[183] Despite the widespread use of pressure garments, the mechanism of their function is not well understood. Some authors suggest they can help by reducing oxygen tension in the scar,[184] while others believe it has cellular effects on mechanoreceptors regulating apoptosis of dermal fibroblasts and cytokine regulation, which would reduce scarring.[185] Pressure garments may also be helpful with the edema, pruritus and pain that can be associated with burn scars.[186] Silicone gels and silicone gel sheeting have been used in combination with compression. Borgognoni suggests that possible mechanisms of action could be occlusion and hydration of the scar surface (stratum corneum),[187] and this is not limited to just silicone products.[188] Other products such as mineral oil-based gel sheeting, hydrocolloid products, silicone-based elastomer inserts and splinting material are also useful and require more research. Burn scar massage may also be beneficial to reduce scar thickness, reduce pruritus and anxiety; more research is needed.[189]

Scar massage therapy is an important part of scar care. Massage must be tailored to the patient's symptoms. Barnes et al. in a review (n=10) studies reported the majority of the studies (9) showed significant improvement with varied techniques. Oscillation and friction and oscillation massage used together improve scar function, where petrissage and effleurage improved scar visibility and pain.[190] Patients and caregivers can be taught how to correctly do burn massage.

Teamwork must continue and be focused on activities of daily living and reintegration into life, work and social activities.

Burn prevention is a topic relevant to both individuals with burn injuries and those at risk for such injuries. The simple safety measures below are a sample of interventions that reduce the risk of burn injury. They should be discussed with all patients to whom they are relevant.

Strategies to Support Burn Prevention

Scald Prevention
- Ensure water heater temperatures are not too high (50° C)
- Keep hot drinks away from tables or counter edges
- Avoid drinking hot liquids through a straw
- Turn the handles of saucepans inward
- Put cold water into baths first, followed by hot water, and test the temperature before using

Contact Burn Prevention
- Test the temperature of car seats before placing children in them
- Unplug hot irons and keep them out of reach of children
- Keep children away from grills
- Use approved glass or metal protective screens in front of fireplaces
- Wear oven mitts to remove items from the stove

Fire/Flash/Flame Prevention

- Install smoke alarms and consider installing sprinklers
- Make a fire escape plan and have regular fire drills
- Use child resistant-lighters and safely store lighters and matches
- Use space heaters carefully and keep them away from anything that can burn
- Never leave candles unattended

Electricity Burn Prevention

- Put covers on electrical outlets that are within a child's reach
- Throw out electrical cords that are frayed or damaged
- Avoid overloading extension cords or outlets
- If flooding occurs, turn off electrical circuits before stepping into the water
- Avoid using hair dryers or other electrical appliances near water

Radiation Burn Prevention

- Avoid direct sun exposure between 10 a.m. and 4 p.m.
- Wear clothing with UPF 50+ protection
- Wear sunglasses with UV protection
- Avoid tanning and UV tanning beds
- Apply sunscreen to your entire body 30 minutes before going outside and reapply every two hours and immediately after swimming

Chemical Burn Prevention

- Store chemicals in their original containers
- Maintain labels on containers holding chemicals
- Store chemicals out of the reach of children
- When possible, purchase chemicals with the least toxicity
- Purchase chemicals with child-resistant closures
- Wear protective clothing/equipment when handling chemicals (follow manufacturer labels).

At discharge, the plan of care needs to be revisited and revised as needed to ensure that appropriate self-management strategies are in place to support the patient and sustain outcomes.

Conclusion

This chapter identifies the need for wound specialists across Canada and is a practical guide for interprofessional wound care providers, administrators and educators to assist them in developing patient-driven, comprehensive, evidence-informed plans of care.

In summary, the first step is to holistically assess the needs of the patient and their burn wound. Determining burn severity is an important outcome of this assessment, as this will dictate the most appropriate location for care. Most minor non-complex burns can be managed on an outpatient basis, whereas moderate burns may require hospitalization and major burns need immediate transfer to a burn centre. Patient and burn wound assessment will also allow for prediction of outcomes based on burn severity, as, generally, superficial burns heal spontaneously with no scar within one week, superficial partial-thickness burns close with conservative treatment and no scar within three weeks, and deep partial-thickness and full-thickness burns heal (with varied amounts of scarring and contracture) over greater periods of time and may require surgical intervention. Furthermore, there is a complexity that needs to be considered when a patient is assessed for morbidity and mortality risk, mental health, quality of life, and coping and social environment. These recommendations delineate these aspects and give the reader guidance into the complex assessment of burn wounds.

Once the patient is properly assessed, realistic goals need to be set, and a plan of care developed, which is reflected in steps 2 and 4 of the Wound Prevention and Management Cycle. The management of burn wounds requires an integrated team approach, the importance of which cannot be overemphasized (See Step 3). Such interventions can be divided into emergent and non-emergent patient needs and may include fluid resuscitation, escharotomies, fasciotomies, transfer to a burn centre, treatment of inhalation injury, and maintaining organ function and circulation.

The general rule is, if in doubt, call a burn centre to receive appropriate guidance and support.

The surgical plan for a patient with a burn injury may include debridement and auto-grafting. At this time there is no alternative to the gold standard: using split-thickness skin grafts from the burn patient (autologous skin grafting). There are various means to temporize or augment that goal, such as the use of skin or dermal substitutes. Currently, the ultimate success depends on the patient's healing, and therefore split-thickness skin grafting is the treatment of choice.

There are a variety of dressings from which to choose. Availability may differ between burn centres or localities. Each dressing has its own indications, but no single one guarantees success.

Long-term outcomes of a burn patient are very different than previously thought, as burn wound closure historically was synonymous with recovery. This dogma has changed significantly over the last 10 years, however, as we realize a burn patient who has healed may not have entirely completed their treatment. There are long-term consequences for burn patients. These consequences not only include scarring or scar contracture restriction in mobility, strength and quality of life, but also metabolic and physiologic aspects as well as mental health.

Mental health has a significant impact on successful long-term outcomes, and in fact dictates the degree of recovery and quality of life. Therefore, following up with a burn patient for a prolonged period is essential.

This chapter provides clinicians with focused and practical guidance to assess a burn patient, create goals, assemble a team and develop, implement and evaluate a plan of care that includes sustainability over the long term and through transitions of location and healing phase. Burn care can be delivered in many settings, depending on the severity and type of injury. When in doubt, however, it is best to call a specialized burn centre to receive information and assistance in developing a plan of care, delivering care or identifying the need for specific interventions.

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