# Burning Questions: Navigating Burn Care & Rehabilitation for the Injured Worker

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# Disclosures

- Dr. Murtaugh does not have any financial or non-financial disclosures related to the content for this educational event.

# Objectives

- Describe the etiology and pathophysiology of burn injury.
- Identify medical and surgical management techniques to address severity of burn injury.
- Analyze value of specialized post-acute rehabilitation.
- Evaluate long-term interventions for hypertrophic scar management to promote function.
- Identify facilitators and barriers of return to work after burn injury.

# Burn Injury 101

# Burn Injury (ABA, 2020)

- 450,000 injuries/year requiring medical treatment.
- 3,400 deaths.
- 30,000 admits to hospital burn centers.
- 96.6% survival rate.
- 43% fire/flame, 34% scald, 9% contact, 4% electrical, 3% chemical.
- 72% occur in the home, 9% work.

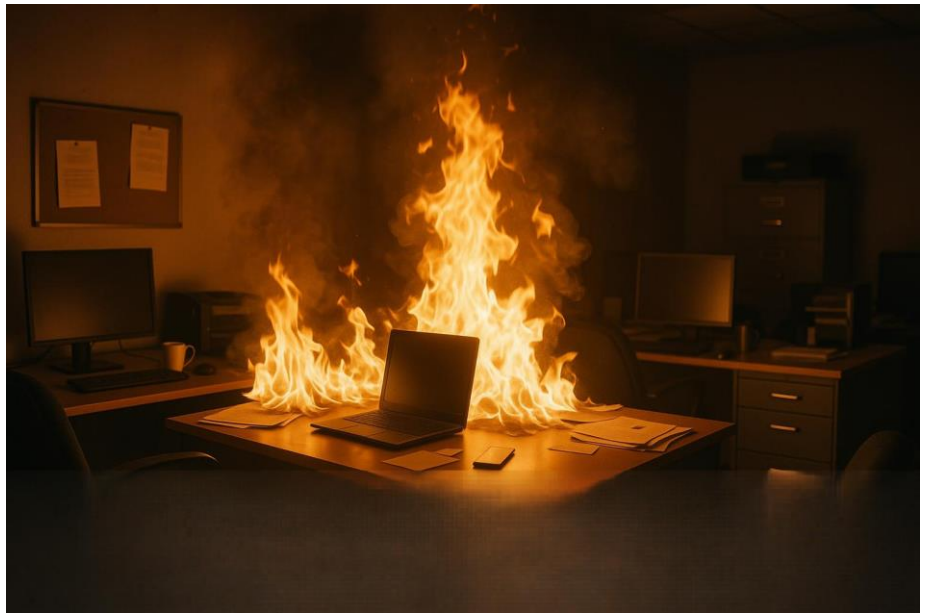
# Cost of Burn Injury

- Dependent upon TBSA%, severity, surgical, rehabilitation, psychosocial and long-term needs.
- Also dependent upon individual patient factors: age, comorbidities
- High-Income Countries=United States
  - $88,2018 (range $704.00-$717,306; median $44, 024)
  - Average cost of 1% TBSA=$6,442.85

# Etiology

- Differs with age and geography
  - Hot liquids
  - Ignition of flammable liquids
  - Ignition of clothing
  - Outdoor recreational fires
  - Fire walking
  - Work related burns
  - Chemical
  - Electrical
  - Assault
  - Self-immolation
  - Child Abuse

- Most Common Work Related MOI:
  - Heat/Flame
  - Electrical
  - Chemical



# Burn Pathophysiology

Superficial burn

3-7 days to heal

Superficial-partial thickness

Deep-partial thickness

2-3 weeks to heal, may need specialized burn intervention

Full Thickness

Need specialized burn medical & surgical intervention

# Electrical Burn

- High intensity thermal burns
- Smaller the body size, greater the intensity of heat, more concentrated
  - Entrance and exit
  - May need grafting
- Smaller TBSA
- Higher mortality
- Higher internal organ/systemic injury
- Increased risk for cardiac arrhythmias
- Increased risk for blowout amputation
- A few case reports on vision changes post electrocution

  - High risk of UE/LE amputations
  - Possible tissue flaps

# Chemical Burn

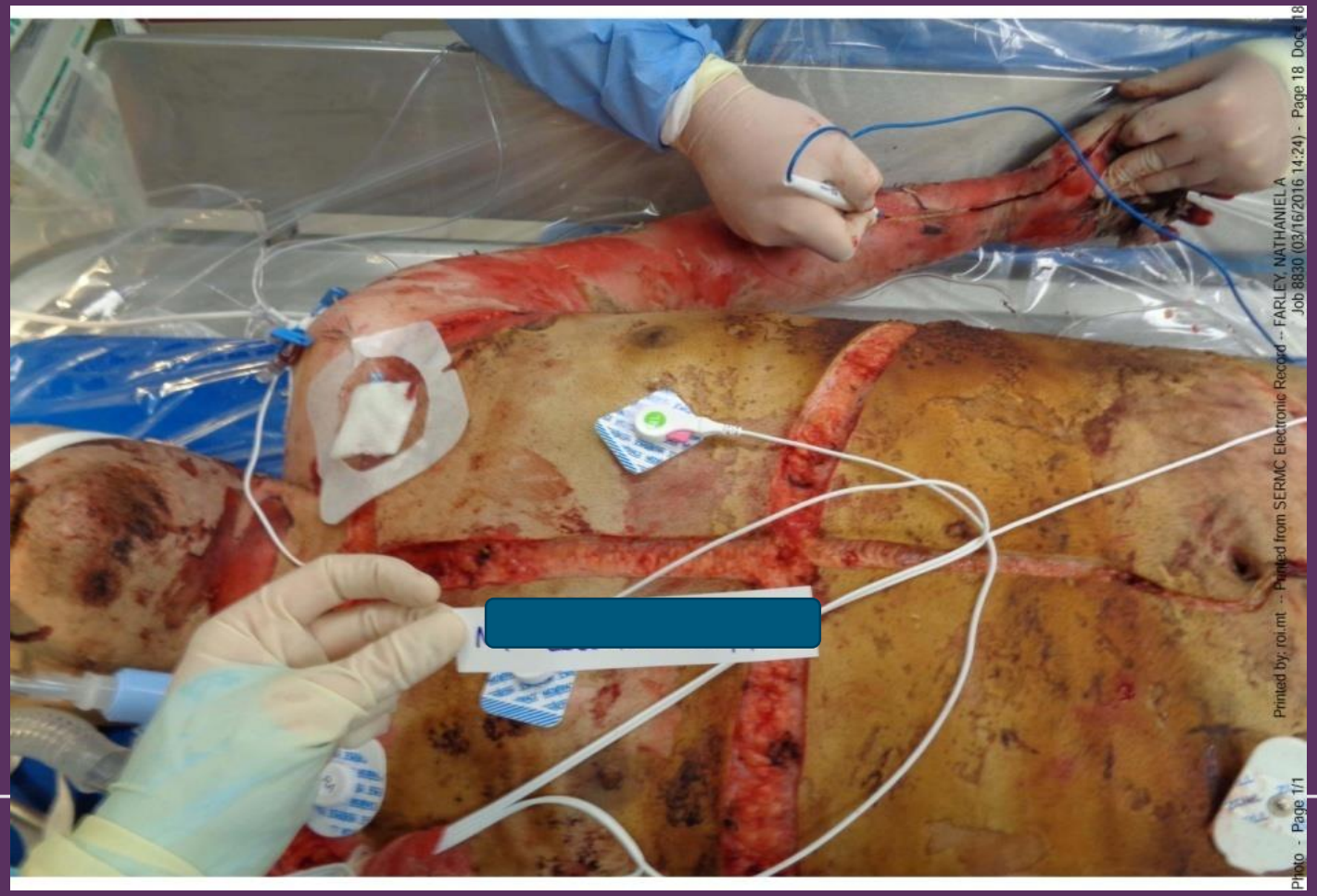
- Progressive damage
- Full thickness can be deceptive as superficial
- Skin remains intact but begins to slough as time goes on

# Who Requires Specialized Burn Center?

- Superficial partial/deep partial burn
- Full thickness burn
- Greater than 10% TBSA
- Any TBSA with involvement of:
  - Hands
  - Face/Neck
  - Perineum
  - Genitals
- Electrical mechanism
- Chemical mechanism

- Burn Injury most excruciating type of pain.
  - Headache Report (2008).
- Burn survivors at higher risk for PTSD development.
- Complicated by repetitive pain and trauma of burn procedures.

# Burn Injury Medical & Surgical Management



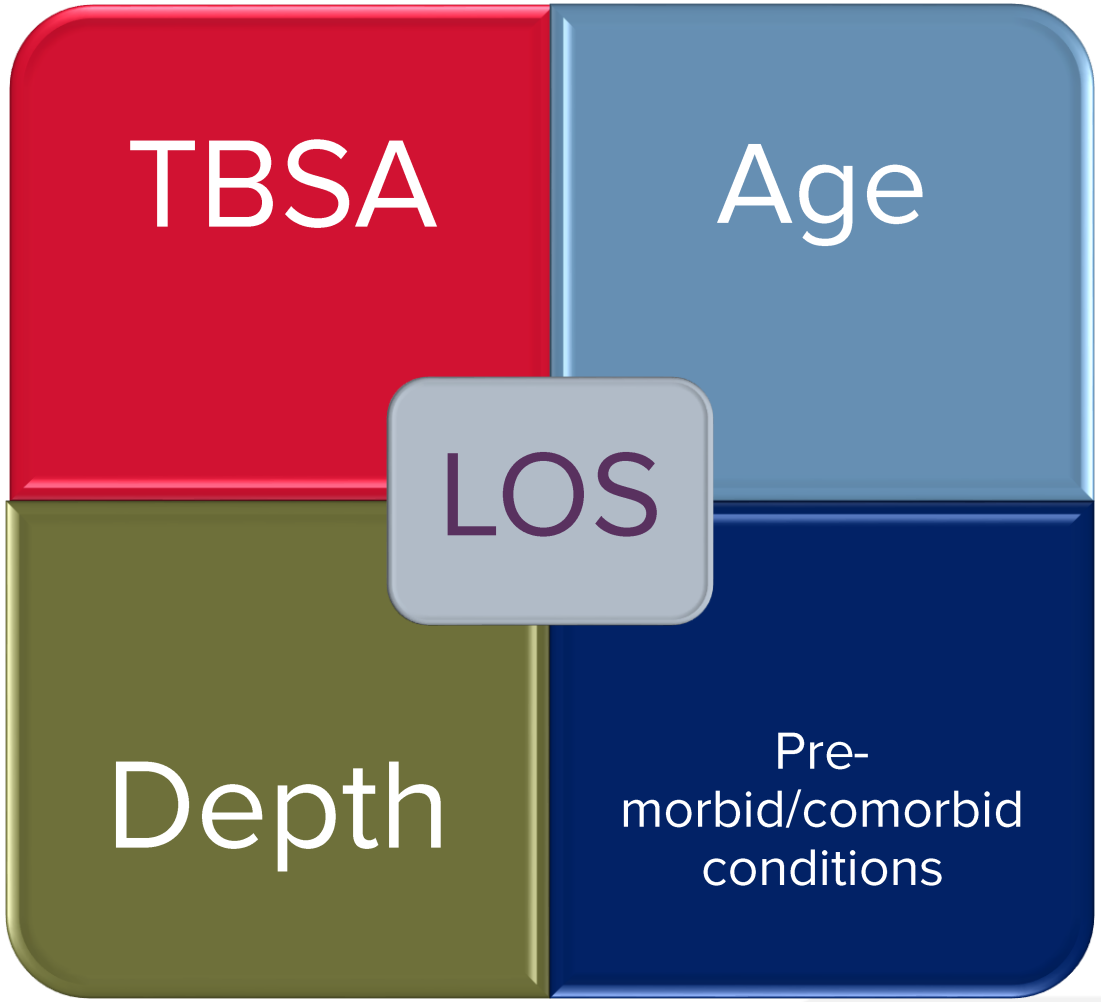
# Burn Injury and Mortality

- Survival of high TBSA continues to increase within the USA.
- Long-term mortality is significantly higher than non-burned counterparts.
  - All cause of death
- Lower life expectancy vs non-burned counterparts
- Infections leading cause of mortality.

# TBSA vs Acute LOS

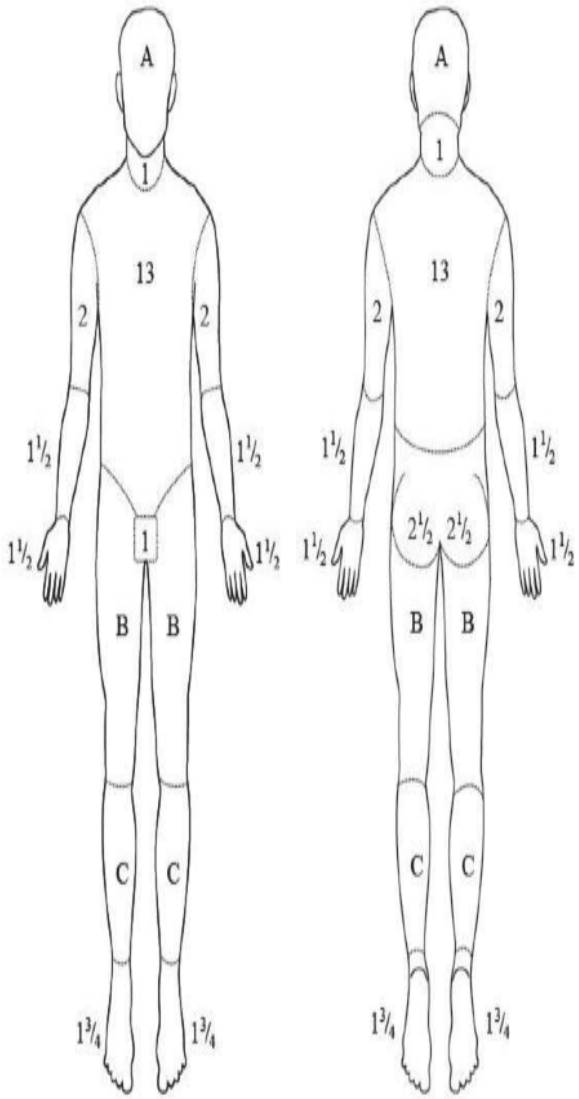
- TBSA most significant factor impacting LOS.
- Age
- Depth of Injury
- Pre-morbid conditions.

(LOS range: 1-455 days;
Median of 5 days)




Ohnah et al., 2021; *International Journal of Environmental Public Health*

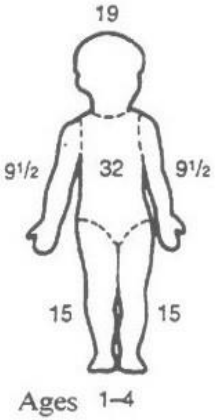
# Lund and Browder Chart

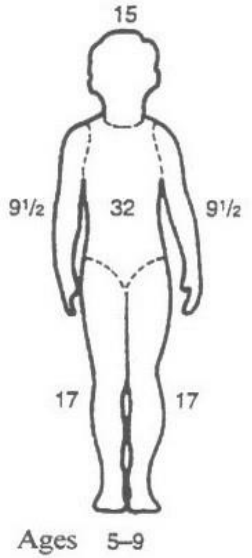


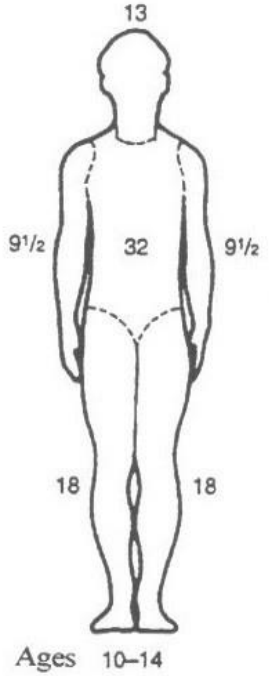

| Region | Partial thickness (%) [NB1] | Full thickness (%) |
|---|---|---|
| head | | |
| neck | | |
| anterior trunk | | |
| posterior trunk | | |
| right arm | | |
| left arm | | |
| buttocks | | |
| genitalia | | |
| right leg | | |
| left leg | | |
| Total burn | | |
| NB1: Do not include erythema | | |

| Area | Age 0 | 1 | 5 | 10 | 15 | Adult |
|---|---|---|---|---|---|---|
| A = half of head | 9½ | 8½ | 6½ | 5½ | 4½ | 3½ |
| B = half of one thigh | 2¾ | 3¼ | 4 | 4½ | 4½ | 4¾ |
| C = half of one lower leg | 2½ | 2½ | 2¾ | 3 | 3¼ | 3½ |

# Rule of 9s

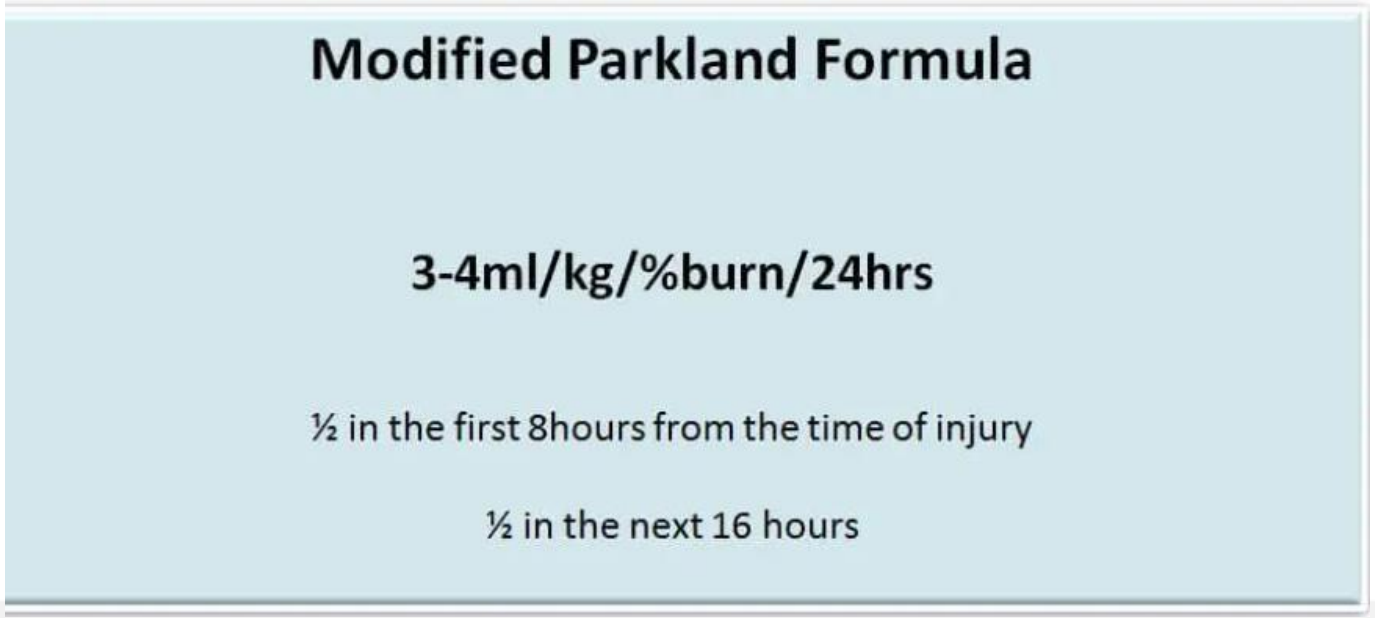


# Burn Pathophysiology

- Pathological response is proportional to % burn.
- Massive fluid shift from cardiovascular system to peripheral tissues.
  - Hypovolemic shock
- Water, sodium, plasma, move from capillaries to interstitial spaces causing increased edema.

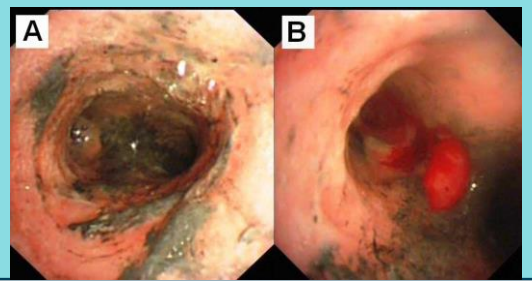


## Skeletal Muscle

- Burns exceeding 40% disrupt bone metabolism
- Bone Loss
- Calcium wasting
- Bone loss up to a year
- Muscle bulk loss
- Muscle atrophy
- Poor bone density
- Increase fx risk

## Cardiovascular/ Pulmonary

- Increased vascular permeability
- Increased interstitial edema
- High cardiac output
- Paradoxical depression of cardiac function
- Intravascular hypovolemia
- Inhalation injury
  - Immediate or late mortality
- ARDS/Pneumonia




## Renal

- Acute renal dysfunction
- Impaired renal function increased mortality rate
- Acute kidney injury
- Kidneys work overtime


## GI

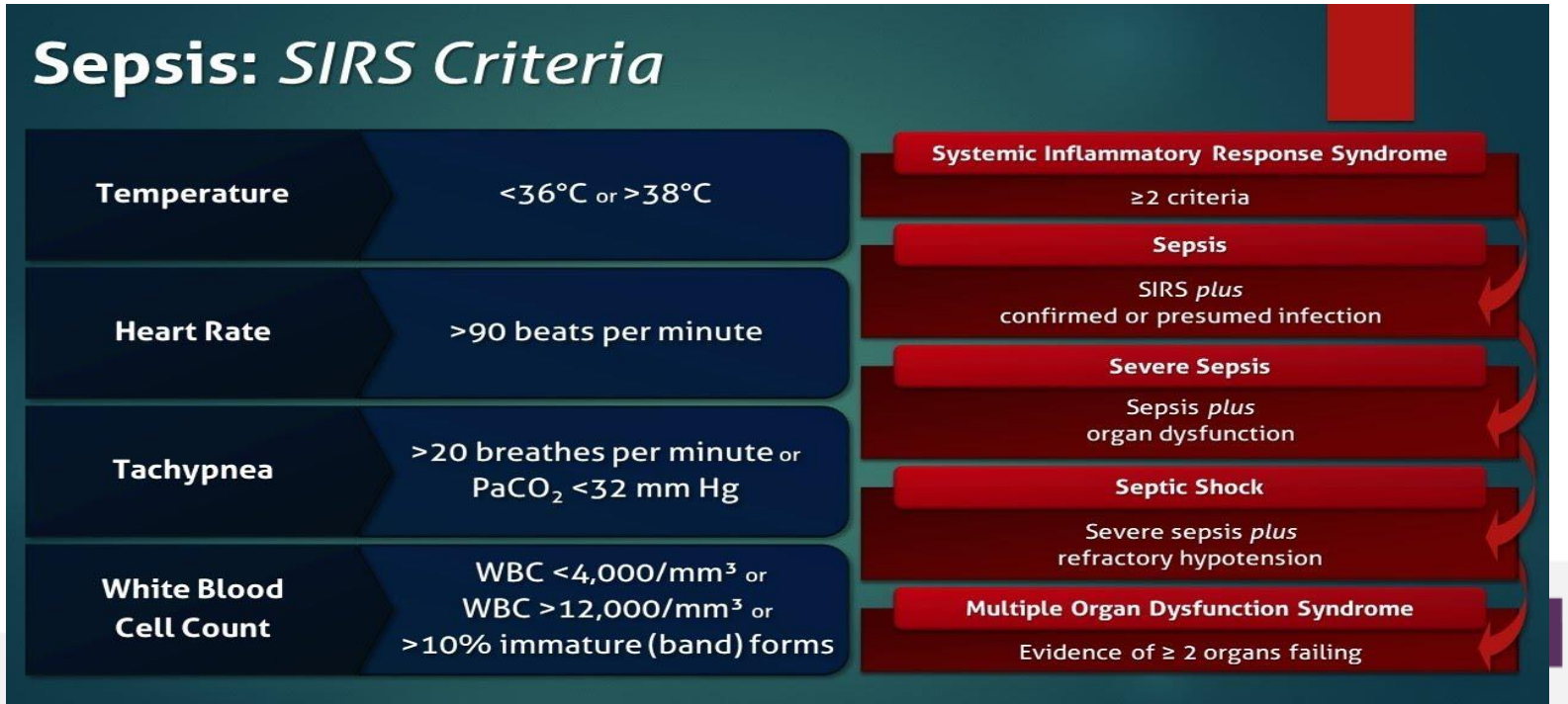
- Changes in digestive absorption
- Decreased intestinal blood flow
- Feeding intolerance
- Reduced motility and ileus
- NG may be required for prolonged periods

# Abdominal Compartment Syndrome

- https://bestpractice.bmj.com/topics/en-gb/1125
- http://www.emdocs.net/abdominal-compartment-syndrome-when-should-it-be-on-your-differential/

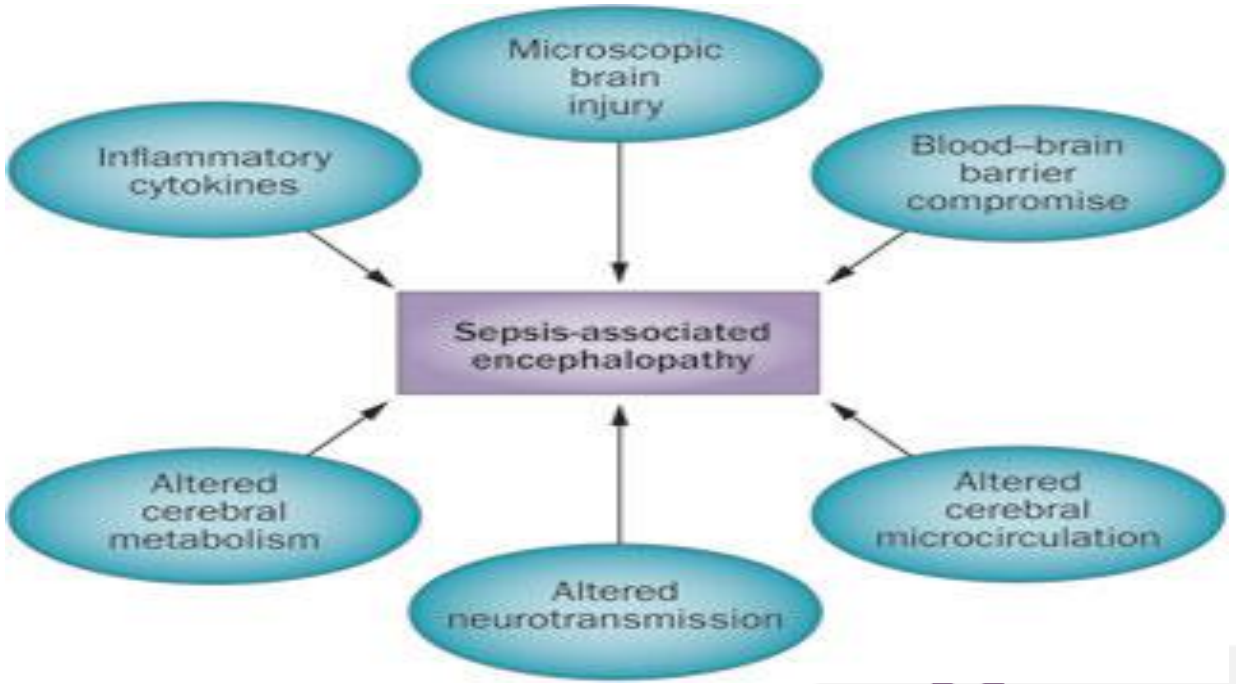
# Systemic Inflammatory Response Syndrome

- Significant cause of morbidity and mortality.
- Progresses to sepsis
- Exaggerated response to trauma, acute inflammation
- Can lead to Multi-System Organ Dysfunction
- Inflammatory response can progress to neuro-inflammation.



# Sepsis Associated Encephalopathy

- Encephalopathy=disease that damages your brain.
- Neurological complication of sepsis.
- Proinflammatory cytokines reduce the integrity of the BBB.
- Has significant impact on limbic system and hippocampus resulting in cognitive deficits.
- Impacts 1/3 of septic patients.



# SAE

- Three major processes involved in SAE:
  - Neuroinflammation
  - Ischemia
  - Neurotransmitter dysfunction
- All resulting in decreased function of the brain.

# Burn Injury & Delirium

- Prevalence of delirium 13-80% in burn patients.
- 77% in mechanically ventilated burn survivors

TABLE 2 Risk factors for delirium in burn patient's summary.

| Items | Details |
|---|---|
| Personal factors | Advanced age, dementia, low educational attainment, diabetes, hypertension, heart disease, history of alcohol use, history of smoking |
| Clinical factors | Severity of burn injury, benzodiazepines, opioids, anticholinergic drugs, surgical treatment, blood transfusion, pain, infection, hypoxemia, MV, dysglycemia, electrolyte disorders |
| Environmental factors | Sleep deprivation, circadian rhythm disorders, physical restraint, absence of family companionship |

MV, mechanical ventilation.

Ren, Y., et al. Research progress on risk factors of delirium in burn patients: a narrative review. *Frontiers in Psychiatry* (2022).

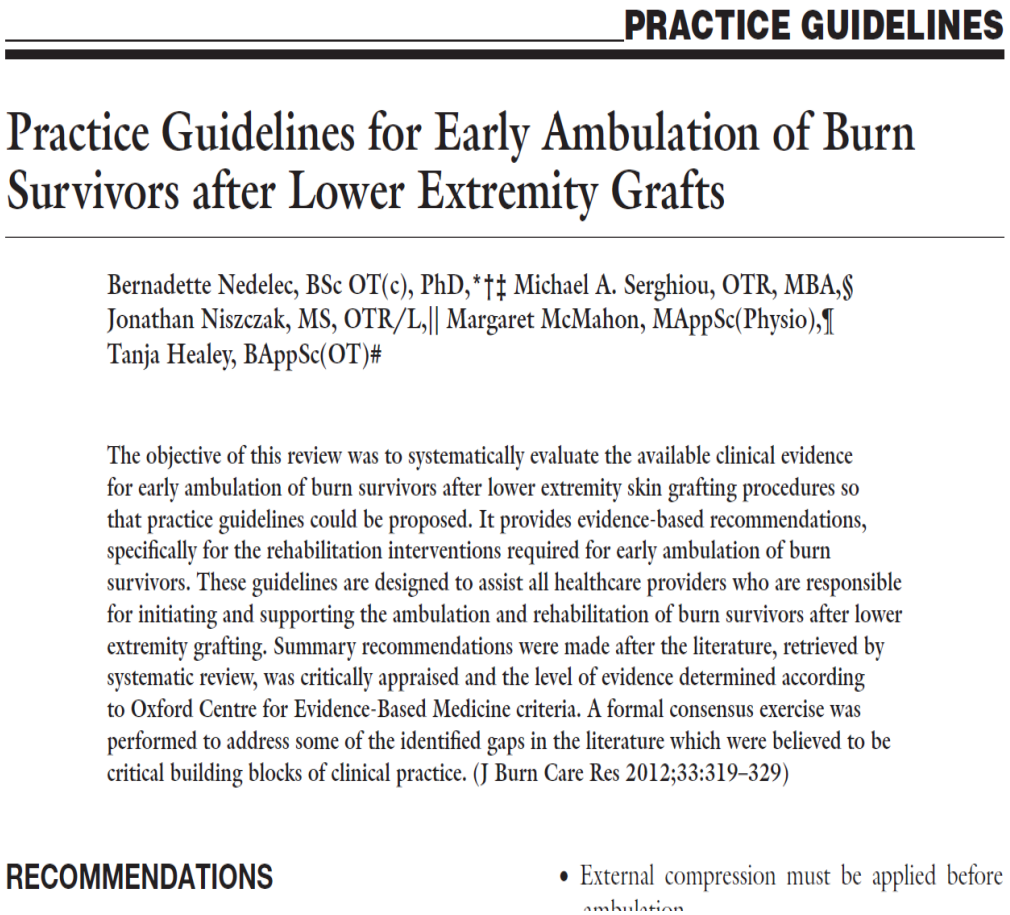
# Ensure SLP & Psych Referrals and Interventions

- PADIS & ABCDEF protocols and Guidelines to decrease delirium and immobilization.
- Implementation of cognitive & delirium screenings
  - Confusion Assessment Method (CAM)
  - ICU Delirium Screening Checklist
  - Nursing Delirium Screening Scale

- Bedrest
  - Depending on physician and autografting location, may be ordered for 3-7 days
  - Compounds immobility sequalea

# Early Mobilization CPG

- Pre-grafting AROM is recommended
  - Biosynthetic Skin Substitute
- Early post-op ambulation protocol should be initiated immediately or as soon as possible.
- External compression must be applied.
- Graft crosses a joint, the joint should be immobilized continuously.



PRACTICE GUIDELINES

## Practice Guidelines for Early Ambulation of Burn Survivors after Lower Extremity Grafts

Bernadette Nedelec, BSc OT(c), PhD,*†‡ Michael A. Serghiou, OTR, MBA,§ Jonathan Niszczak, MS, OTR/L,|| Margaret McMahon, MAppSc(Physio),¶ Tanja Healey, BAppSc(OT)#

The objective of this review was to systematically evaluate the available clinical evidence for early ambulation of burn survivors after lower extremity skin grafting procedures so that practice guidelines could be proposed. It provides evidence-based recommendations, specifically for the rehabilitation interventions required for early ambulation of burn survivors. These guidelines are designed to assist all healthcare providers who are responsible for initiating and supporting the ambulation and rehabilitation of burn survivors after lower extremity grafting. Summary recommendations were made after the literature, retrieved by systematic review, was critically appraised and the level of evidence determined according to Oxford Centre for Evidence-Based Medicine criteria. A formal consensus exercise was performed to address some of the identified gaps in the literature which were believed to be critical building blocks of clinical practice. (J Burn Care Res 2012;33:319–329)

RECOMMENDATIONS

• External compression must be applied before ambulation

# Post-Burn Metabolism & Nutrition

# Nutritional Support

- Crucial for survival and healing/recovery
- Metabolic rate increases >2x of their baseline
- Parenteral Nutrition
- Enteral Nutrition
  - NG/PeG Tube
- Ideally transition to PO intake
- Hypermetabolism ≥ 2 years post-injury
- Long-term Nutrition Therapist may be needed

# Effective Post-Burn Pain Management

Greatest barrier to participation

Goal:

Effective pain management to participate in daily rehabilitation and return to community.

# Burn Pain

- Can manifest in many forms.
  - Sharp/Stabbing
  - “on fire”/burning pain
  - “pins and needles”
  - Chronic ache
  - Hypersensitivity

- Burn survivors less likely to be provided opioids and non-opioid pain management compared to ortho trauma. (Prasad, 2018)
- Pain experience changes over time

# Post-Burn pain can by physical and/or psychological.

# Pain Management

- #1 complaint
- 2 types of post-burn pain:
  - Evoked & Procedural
  - Background pain

- Inflammatory response causes pain.
- Ischemia to tissues can cause pain.
- Neuropathic pain=damage to somatosensory system.
- Immobility/joint and soft tissue changes

- Appropriate pain management reduces morbidities and chronic pain issues.

- Opioids
  - IV, enteral, PO
  - Burn may need opioid escalation over other dx.
  - Pain reassessment should be frequent to decrease opioid side effects and dependence.
  - Should be weaned during IRF stay

# ABA Burn CPG for Pain Management

## Recommendations

- Serial pain assessment
- Recorded by MD & nursing
- Individualized opioid therapy
- Opiates not used in isolation
- Consider Ketamine for procedural sedation
- Agents for neuropathic pain should be considered.
- Anxiety medications to decrease anxiety related to pain

## Non-pharmacologic pain management recommendations

- Cognitive behavioral therapy
  - Visual imagery
  - Distraction
  - Hypnosis
  - Virtual Reality
  - Individualized coping strategies

**Must have pain management regimen appropriate for home & community.**

**Community PCP Management**

**Poor pain control and chronic pain is a barrier to return to work and quality of life after burn injury.**

# Psychological Sequelae Post Burn

# Psychological Recovery

- Response is normal to abnormal experience.
- Emotional Themes
  - Fear and worry
  - Uncertainty about the future
  - Physical Pain
  - Disfigurement
  - Family/Sexual Relationships
  - Depression/Anxiety

# Psychological Recovery

- Must assist in addressing any premorbid issues
  - Mental health
  - Substance Abuse
  - Support Systems
- Address issues post burn
  - PTSD
  - Coping
  - Adjustment
  - Death

# Surgical Management of Burns

# Initial Surgical Management

- Expedient tangential excision eschar and necrotic tissue debridement.
  - Decreases risk of infection
  - Decreases risk of SIRS
  - Timely wound closure
  - Identify depth of burn

# Acute Care Management

Escharotomy

Fasciotomy

# Temporary Skin Substitutes

- Porcine/xenograft
- Human allograft
- Human amnion
- Biosynthetic Skin Substitute

# Skin Grafting

- Autografting
  - Mesh
  - Sheet
- Allograft
  - Cadaver
  - Skin Banks
- CEA
  - Increase cosmesis
  - >LOS
  - Thin & delicate
  - Prone to shearing


# Donor Sites

- Site of graft harvest
- Try to match skin tone
- Most common sites
  - Thighs
  - Back
  - Abdomen
  - Scalp
- Can be painful
- Itching
- Dryness

Donor adjacent to graft

# Tissue Flaps

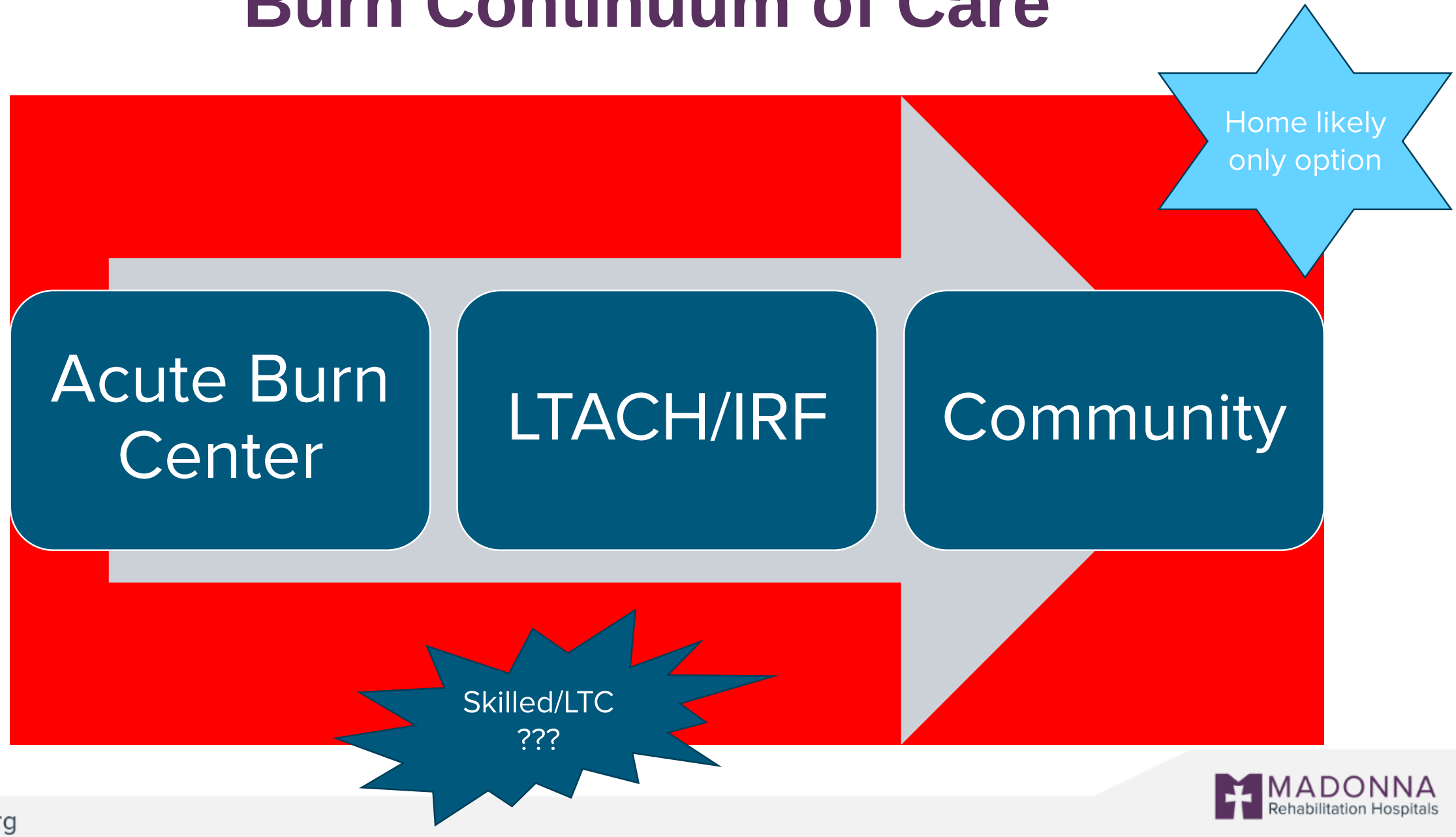
- Full thickness burn
  - Bone
  - Joint capsule
  - Exposure of bones and joints
- Only used in small areas and to salvage appendage length.

# Amputation

- Non-viable tissue
- Life-saving measure
- Increased incidence in electrical burns.
- Involve prothetists early!!

# Guide the Burn Team on Appropriate Discharge Disposition

# Burn Continuum of Care



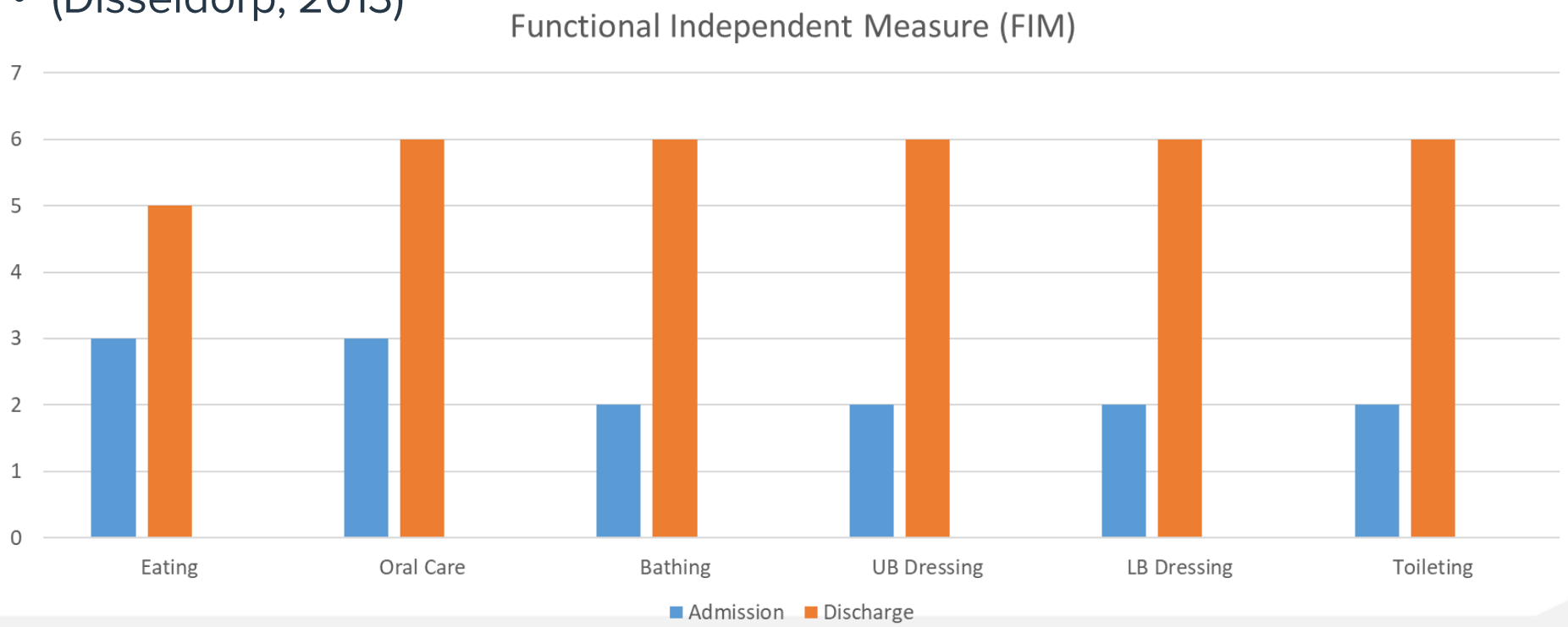
# Why Burn Rehabilitation?

- “An early and intensive inpatient rehabilitation program is critical for restoration of physical, psychological, and functional outcomes after significant burn injury.”

    - Gomez, 2016.

# Burn Rehabilitation

- Greater FIM Gain
  - (Spires et al, 2005)
- Decrease need for long-term care
  - Decrease need for long term health care resources
- Decrease incidence of long term disability
  - (Disseldorp, 2013)






MADONNA Rehabilitation Hospitals

9000 burn survivors utilized IRF services since 2012

# IRF Burn Characteristics

- Burn dx included in the CMS inclusion rule for IRF.
- 8-26% of burn injuries require IRF.
- Greater than 20% TBSA
- Multiple comorbidities
- Hands and feet involved in TBSA
- Prolonged ICU stay
- Mechanical ventilation
- Usually meet InterQual Criteria for 3 hours

# Post-Acute Wound Care

Goal:

Promote continued wound healing & decrease burden of wound care

# Interdisciplinary Collaboration

- Dressing orders from Acute Burn Team
- Wound Care evolution and changes in dressing orders required
- Infection Prevention
- Functional
- Who on team leads daily burn cares?
- Increase pt Independence with burn cares/family education

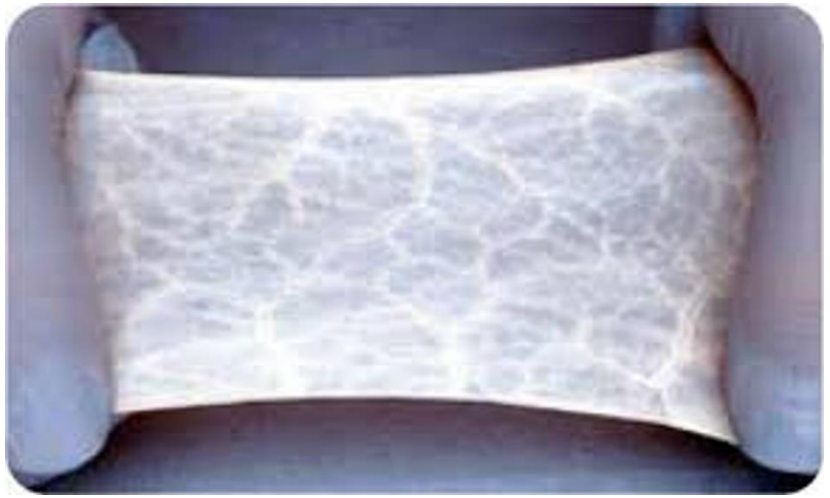
# Burn Dressings

Therabond

Xeroform

Wound Veil

Dermal Matrix



# Burn Dressings

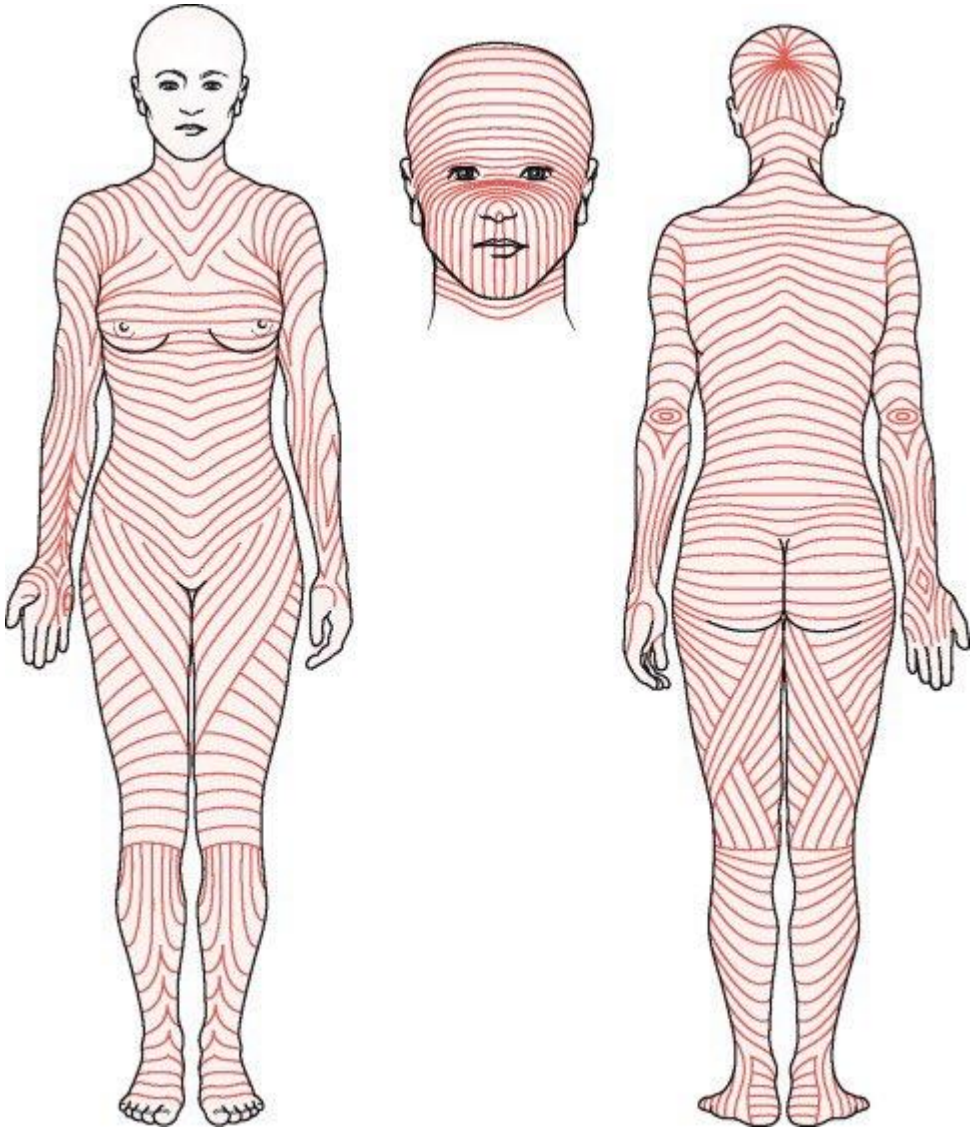
- Compression
- 23 hours a day
  - Scar management
  - Edema management
  - Cosmetic
  - Surgilast
    - Appropriate size
  - Ace wrap
    - Distal to proximal wrap
  - Tubigrip
    - Appropriate size
  - Permanent garments

# Hypertrophic Scar

Most apparent pathognomnic characteristic of burn injury.
Undesired outcome
Visually and functionally distinct from intact skin

# Skin Tension Lines

- 2x more skin movement distally.
- Proximally skin moves less.
- Distal skin needs to move more.
- Must assess skin/burn patterns
  - Adjacent burns
  - Burns crossing joint surface.



# Burn Hypertrophic Scar

- Significant patient burden: functionally, cosmetically/psychologically
- Absent elastic fibers
- Collagen and fibroblasts develop a transverse orientation vs. linear.
- Ground substance takes over-20% increase
- Prolonged inflammatory phase of healing.
- Prolonged healing via secondary intent.
- Raised above the level of the skin.
- Incidence: 38-54% at hospital dc

# Characteristics of Hypertrophic Scar

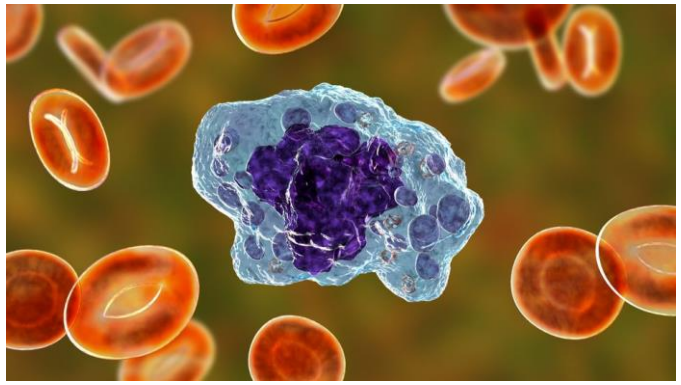
- Thick & Raised
- Inelastic & Contractile
- Discolored/hyperpigmented
- Pruritic
- Painful

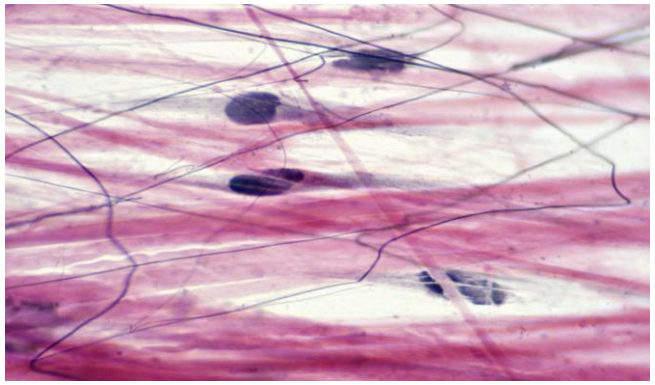
Risk Factors

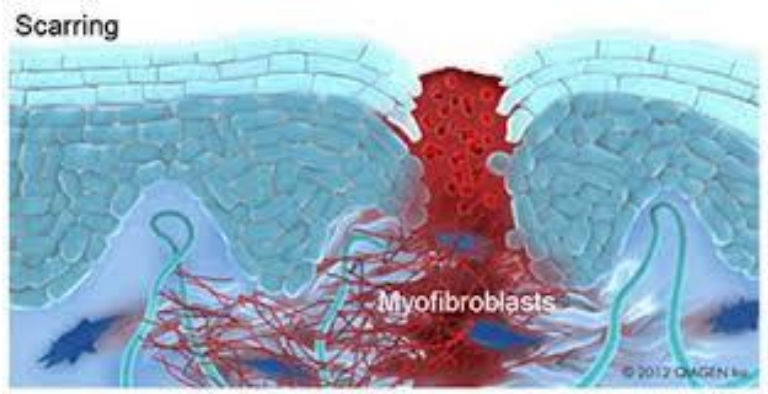
- Age
- Race/Genetics
- Depth & time of healing
- Infections

# Hypertrophic Scar Formation

Inflammation → Cell Proliferation → Matrix Remodeling

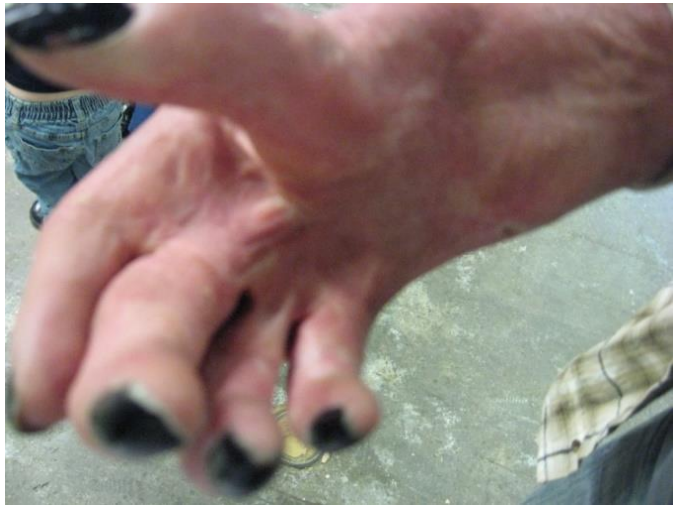






# Burn Scar

- Red
- Raised
- Rigid
- Gradual replacement of original scar tissue over 6-12 month period



# HTS Conservative Management Interventions

- Prolonged positioning
- Orthotics
- Edema management
- Silicone therapy
- Compression therapy
- Surgical interventions

# HTS & Burn Complication Surgical Management Techniques

Long-term and chronic management

**Early treatment and rehabilitation to address scars and deformities will lessen the risk of need of surgical reconstruction.**

# Burn Injury Surgical Reconstruction

- Various techniques
- Spectrum of timeframe post injury dependent upon body part
- 18-24 months to allow for scar maturation
  - May be earlier for functional limitations
- Surgical Reconstruction Techniques
  - Primary wound closure
  - Skin flaps/skin grafts
  - Z-plasty
  - Tissue expanders
  - Laser therapy

# Ablative Fractional CO2 Laser Treatment

- Co2 laser creates microscopic “cuts” in the scar/treatment area
- Stimulates collagen and myofibroblasts and epidermal matrix production for resurfacing of scar
- Allows for increased elasticity, reduces scar tissue and smoothens surface of scar
- Preps scar for response to continued stretch and compression therapies.

https://www.thepmfajournal.com/features/post/co-laser-treatment-for-burn-scars

# Evidence for Fractional CO2 Laser Treatment & Burn Scars

- Meta-analysis (Choi, et al; 2021)
- 15 studies analyzed
- Vancouver Scar Scale & Patient/Observer Subjective Assessment Scale
- 778 patients
- Median 2.5 treatments/patient
- 1-3 months between treatments
- 80% of studies found statistically significant improvement in VSS & POSAS scores vs control group

# Pulsed Dye Laser

- Targets blood vessels within scar to remodel scar and reduce pigmentation and height.
- Improves pliability
- Scar height and size is not primary outcome of PDL

# Laser Therapy Implementation

- Paradigm of implementation evolving
- Waiting 1 yr. post isn't better
- Recent evidence supports early laser treatment before scar is mature
  - (Warble et al; 2019); (Ukoummunne, et al; 2025); (Lewis et al. 2023)
  - Statistically significant improvement in scar characteristics
  - Laser completed within 3 months of injury
  - Improved visual and functional outcomes
- 1-3 months post injury
- Treatments can be every 6 weeks ongoing

# Return to Work

- Several studies report barriers to return to work:
  - Physical abilities
  - Working conditions
  - Wound issues
  - Psychological factors
  - Social factors
    - Appearance
  - LT Disability

# Return to Work

- Espinoza et al (2019):
  - BMS study
  - 695 burn pts.
  - Access to PAC resulted in increased RTW
  - 66-90% RTW @ 6-24 months post injury
  - RTW resulted in:
    - Increased QOL
    - Less utilization of Medicare/Medicaid
    - Increased psychosocial health
    - Less chronic pain

https://burncenters.com/patient-stories/burn-survivor-soars-to-new-heights/

# Long-Term Management

- Employment status
  - Disabled?
  - Return to work?
- Continued follow up with outpatient burn clinic
  - Compression therapy
  - Reconstructive surgery
  - Laser surgery
  - 18-24 months
  - Chronic pain management
- Continue to manage psychological/emotional aspect of injury
- Peer support

# Burn Rehabilitation: Case Study

# NF

- 22 year old male
- North Platte, NE.
- Working at Menards
- Has 18 month old son.
- Enjoyed movies, video games, music, time with family and friends.

- Explosion working on his motorcycle.
- 96% Total Body Surface Area full-thickness burns.
- Father sustained 80% burn injury.
  - Succumbed to injuries 11 days later.
- Flown to St. Elizabeth's Regional Burn Center

- Acute Burn Center
  - 36 surgeries
  - B LE Amputations
  - Digit amputations R hand
  - HO R elbow
  - Not counting central line placements and changes.
  - Was at Burn Center from February 2015-August 2015.
  - Much of that time on bed rest secondary to multiple graftings and surgeries.
  - $>1 Million in costs

- Inpatient Rehabilitation August-December 2015
- Admit
  - Dependent for all self cares, transfers, mobility
  - Power wheelchair mobility
  - Collaboration with Prosthetist for LE prosthetics
  - Family Training
  - Home Modifications

- D/C
  - Independent with Transfers
  - Independent with bed mobility
  - Minimum assist for bathing
  - On commode for toileting, continues to require assistance for toileting.
  - Set up for upper body dressing sitting up in w/c.
  - Participating in lower body dressing.
  - R UE still non functional
  - Continued with OP therapies for increased function and prosthetic training

# Questions?

Thank you!!

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