



**Standard of Care: Burn**

**ICD 10 Codes:**

- T21.00XA Burn of trunk
  - T22.0 Burn of upper limb, except wrist and hand
  - T23.09 Burn of wrist(s) and hands(s)
  - T24.00 Burn of lower limb(s)
  - T25.09 Burn of foot and ankle
  - T31 Burns classified according to extent of body surface involved
  - T69.9XXA Effects of reduced temperature (i.e. frostbite)
  - L51.3 Erythema multiforme, Toxic epidermal nectolysis (TEN)
- Others may also apply (e.g. various extensive wound diagnoses)

**Case Type / Diagnosis:** (diagnosis specific, impairment/ dysfunction specific/ ICD 10 codes)

This standard of care applies to patients who are admitted to the Brigham and Women's Hospital (BWH) for the management of burn injuries, as well as burn similar conditions (i.e. Stephen Johnson Syndrome/toxic epidermal necrosis). A burn injury can be sustained through a variety of sources including thermal/heat (flame, flash, scald, and steam), chemicals, radiation, sunlight, or electricity. Burn-like injuries can also occur due to reduced temperature [frostbite<sup>15</sup>] and as a reaction to medication and from an autoimmune reaction as in Graft vs Host Disease (GVHD) of the skin. Care of the patient with burns extends along a lengthy continuum, spanning months to years. Patients often require prolonged initial acute hospitalizations, extensive rehabilitation, and readmissions to acute hospitals for additional debridements, contracture releases, reconstructive, and cosmetic procedures.

According to the American Burn Association (ABA), in 2016 there were 486,000 burn injuries occurred and of these 40,000 required hospitalizations. During the years 2005 until 2014 the most common mechanisms of injury were 43% fire/flame, 34% scald, 9% contact, 4% electrical, 3% chemical, 7% other. There has been a focus on community prevention, safety, and education/training community hospitals which has significantly reduced burn morbidity and mortality in recent years.<sup>1</sup>

Initial burn care originates at the accident scene with emergency medical services performing an initial survey, assessment and the beginning of the resuscitative efforts. One decision made by EMS personnel is to determine whether an individual requires care at a regional burn center. Regional burn centers achieve specialized certification from both the American Burn Association and the American College of Surgeons. Each center must demonstrate the ability to provide optimal care for patients with burns. The American Burn

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Association has developed criteria to assist EMS and hospitals determine which patients require transfer to a burn center. These criteria are listed below<sup>1</sup>.

- Patients who sustain partial thickness burns greater than 10% of total body surface area (TBSA) require more intensive medical monitoring and intervention due to effects of significant edema. They are more likely to have mobility and movement issues and will require early physical therapy/occupational therapy intervention.
- Patients who sustain burns of the neck and face are at higher risk for significant edema that can cause respiratory distress. They may need to be intubated for an extended period.
- Patients who sustain burns involving the hands, feet, genitalia, perineum, or major joints are at higher risk for decreased healing, hypertrophic scarring and contractures. These parts of the body are crucial for normal function and require specialized intervention for best recovery.
- Patients who sustain full-thickness (i.e. third degree) burns of any size are at significantly higher risk for decreased healing, hypertrophic scarring and contractures. They almost always need complex wound care and surgical intervention. These patients also require intensive nutritional support and hemodynamic monitoring. They require more specialized, intensive PT and OT intervention for optimal progress.
- Patients with electrical burns, including lightning injury are at risk for cardiac symptoms such as arrhythmias due to the electrical current. In addition, the path of an electrical current can cause deeper, less obvious injuries that can affect vital organs and deep muscles. Frequent surgical debridement as well as hemodynamic monitoring is essential.
- Patients who sustain chemical burns require more intensive management. The chemical can be absorbed into the skin and cause damage for an extended period of time. These patients often require specialized cleansing procedures and close monitoring.
- Patients with inhalation injuries often require ventilation and intensive pulmonary hygiene.
- Patients who sustain a burn and have pre-existing medical disorders require more intensive management and frequently have slower progress. Their medical status can complicate management and prolong recovery.
- Patients with burns and concomitant trauma (such as fractures) in which the burn poses the greatest risk of morbidity or mortality require higher intensity of care.
- Patients with burn injuries who will require special social, emotional, or long-term rehabilitative intervention.

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## Phases of Burn Care:

Burn management can be divided into three phases. An interdisciplinary approach including PT and OT involvement is essential in all three phases<sup>18</sup>:

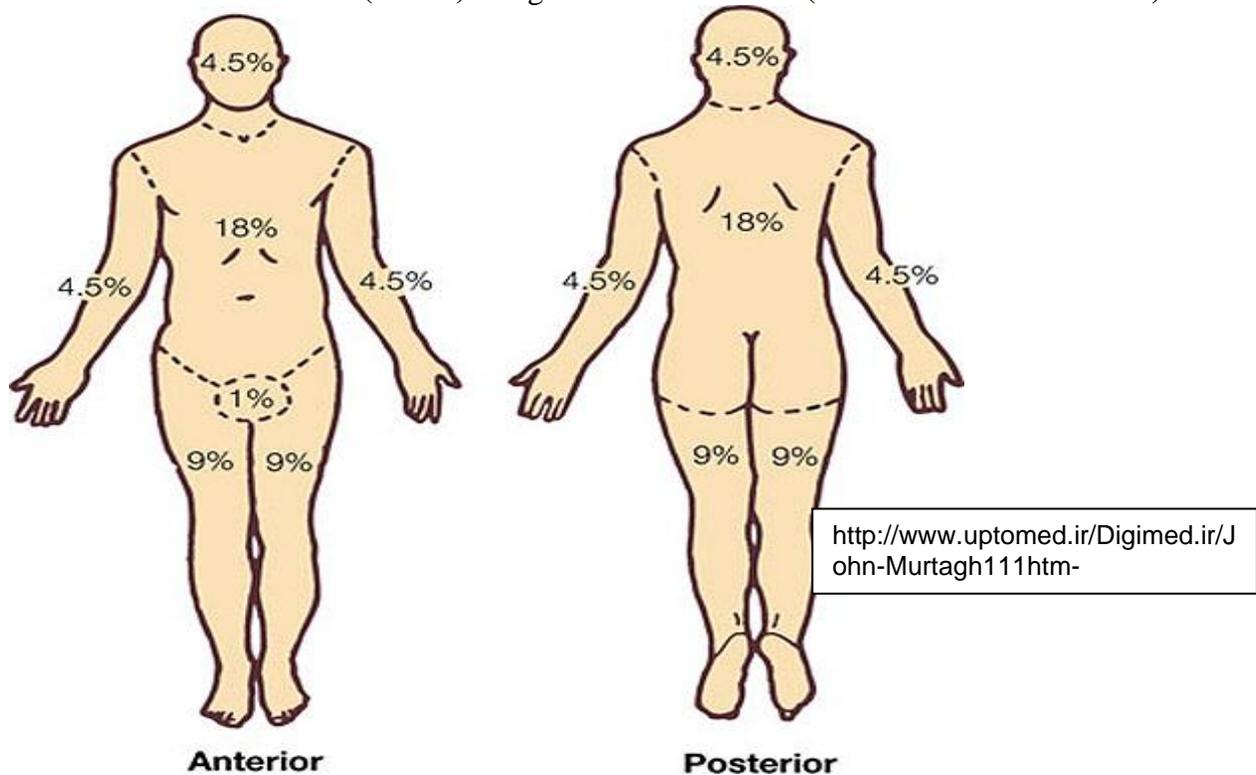
**Emergent or Resuscitative Phase:** The primary goal of this phase is performing the primary survey (airway, circulation and breathing- ABCs) a process completed for any trauma patient, continuing or beginning fluid resuscitation, initial wound care, and nutritional support.

### Medical Assessment

- **Assess and obtain a patent airway.** Many patients who sustain a burn injury are intubated early, often in the field, due to concern for inhalation injuries. The frequency of these injuries vary but they do occur in approximately 7% to 20% of burn cases which require admission to a hospital.<sup>5</sup> The risk for inhalation injury increases with the extent of the burn and has been found to be present in two-thirds of patients with burns greater than 70% TBSA.<sup>14</sup> Inhalation injuries are caused by either direct trauma to the lung tissue from smoke or other chemicals present during a fire or by secondary injury following the activation of the systemic inflammatory response<sup>10</sup>. This inflammatory response from either direct or indirect causes can create rapid upper airway edema; therefore, intubation should not be delayed. Some common signs of airway injury include persistent cough, stridor, wheezing, hoarseness, deep facial or circumferential neck burns, nares with singed hair, carbonaceous sputum, hypoxia, and elevated carbon monoxide and/or cyanide levels<sup>14</sup>. The presence of an inhalation injury can significantly increase mortality, (3% vs 16% per one study) as well as length of stay<sup>3</sup>. If an inhalation injury is suspected patients often undergo bronchoscopy, and can be given bronchodilators when bronchospasm is present. Corticosteroids and prophylactic antibiotics have been associated with increased risk of bacterial infection and therefore are not used.<sup>11,14</sup>
- **Establish hemodynamic stability** using fluid resuscitation (see below) and other medications. After a burn injury, the systemic microcirculation loses vessel wall integrity. Protein is then lost to the interstitium thus changing the osmotic gradient. As a result, large amounts of fluid, electrolytes, and proteins leave the intravascular space.<sup>11</sup> Clinically this results in massive edema, decreased urine output, hypotension, and tachycardia. High volume fluid resuscitation is gold standard in initial burn management, and a large percentage of facilities use the Parkland Formula to calculate fluid needs. The Parkland formula gives IV lactated ringer's solution at the rate of 4mL/kg x %TBSA involved. This amount is given over 24 hours, with half being given within the first 8 hours and the remaining half is given over the next 16 hours<sup>11</sup>. Brigham and Women's Hospital uses a variation of the Parkland Formula.

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- Assess size of burn (TBSA) using the “Rule of Nines (Lund and Browder form):”



Physicians and first responders use this strategy to determine extent of burn injury which helps to guide management. Burn severity and depth is then assessed. Burns are classified as superficial or deep and partial thickness or full thickness, or previously called 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, and 4<sup>th</sup> degree. However numbered degree of burn injuries is antiquated and falling out of favor.

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	Appearance	Area Affected	Sensation	Blanching	Wound Closure
<b>First Degree (Superficial)</b>	Pink or red; May be dry or moist	Epidermis	Intact, painful	Present	Typically heals within 3-5 days with no scarring
<b>Second Degree (Superficial partial thickness)</b>	Bright pink or red, wet, blisters	Epidermis and portion of dermis	Intact, painful and sensitive to change in temperature and exposure to air or touch	Present	Heals by re-epithelialization in 10-14 days; typically no scarring or grafting needed
<b>Second Degree (Deep Partial Thickness)</b>	Mottled, red and waxy white; wet	Epidermis and deeper portion of dermis	Variable; may be intact with areas of diminished sensation	Diminished	Heals by re-epithelialization in 14-21 days or longer; scarring is likely if burn in > 30% TBSA
<b>Third Degree (Full Thickness)</b>	White or tan; dry and leathery, non-pliable	Entire epidermis and dermis	Painless; may be sensitive to deep pressure; anesthetic to temperature	Absent	Skin graft required
<b>Fourth Degree</b>	May be charred or dry	Deep soft tissue damage to fat, muscle, tendon, fascia, nerve and/or bone	Absent	Absent	Excision of necrotic tissue and skin graft required, possible amputation in some cases

(Herndon, 1996)<sup>8</sup>

- Establish adequate tissue perfusion:**  
 Due to the large amount of edema present, disruption of vascular supply, and the potential for other extremity injuries, the extremities and the abdomen must be monitored for adequate perfusion. If perfusion becomes a concern, an escharotomy or potentially a fasciotomy may need to be performed. These procedures incise burned tissue (escharotomy) or fascial compartments (fasciotomy) to relieve pressure on the surrounding structures and improve perfusion. Patients with circumferential neck, trunk, and extremity burns are at particularly high risk to develop a perfusion injury or compartment syndrome and often require these procedures.<sup>11</sup>
- Initial wound management:** The burn wound is extensively cleaned with mild soap and water with the goal of removing all nonviable tissue<sup>11</sup>. Once the wound is clean, topical antibiotics are applied to all superficial burns and in some cases to deep burn wounds, particularly pending timing of surgery. Additional medications such as enzymatic debriding agents or substances which soften eschar will be applied. Initial dressings should include non-adherent mesh gauze. Topical agents and medication regimes will be adjusted frequently throughout hospitalization depending on the status of the wounds<sup>14</sup>.
- Nutritional support** is particularly important due to the patient's hypermetabolic state and significant metabolic demands created by a burn injury. Patients with > 20% TBSA burns will not be able to meet their caloric needs by oral intake alone, therefore a feeding tube is often placed. Inadequate nutrition leads to delayed wound healing and longer hospitalizations.<sup>11</sup>
- Physical Therapy Management:**  
 The initial focus of physical therapy management in this phase involves primarily splinting and positioning needs.

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## Acute Phase: (after emergent phase and until wounds are closed)

### Medical Management

- **Ongoing wound debridement, assessment for evolution of burn wound depth.** Burn wounds can often progress or worsen with time as the retained heat from the injury continues to damage tissue. Therefore, it is necessary to continue to monitor the wound for conversion of the burn to a deeper level. It is not uncommon for second degree burns to convert to third degree, for example.
- **Skin grafting** is initiated once burn wounds are cleaned and debrided either at bedside or in the operating room (OR). Autologous grafting or split thickness skin grafting (STSG) involves using the patient's own skin to close an integumentary defect created after removing burned, non-viable tissue. The donor skin is usually meshed to increase its surface area and thus allow a smaller amount of donor skin to cover a larger recipient area. For areas such as the face and hands sheet (or unmeshed) grafts are used for improved cosmetic appearance. Various biologic dressings can also be used as temporary wound coverage to provide a protective barrier, giving time for donor sites to heal for future split thickness skin grafts. Allografts are human cadaver skin, while xenografts are skin from a different species, usually a pig as porcine skin closely resembles human skin<sup>16</sup>.
- **Cultured Epidermal Autografts (CEA)** are used primarily for patients who have sustained large TBSA burns (> 50 %) and therefore may not have enough donor skin available to provide complete wound coverage following primary excision<sup>16</sup>. A section of the patient's own skin is sampled, and grown in a laboratory. It can take several weeks to become ready for use. This technique is costly, and once the new skin is ready for use, it must be applied immediately, regardless of the status of the recipient wound beds. CEA also requires up to two weeks of immobility following application, including cessation of all OT/PT range of motion activities, exercises and functional mobility. Even turns and positioning with nursing staff is minimized.
- **Vacuum assisted closure (VAC)** are often used frequently following operative management of burn injuries. VACs are placed over donor sites as well as newly grafted integument. For patients who have sustained a large TBSA burn, a large number VACs may be used, as there will multiple operative wounds. Physicians/Physician assistants/nurse practitioners apply and remove VACs, this can be done bedside, or in the OR and this depends on the size of the wound and patient tolerance.
- **Wound care** is ongoing throughout a patient's hospital stay and can change as often as daily depending on the needs of the wound. Below are the common topical agents and dressings used at BWH.

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- TOPICAL BURN THERAPY (from Stefan Strojwas, RN, Burn ICU Nurse and former Nurse Educator)

AGENT	DESCRIPTION	ACTIONS	ADVANTAGES	DISADVANTAGES	CONSIDERATIONS
Acticoat	Silver impregnated gauze	Antimicrobial	Can remain in place up to 3 days so decreases dressing time	Needs to be applied wet	-deep dressing moist with sterile water -monitor pt. Temperature due to wet dressings
Bacitracin	Bactericidal ointment	Gram +/- effective	Nonpainful and easy to apply	May be nephrotoxic	Monitor serum BUN and Cre
Betadine	Iodine complex, solution or ointment	Antimicrobial for gram +/-	Effective against organisms not controlled by Silvadene	May cause metabolic acidosis, can be painful to apply	May form crust around wound which needs to be removed
Biobrane	Bio-synthetic wound covering, good for partial thickness burns, clean wound beds	Controls water loss & minimizes bacteria growth	Decreases pain, remains in place until re-epithelialization occurs. Allows for movement	Wound surface must be debrided and clean before application	Need to observe for signs/symptoms of infection and adherence
Fine Mesh Gauze	Sterile	Carrier for ointments/creams. Gentle debridement when removed	Allows for specific placement	May stick to wounds causing pain	
Gentamycin	Antibiotic cream	Antibiotic, effective against many organisms	Effective against pseudomonas	May be nephrotoxic	Monitor serum BUN and Cre
Integra	Biologic dressing composed of bovine tendon collagen and glycosaminoglycan	Provides as scaffold for capillary growth and cellular matrix	Provides coverage over exposed tendons, bones, cartilage and joints. Can be applied immediately	Not to be used over full thickness burn injuries	
Lotrimin	Antifungal cream	Interferes with fungal DNA	Can be used with other topicals	May cause burning and redness	Affected area must be fully covered

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AGENT	DESCRIPTION	ACTIONS	ADVANTAGES	DISADVANTAGES	CONSIDERATIONS
Silvadene (Silver sulfadiazine)	Antimicrobial cream	Binds to organism's cell membranes and interferes with DNA	Wide spectrum for gram +/- . Does not delay eschar separation	Shallow penetration, depresses granulocyte formation	Check for sulfa allergies,
Silver nitrate	5% silver salt antimicrobial solution	Antimicrobial	Easy application, delays granulation hypertrophy	Shallow penetration, stains and stings. May cause hyponatremia, hypochloremia, hypocalcemia	Keep dressings wet, check daily electrolytes
Sulfamylon Mafenide Acetate	Water based bacteriostatic creme	Effective against gram +/- organisms	Effective against pseudomonas, penetrates thick eschar	May cause metabolic acidosis and rash, can be painful, delays eschar separation	Monitor blood gases and electrolytes
Triple antibiotic ointment	Mixture of neomycin, polymyxin, bacitracin	Bactericidal for gram +/- organisms for partial thickness burns	No pain on applications	Cannot be used for full thickness burns	Monitor for infection
Vitamin A&D	Petroleum based ointment	Fat soluble vitamins assist with healing	Moisturized newly healed tissue	No antibacterial effects	
Xeroform bismuth tribromphenate	Yellow substance on Vaseline impregnated gauze	Debrides and protects wounds, donor sites and grafts	Conforms to wound, nontoxic	Can stick to wounds, no antibacterial properties	Careful removal from new grafts essential

- **Continued nutritional support**
- **Continued hemodynamic support**
- **Physical therapy management** includes comprehensive intervention addressing positioning, stretching, mobility, integumentary assessments, scar management, education, and aerobic conditioning

### Rehabilitative Phase

#### **Medical Management:**

- Surgical release of contractures
- Nutritional support
- Reconstructive or plastic surgery to maximize function and cosmesis. These procedures are often done following discharge from the hospital after the original injury. They include techniques such as contracture releases and Z-plasties.

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## Physical therapy Management

- Intensive rehabilitation program—scar management, range of motion (ROM) and stretching with techniques, mobility training as needed, education re: self- management. See below for details.

## Indications for Treatment:

Patients with burn injuries involving superficial, partial, or full thickness skin with potential extension into fascia, muscle, or bone, and at risk for contracture and scar formation will require intervention. These burns can result in impairments such as loss of joint ROM, peri-articular or intra-articular joint changes, sensory loss, edema, pain, impaired ventilation/aerobic capacity, impaired activity tolerance, impaired balance, coordination, and strength. They can cause functional deficits such as impaired mobility, difficulty performing activities of daily living (ADL's) and instrumental activities of daily living (IADL's). Patients also lack knowledge about wound healing, self-care, and coping/adjustment strategies following burn injury.

## Contraindications / Precautions/Considerations for Treatment:

- **Hemodynamic Instability:** Unstable heart rate, blood pressure, respiratory status and fevers of more than 102 degrees can impact Physical Therapy intervention. Both tachycardia and fevers can be a result of the patient's hypermetabolic state and do not always preclude intervention, as patients with burns have a harder time maintaining a stable body temperature due to the presence of open wounds.<sup>15</sup> However it is imperative to determine the origin of patient's hemodynamic changes and intervene as appropriate
- **Heterotopic Ossificans (HO)** is a condition where lamellar bone develops in damaged structures such as muscle and other soft tissue. It is particularly common after burn injuries but also can be seen following musculoskeletal trauma, amputations, traumatic brain injuries. Specifically, in the burn population HO has found to have a 0.2%-4% incidence<sup>12</sup>. There has been some evidence in the literature that aggressive, forceful, manipulations of extremities in the presence of HO can worsen the condition and cause complete joint ankylosis. In contrast, there are several studies which show that gentle passive range of motion, and active assisted range of motion does not increase the severity HO. Therefore, when HO is suspected or known to be present, gentle range of motion can continue with close monitoring of patients' symptoms and the effect on the joint range of motion measurements<sup>2,3</sup>.
- **Mobility:** Patients who undergo autologous skin grafting procedures or split thickness skin grafting (STSG) frequently are placed on bed rest activity restrictions due to concern of shearing of graft on wound bed or increased edema (when limb is dependent) thus causing graft loss. This is particularly true for patients who undergo lower extremity, buttock grafting or large upper extremity/torso burns. The duration of bed rest varies from patient to patient, procedure to procedure, and by surgeon preference. Liberalizing of activity often occurs following the first dressing change or VAC removal following grafting. At that time the medical team can assess whether the graft has "taken" or adhered and incorporated into the wound bed. If so, in most cases, patients will be allowed to mobilize and perform ROM/therapeutic exercise as tolerated. See below for further ROM details. Ideally the therapist is able to visualize the newly grafted area to determine how the graft has healed and to assess for any areas of graft loss. Current research indicates that it is possible to safely mobilize following STSG procedures,

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provided certain precautions are taken, as early as post op day zero. These precautions include immobilization of the grafted area with ambulatory aides (air cast boots, knee immobilizers) and compression provided by elastic bandages.<sup>13</sup> However, a discussion with the medical staff remains necessary to confirm if a patient's mobility can be progressed and to determine if there are any ROM or positioning restrictions.

- **ROM precautions and restrictions** must be known prior to starting each treatment session, due to one or more of the following reasons:
  - Cultured Skin (Cultured Epidermal Autografts or CEA)—ROM to area of CEA is contra-indicated for the first 10-14 days and prior to initial takedown to avoid graft disruption. Patients are also on complete bedrest, with minimal turns with RN staff, and sedated to prevent movement. Splinting and casting is permissive if not over areas covered by CEA.
  - Autologous skin grafts: Following grafting involved areas and joints crossed by grafts are usually immobilized for a period of time following surgery. The length of time can be surgeon or patient dependent and requires close communication with the surgical team to determine guidelines. For areas that do not cross joints ROM and mobility may be initiated earlier however clarification with the team is necessary prior to activity or exercise.
  - Biobrane: Applied to partial thickness burns to promote healing, ROM and mobility should be held until 24 hours after application to ensure adherence
  - VACs are often applied over both grafts and donor sites, over extremities including joints. The ability to perform ROM with VACs in place must be clarified with the team. If ROM is allowed, it is imperative to not disrupt the seal of the VACs therefore ROM should be completed slowly, with caution and with good visualization of the VAC.
  - Muscle or myocutaneous flaps usually require total immobilization for a period of time to promote viability Therefore it is necessary to await physician clearance prior to resuming ROM or mobility. If the flap is located on an extremity there also may be a time limit to dependent positioning of that extremity.
  - ROM, mobility with exposed tendons is permitted with caution unless the area has been recently grafted in which case the joint/area is often immobilized for up to 5 to 7 days. However, it is important to perform ROM gently and with caution due to delicate nature of the structure. Exposed tendons have potential to desiccate and be prone to rupture.

## Evaluation:

**Medical History:** It is important to consider any pre-morbid conditions that may affect the patient's hospital course or effect on wound healing. Examples of these conditions would include: diabetes, PVD, any oncological diagnoses, cardiopulmonary conditions, or other integumentary conditions.

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**History of Present Illness:** A thorough HPI includes the following components

- Mechanism of injury
- Nature of burn (thermal, chemical, electrical, allergic reaction)
- Extent of burn (TBSA, location, depth) with mention of burns that cross joints
- Evidence of inhalation injury
- Any additional injuries sustained in the accident (fractures, head injuries, internal injuries)
- Relevant medications (e.g. pressors, fluid resuscitation, pain medications, sedation)
- Any medical/surgical interventions that have occurred prior to PT evaluation including trips to the OR, escharotomies/fasciotomies as well as planned procedures
- Current topical medication management plan

**Social History:**

- Specifics about home environment, architectural barriers
- Family support, normal role in family
- Baseline level of function
- Adaptive equipment use
- Psycho/social issues, substance abuse issues

**Medications:**

- Pressors
- Fluid resuscitation
- Pain medications (Fentanyl, Morphine, Dilaudid, Neurontin, NSAIDS)
- Sedation (Versed, Fentanyl, Propofol, Precedex)
- Topicals for care of wounds

**Examination** (Physical / Cognitive / applicable tests and measures / other)

This section is intended to capture the most commonly used assessment tools for this case type/diagnosis. It is not intended to be either inclusive or exclusive of assessment tools.

**Observation:**

- Positioning: attention should be paid to patient's position in bed or chair with the goal to place patients in anti-deformity positions
- Presence of lines and tubes
- Presence of any splints or other positioning devices

**Integument:**

- Burn wound assessment: Ideally burn wounds should be visualized in person, with dressings down during the initial evaluation. The specific burn locations, described using anatomical landmarks, should be documented along with burn wound depth and a general qualitative description of the tissue. Please see the above table for descriptions of burned tissue appearance, additionally please refer to the Wound

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Standard of Care for further guidance Admission photos, which are usually in the chart, taken by the MDs/RNs can be used if necessary in order to acquire information if a dressings down assessment cannot be performed.

- Edema: Location, amount
- Additional integumentary issues such as incisions from surgeries, other soft tissue injuries.

**Pain:**

- Recommend use of the VAS scale (if able to communicate)
- If the patient is unable to speak assess by monitoring heart rate, blood pressure, respiration rate, facial grimacing, gesturing or by using other nonverbal pain scales
- Communicate with nursing re: need for additional pain medication

**Musculoskeletal**

- ROM is measured using goniometric measurements particularly of all burned areas
- Strength is measured using manual muscle test (MMT) if patient can participate in exam. If not, assess functional and spontaneous motion by observation and reassess more specifically later in course
- Posture/alignment can be assessed by observation when patient is able to sit or stand. Asymmetries can indicate scarring or weakness

**Cardio-Pulmonary**

- Evaluation of the respiratory status including presence of inhalation injury and the level of ventilatory support required
- Vital sign monitoring (HR, BP, RR, SpO2) at rest and with treatment
- Cough assessment
- Lung sound assessment
- Costal expansion/rib cage excursion particularly with trunk burns
- Endurance/activity tolerance assessment using RPE scale and other standardized test (i.e. 6 minute or 2 minute walk tests) if possible

**Neuromuscular**

- Balance: sitting, standing
- Sensation: light touch, deep pressure particularly over burned areas, hypersensitivities or abnormal responses to touch
- Proprioception

**Mental Status and Cognition**

- Level of consciousness
- Orientation
- Safety judgment
- Ability to follow direction

**Psychological Considerations**

- Coping with altered body image and appearance
- Learning style, educational level
- Patient's goals for recovery
- Impact of psychiatric disorders on participation and recovery as this impact patient's ability to participate in treatment plans <sup>4</sup>

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**Functional Mobility:** Assess bed mobility, transfers, ambulation and stairs appropriate

**Assessment:**

Patients who sustain burn injuries are at high risk for scarring, contractures, and impaired functional mobility. Also, particularly with large TBSA burns and/or inhalation injuries, there is usually a long period of relative immobility as patients undergo multiple grafting procedures, and require prolonged intubation and sedation. These patients are at high risk of developing aerobic capacity/endurance impairments, balance derangements as well cognitive dysfunction. Given all of this, patients who sustain burn injuries often require intensive and frequent intervention. It is important that a therapist be well versed in the specific intervention strategies that are unique to the burn population and have demonstrated competency in these areas.

**Problem List**

**Health Condition:** Burn

**Body Structure and Functions:**

- Impaired integument
- Impaired ROM
- Impaired motor performance
- Impaired balance
- Impaired aerobic conditioning
- Impaired airway clearance
- Impaired ventilation
- Impaired balance
- Edema
- Impaired cognition
- Impaired communication

**Activity Limitations:**

- Decreased bed mobility
- Decreased transfers
- Decreased ambulation
- Decreased stairs

**Participation:**

- Decreased community mobility
- Impaired vocation
- Impaired role in family
- Decreased home management

**Prognosis:** Overall, there has been a significant decline in the incidence of burn injuries over the decades. In the 1950's burns occurred approximately 10 per 1000 people as compared with 4.2 per 1000 in the 1990's. This decline has been associated with increased injury prevention in the workplace and at home along with the implementation of other safety measures. Along with a decline in overall incidence, mortality has also significantly declined due to the development of comprehensive burn centers, advancement in treatment such as improved resuscitation, topical agents, new

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reduce anxiety and pain during a session. Completing ROM with techniques such as AAROM and contract relax can be very beneficial. Creating a daily schedule, with set times for PT and OT, with the assistance of the primary RNs and the involvement of the patient (if possible) helps coordinate pain medication schedules, gives patients both self-efficacy and structure to their day. Use of cognitive behavioral strategies such as relaxation techniques, and guided imagery are also helpful.

- ROM/Therapeutic exercise.** A cornerstone in burn injury management is the use of effective range of motion exercises. Due to nature of burn injury, patients are high risk for scarring and thus early and frequent range of motion to prevent long standing wound contractures is necessary. Burn stretches should be held, at end range, for a prolonged period of time. One study found that holding each individual stretch at end range (as evidenced by blanching of the soft tissue) for 3 minutes for a total of 60 minutes per day (divided between both OT and PT) resulted in an improvement in ROM by 8.2 degrees per week<sup>7</sup>. Once awake and participatory, involving patients in self stretching AAROM and using techniques such as contract relax or hold relax can help with gaining additional range of motion as well decreasing patient anxiety.
- Positioning and splinting** are necessary to maintain gains achieved during therapy sessions as well to prevent any additional range of motion losses. Good positioning can also be useful as a source integumentary protection following grafting or in general. Depending on location of burns various splinting options are available. Roylan™ resting foot splints, pre-fabricated intrinsic plus hand splints, hip abduction pillows (used at hips and in axilla), and knee immobilizers are the most common. Custom splinting is possible in certain circumstances, in these scenarios collaboration with OT and/or orthopedic technicians is recommended. Using towel rolls behind the shoulders and cervical collars are useful tools in the case of anterior neck burns. Please see below for preferred anti-deformity positions and available positioning devices. Location of burn may require modification of these optimal positions.

Area of the Body	Position	Device
Neck	Neutral or extension for anterior neck burns, no rotation	Pre-fabricated neck collars (Soft, Philadelphia and Miami J) Custom made neck collars are possible (collaborate with OT)
Shoulder	Abduction (90 degrees) External Rotation Horizontal Adduction (10 degrees)	Shoulder abduction pillows Custom made splints (“airplane splints”) SCOI brace

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Area of the Body	Position	Device
Elbow and forearm	Extension with supination	Pre-fabricated and custom elbow extension splints (OT to create and implement)
Wrist	Neutral or slight extension	Pre-fabricated and custom splints (OT to create and implement)
Hand	Functional position (dorsal burn) Finger and thumb extension (palmar burn)	Pre-fabricated and custom splinting by OT
Trunk	Straight postural alignment	Bed positioning, pillows
Hip	Neutral extension Neutral rotation Slight abduction	Bed positioning, pillows, hip abduction pillows, and neutral resting foot splints with rotational bars in place
Knee	Extension	Knee immobilizers, hinged knee braces, serial casting, custom splints (consult with OT and ortho tech as needed)
Ankle	Neutral or slight dorsiflexion No inversion Neutral toe extension/flexion	Pre-fabricated resting foot splints (Roylan™), serial casting

- Scar management** is frequently addressed by compression therapy and garments. These are utilized frequently by burn therapist to prevent hypertrophic/keloid scarring. Keloid scar formation is more typical in persons of color and therefore particular attention should be paid for this population. It is hypothesized that compression causes tissue hypoxia and therefore a reduction in cell proliferation. Unfortunately, thus far, the evidence has not been able to show a significant improvement in the prevention of hypertrophic wounds with the application of compression, however many therapists continue to incorporate pressure garments into their treatment plans<sup>6</sup>. It has been found that 49% of physical therapists surveyed always used compression garments on patients who undergone grafting<sup>9</sup>. Compression garments can be non-custom such as Tubigrip<sup>R</sup> or elastic bandages or can be measured and custom made for each individual patient, such as Jobst<sup>R</sup> garments. It is important to ensure that the patient has achieved and maintained a stable weight prior to ordering Jobst<sup>R</sup> garments, as even small fluctuations in limb or abdominal girth can affect the fit of the Jobst. Additionally, most the burn wounds should be closed and close to well healed prior to the application of custom compressive garments. At Brigham and Women's Hospital an outside

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vendor, who can measure both inpatients as well as outpatients in burn clinic, provides custom compressive garments. The burn program manager/burn department can facilitate acquiring compressive garments, and should be contacted by the therapist when a patient is deemed ready.

- **Functional mobility training**
- **Ventilatory training** such as costal expansion, diaphragmatic breathing particularly for patients who have sustained truncal burns.
- **Endurance/aerobic conditioning**

**Frequency & Duration:** Patients who are admitted to Brigham and Women's Hospital for management of a burn injury are frequently seen 5-7 times weekly, based on clinical need. The severity and location of burn wounds and the need for aggressive ROM and mobility are the primary factors determining frequency. Length of stay is dependent on extent and severity of burns and need for intensive acute care intervention. Hospital stay can vary from 2-3 days for a localized burn (such as partial thickness burn to hand or foot) to many weeks to months for a high percentage, full thickness burns that require multiple surgical procedures and prolonged intubation.

#### **Patient / family education**

- Discussion with patient and family re: Physical Therapy involvement with patient and expected progression
- Discussion with patient and family re: optimizing patient's independent mobility and self-care and providing the appropriate level of assistance to the patient
- Instruction of patient and family in appropriate exercises and activities with written exercise program and exercise/activity log
- Discussion of longer term issues common following a burn injuries
  1. phases of burn healing, estimated time line, risk of scarring
  2. ways to minimize scarring and contracture
  3. proper management of pressure garments, DME
  4. proper skin care and protection

#### **Recommendations and referrals to other providers.**

- Occupational Therapy
- Speech Therapy
- Social Work
- Care Coordination
- Psychiatry
- Orthopedic Technician
- Medical interpreters
- Outside resources for the measurement and fit of compression garments
- Outside Resources such as support groups (e.g. the Phoenix Society). Visits by known burn survivors who can talk with patient and family can be arranged by the social worker

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## Re-evaluation

Re-evaluations should be performed every 10 days while patient is admitted to the hospital. However, re-evaluations may need to be performed more frequently in the setting of changes to medical status, new procedures or a significant change in function.

## Discharge Planning

**Commonly expected outcomes at discharge:** Patients who sustain large TBSA burns or smaller burns with complications, often require rehab placement to address continued impairments from a physical therapy standpoint as well as for continued wound management. Brigham and Women's Hospital has an established relationship with Spaulding Rehab in Boston and large majority of patients who have burn injuries are discharged to this facility. Sub-acute/SNF level rehab centers are an option for less involved burns if needed. Smaller burns can often be managed in the community usually with family assistance and home or outpatient physical therapy involvement. These patients are seen frequently in the burn clinic at BWH as well have daily visits by visiting nurses for dressing changes.

**Transfer of Care** When a patient leaves Brigham and Women's a thorough physical therapy discharge summary is necessary to assist with transition of care. The referral should include an updated hospital course particularly all grafting procedures, current functional status, an updated and complete integumentary assessment, status of compression garments, and current ROM measurements.

**Patient's discharge instructions** Patients who are discharged home are often given a written independent therapeutic exercise program, and with the involvement of their home physical therapists. Patients are also educated on the need for eventual compression garments and the mechanisms for obtaining these garments.

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