Pediatric Burn Rehabilitation

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Pediatric Burn Injury: Incidence and Cause

• Among children, burns are the third leading cause of injury leading to death (CDC data 2013)
• 28% of burn admissions under the age of 16 (National Burn Repository 2015 Report)
• Over half of all pediatric burns occur in children under 4 yrs (Birchenough et al., 2008).
• Cognitive and physical development influence burn etiology
• High percentage of children with burn injury are from “suspect home environment” and demonstrate developmental delay in language acquisition (Gorga et al. 1999)

Classification of Burn by Type

• Thermal-flame: more common in older children. Often high risk behavior and accidents
• Thermal-scald: most common in 1-4 year age group. Often involves cooking accidents and hot beverage spills. Abuse by scalding, especially at bath time, is a significant cause
• Thermal-contact: hot iron, smoldering coals, glass fireplace
• Chemical: less common in children
• Electrical: AC exposure can result in tetany and longer exposure to current. Look for signs of deep soft tissue injury, and delayed-onset neurologic damage, including sensation loss. Cardiac function closely monitored

Classification of Burn by Depth of Injury

• Superficial Thickness: Epidermis is erythematous and painful. Red skin blanches with pressure, typically heals in 3-6 days. Sunburn or flash burn
• Superficial-Partial Thickness: Papillary dermis is exposed (when blister de-roofed). Dermal appendages (hair follicles and sweat glands) intact. Painful, redness with blistering, moist, blanches, heals in 7-20 days
• Deep-Partial Thickness: Reticular dermis is exposed. Pain varies (nerve destruction) waxy appearance, heals 21+ days
• Full Thickness: Subdermal tissue exposed. Not usually painful, white/gray/black appearance, leathery and dry, over 2% TBSA does not spontaneously heal

• “Fourth Degree”: destruction of underlying tendon, muscle, bone
Brief Overview of Medical and Surgical Management

Airway protection, ventilation, oxygenation
• Inhalation injury: should be suspected any time patient was injured in an enclosed space, room, car, etc. CO poisoning
• Pulmonary toileting: mobility, CPT, percussive ventilation

Fluid Resuscitation/ circulatory maintenance/organ and tissue perfusion.
• In response to heat exposure protein is denatured and coagulates, resulting in tissue death. Vasoactive mediators are released in response to tissue destruction. When TBSA is greater than 10% (in young children or 15% in older children), inflammatory response to mediators is global/systemic. This leads to increased capillary permeability, intravascular fluid loss and interstitial fluid accumulation. (Sherwood and Traber in Herndon 2011)
• Parkland formula: fluid replacement to address burn-induced intra vascular fluid loss. Started immediately, urine output monitored closely
• Escharotomy: surgical incision through eschar with the goal of relieving pressure on underlying tissue
• Fasciotomy: incision through fascia of muscle compartment to relieve pressure which would otherwise result in compartment syndrome

Autografting
• Timing: “early” autografting procedure v. allowing epithelialization and or scarring. Progress in therapy is a consideration
• Thickness: full v. split-thickness autograft
• Wound preparation: stages may be required to establish a wound bed

Wound Care
• Principles and dressing selection: promote re-epithelialization, control microbial growth, minimize discomfort

Nutrition
• In larger burns the body enters hypermetabolic and catabolic state. Children are highly susceptible to protein-calorie deficit due to smaller muscle mass. Continuous feeds are started almost immediately. (Lee, Norbury, and Herndon in Herndon 2011)
**Biomechanical principles of tissue elongation:** (Dewey, Richard, Parry 2011)

- Successive Length Induction: Repeated “stretch” of skin or scar, through a plane of motion, until tissue length (as measured by joint ROM) no longer increases. Pulleys, theraband, etc
- Stress relaxation: The amount of force required to maintain a certain tissue length (measured by joint ROM) will decrease over time. Static progressive splints, serial casting
- Tissue creep: a constant force results in tissue lengthening. As force continues, tissue lengthening continues. Dynamic splints, tissue expanders

**Evaluation/Assessment.** Special attention paid to:

- Range of motion, power, neurological exam, and caregiver resources.
- Common post burn complications (especially for those sustaining an electrical current injury) include progressive paresis, paralysis, tremor, ataxia, (Arnoldo, et al in Herndon 2011)
- Parkinsonism can occur in cases of CO poisoning with symptoms appeared from 2 to 26 weeks after exposure (Choi 2002)
- Mononeuropathy as well as peripheral polyneuropathy are well documented complications of burn injury (Schneider and Qu 2011)
- Depth and location of burn injury
- Cutaneous functional unit (CFU) involvement. To allow range of motion (about a joint) fields of skin (usually proximal and distal to that joint) must move freely, and often accommodate a longer limb length. The areas of skin which contribute to this movement have been identified and referred to as CFU’s. (Richard, et al. 2009)

**Treatment**

**Mobility/Ambulation:**

- Ventilator dependence, use of vasoactive drugs, and/or poor cognition are not contraindications to transfers and walking
- LE vascular support is vital for pain control and wound healing. Goal should be normal gait pattern at independent. Assistive device may unnecessarily extend time frame for achieving goal of normal gait
Positioning:
- Positioning is vital to help manage edema and its’ side effects
- The position of comfort is often the position of deformity/contracture. The anti-deformity position is, in general, opposite the fetal position
- Ideally a patient with burn injury will be able to position themselves in the anti-deformity position while they are not actively participating in therapy, completing ADL’s, etc. however, restraints and splints may be required

Passive Range of Motion
- frequently used intervention to provide more force (stress) through a field of scar or skin than the patient is able to apply themselves
- Therapist should choose a position with allows the patient the possibility to be relaxed. This should be balanced with choosing a position which recruits as much of the involved CFU(s) as possible
- Be cognizant of joint kinematics and the influence scar band(s) may be playing on normal joint motion
- As soon as possible, train family in a technique which can be used at home

Splinting
Indications
- Primary focus= prevent and manage scar contracture
- Protection of vulnerable soft tissue or open wounds, and increasing or maintain skin or scar length (Richard and Ward 2005)
- Splinting can decrease scar contracture faster compared with daily ROM, massage, compression therapy (Richard, et al 2000)
- Acute, post-operative graft protection, reconstructive needs
  - Acute: Early splinting is key

Pediatric Hand Anatomy considerations:
- The pediatric population has thinner skin than adults, thus a deeper burn results with less insult
- Children do not have the thicker, protective skin calluses that protects adults (Birchenough, Gampper, Morgan, 2008)
- Palmar skin has a thick dermis, is hairless, and has no pigmented cells
- The thickest keratinized layer is over the finger pads and other surfaces that make frequent contact
- The skin is thinner in flexion creases, such as the DPC

Post-operative graft protection:
- Therapy present in OR s/p grafting
- Length of time of post-op splinting dependent on type of graft
Principles
• Visually assess wound depth and baseline ROM
• Determine direction and degree of pull
• Fabricate splint that will use tissue creep, constant force for CFU gains in time
• Educate family re: precautions, schedule, compliance necessity
• TIMELY and tedious, be patient, distraction is necessary

Design
• Static vs. Dynamic, take in consideration age= Choose static splinting
• Custom splints are best for child’s size, remolding, and best fit
• Consider “child-friendly” and appealing splints with colors, decorations
• Materials: Orthoplast, Polyform, thermoplastic with good memory
• Type of splint for hand burns:
  Dorsal hand burns: Anti-deformity or Intrinsic + position
  Palmar hand burns: “Pan” hand
  Circumferential hands burns: BOTH but with alternating schedule
• Other pediatric splints for contracture prevention:
  Airplane/axillary extension splint
  Elbow extension splint
  Knee extension splint
  Dorsi-flexion/foot drop splint

Wearing schedule considerations
• Deep partial or full thickness open wounds under age 2= splint wounds 24/7
• Remove 5 times/day for PROM IF family is compliant with HEP, otherwise splint
• If bilateral hands burned, alternate schedule (4 hours on/4 off)
• Always splint at night to prevent flexion contracture
• Scar maturation is not complete until 6-8 months post-burn, splint throughout
• Changes in ROM can occur week to week, so splint and/or schedule may alter

Scar Management Interventions
• Compression garment therapy
  Fabricated to decreased vascular symptoms such as edema, itching, and to promote wound healing
  Mostly custom based using Tubigrip, Demagrip materials
  Coban wrapping for fingers, smaller extremities
  May have to wear compression up to 2 years post-burn depending on depth of burn
• Scar massage
  Daily deep pressure massage 3x/day to scar contracture with thick cream
  Assists with desensitization and hypersensitivity of scar tissue

• Silicone
  Different silicone products such as hydrogel, gel sheets can assist with softening
  scar tissue/contracture
  Can be used and applied with compression garments

Case Studies
References: Pediatric Burn Rehabilitation


