Burn Rehabilitation

University of Toronto

November 3rd, 2017

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St. John's Rehab

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Disclosures

- Nothing to disclose

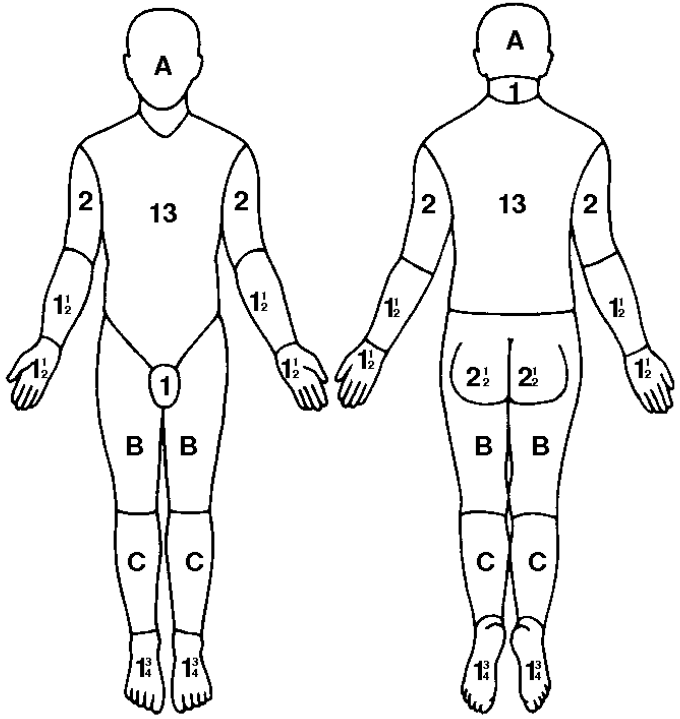
Learning Objectives

- Functional implications of burn injury
- Rehabilitation interventions
- Burn injury specific complications
- Burn rehabilitation research

DEFINING BURN INJURY

Size – Total Body Surface Area (TBSA)

LUND AND BROWDER CHARTS



Ignore simple erythema.

Superficial

Deep

REGION	%
HAED	
NECK	
ANT. TRUNK	
POST. TRUNK	
RIGHT ARM	
LEFT ARM	
BUTTOCKS	
GENITALIA	
RIGHT LEG	
LEFT LEG	
TOTAL BURN	

RELATIVE PERCENTAGE OF BODY SURFACE AREA AFFECTED BY AGE

AREA	AGE 0	1	5	10	15	ADULT
A = 1/2 OF HEAD	9 1/2	8 1/2	6 1/2	5 1/2	4 1/2	3 1/2
B = 1/2 OF THIGH	2 3/4	3 1/4	4	4 1/2	4 1/2	4 3/4
C = 1/2 OF ONE LOWER LEG	2 1/2	2 1/2	2 3/4	3	3 1/4	3 1/2

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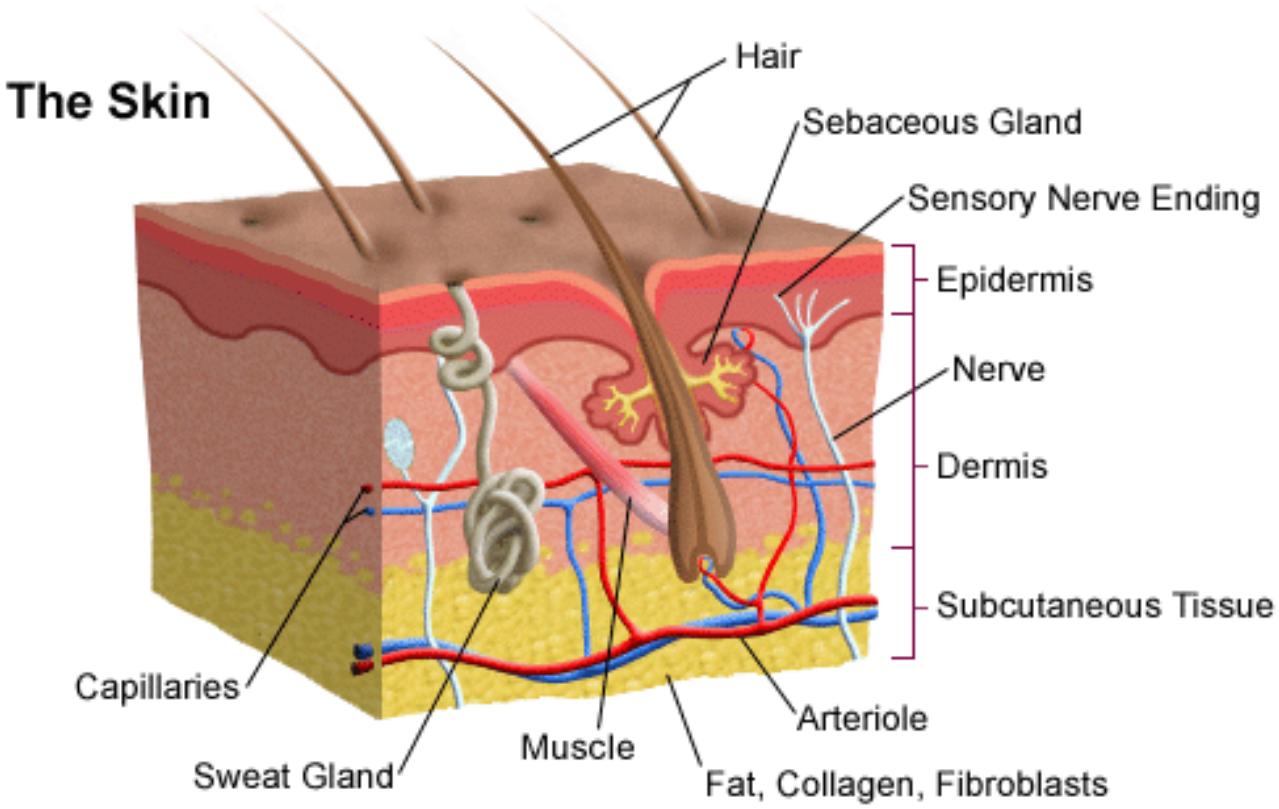
Cause

- Thermal
  - Flame/flash
  - Scald
    - Children, impaired mobility
  - Contact
    - Altered level of consciousness, restrained
- Chemical
- Electrical
  - All thermal complications, multiple additional issues

Depth



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Depth

Superficial

1st degree burn

Partial Thickness

2nd degree burn

Full Thickness

3rd degree burn

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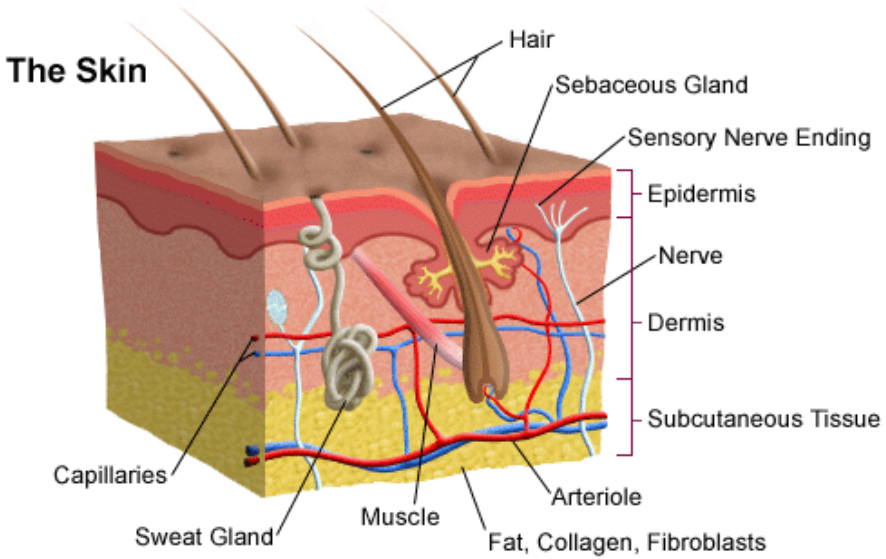
Rehabilitation

LOSS



REACTION

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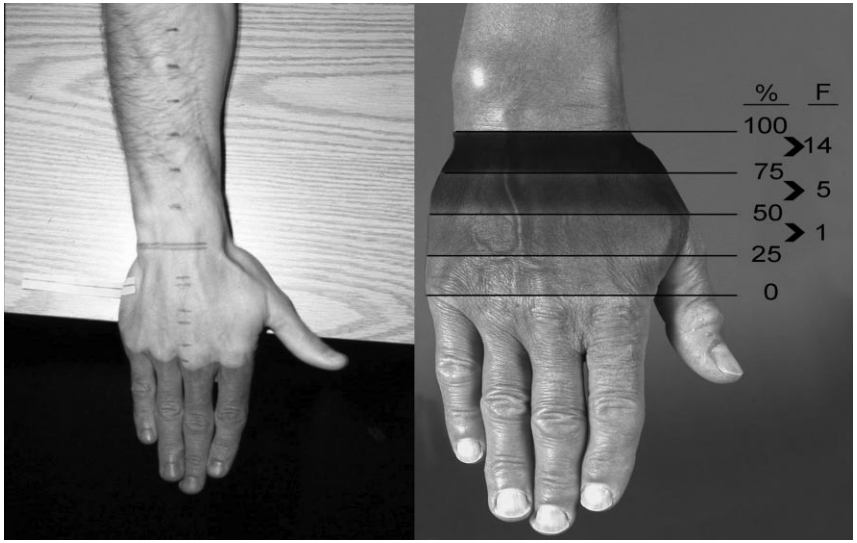
PREVENTING FUNCTIONAL IMPACT

Scar Contracture

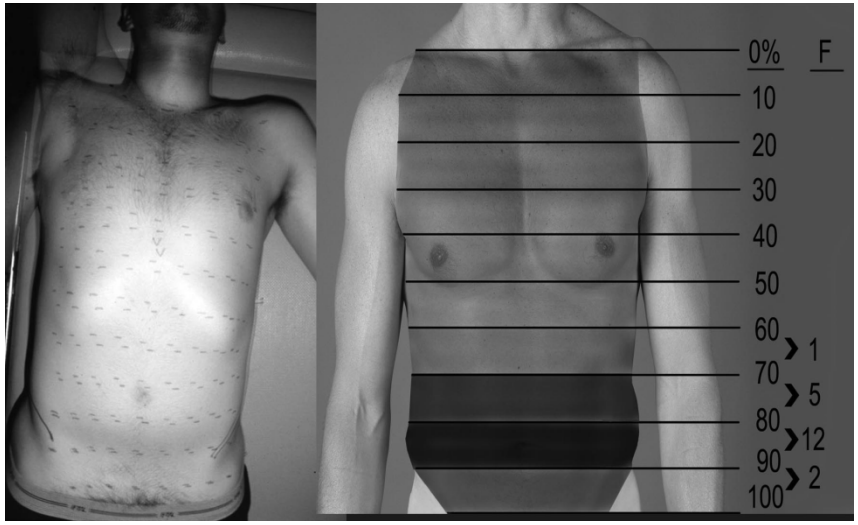
- Scar Formation
  - Inflammatory phase
  - Proliferative phase
  - Maturation phase
- Contracture
  - Pathological effect of scar contraction opposing ROM
- Normal skin mobilization

Cutaneous Functional Units

MCP Flexion



Shoulder Abduction



Identification of Cutaneous Functional Units Related to Burn Scar Contracture Development, Richard et al., 2009

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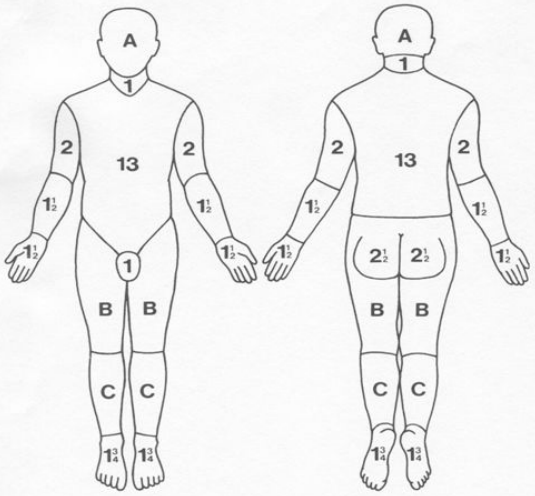
Location

Burn Assessment Lund & Browder Chart

LUND AND BROWDER CHARTS

IGNORE
SIMPLE ERYTHEMA



Superficial
Deep

REGION	%
HEAD	
NECK	
ANT. TRUNK	
POST. TRUNK	
RIGHT ARM	
LEFT ARM	
BUTTOCKS	
GENITALIA	
RIGHT LEG	
LEFT LEG	
TOTAL BURN	

RELATIVE PERCENTAGE OF BODY SURFACE AREA AFFECTED BY GROWTH

AREA	AGE 0	1	5	10	15	ADULT
A = ½ OF HEAD	9½	8½	6½	5½	4½	3½
B = ½ OF ONE THIGH	2¾	3¼	4	4½	4½	4¾
C = ½ OF ONE LEG	2½	2½	2¾	3	3¼	3½

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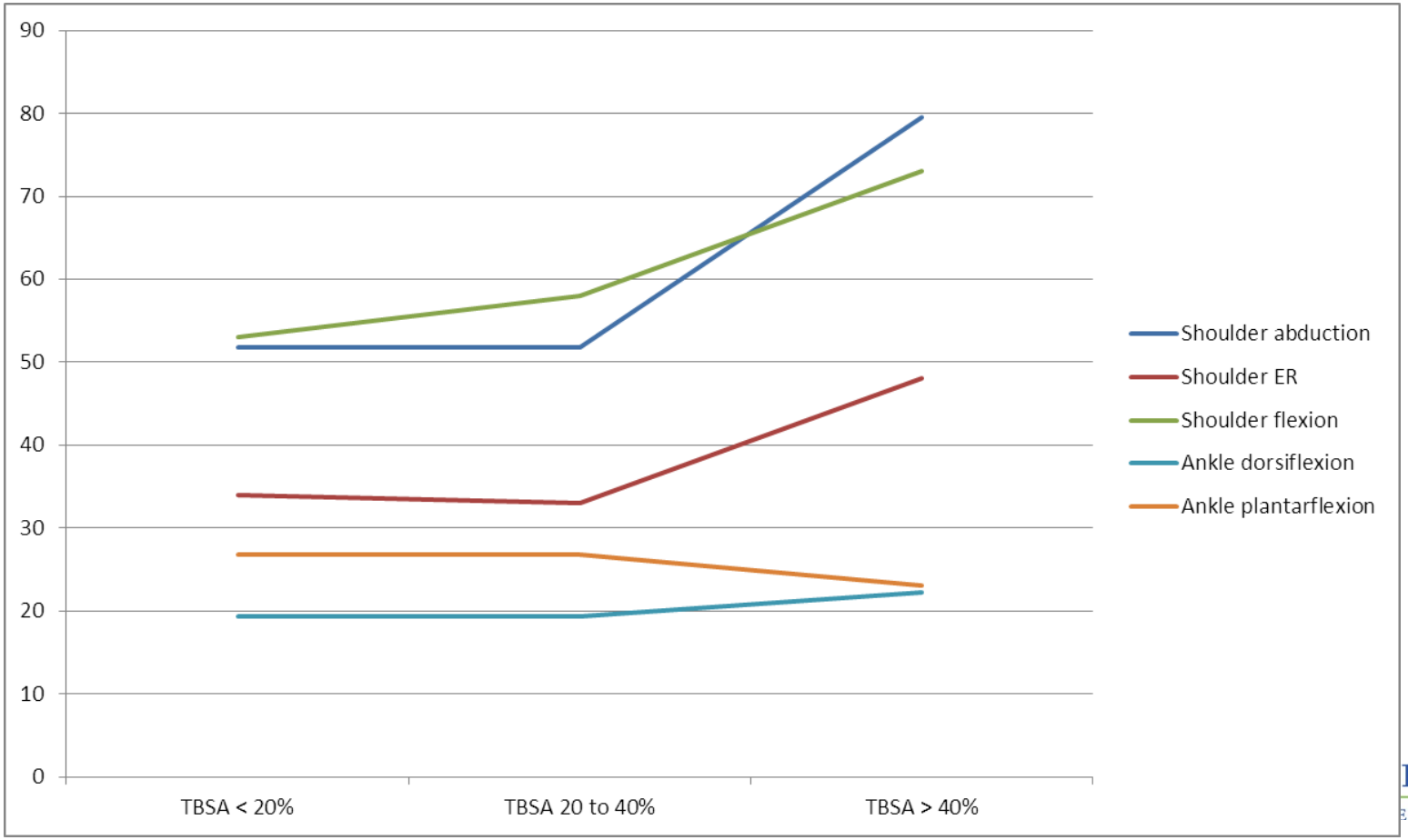
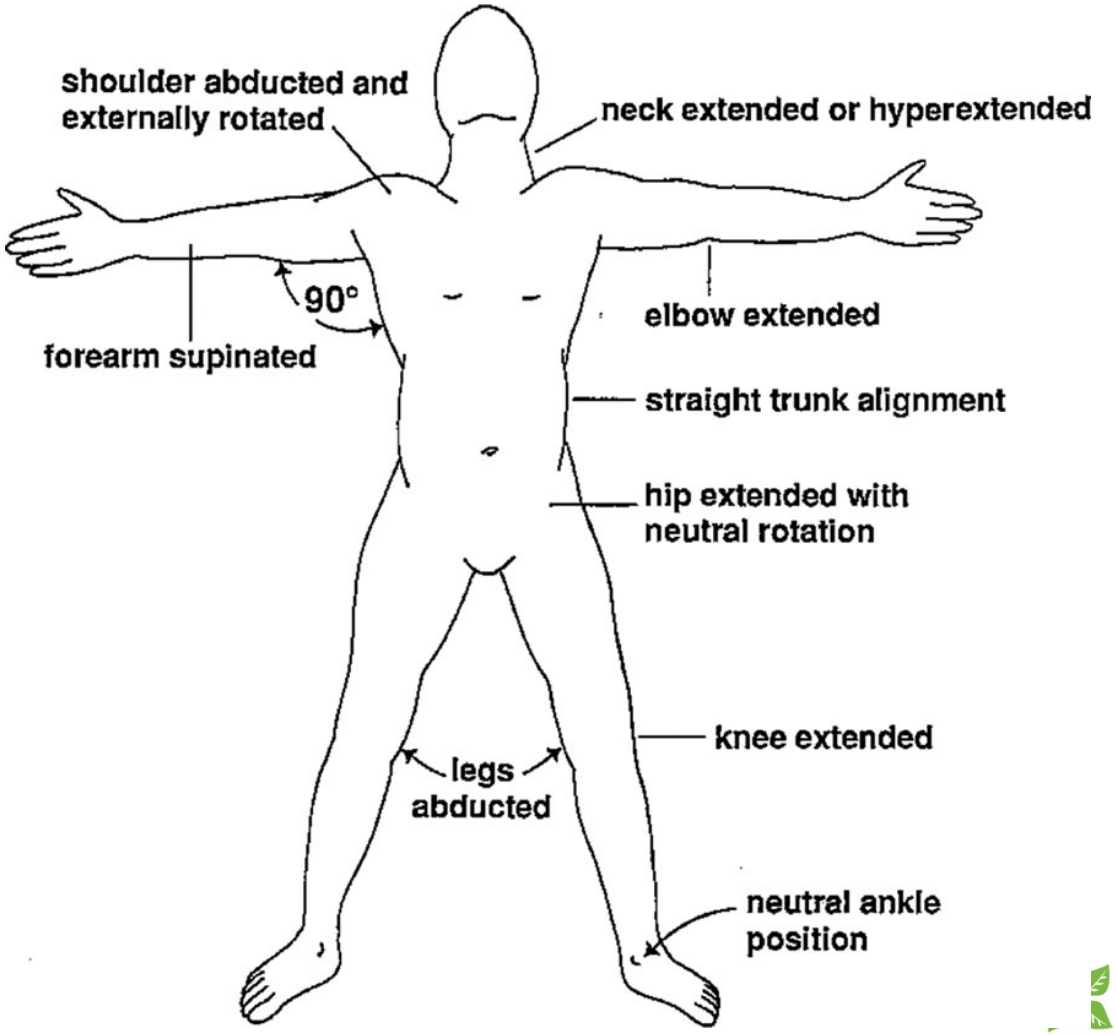
Mean ROM losses by burn severity category.

Impaired joint movement	TBSA < 20%			TBSA 20 to 40%			TBSA > 40%			p-value
	Contractures	Absolute loss (degrees), mean	Percent loss, mean	Contractures	Absolute loss (degrees), mean	Percent loss, mean	Contractures	Absolute loss (degrees), mean	Percent loss, mean	
Shoulder abduction	78	52	23%	110	52	28%	82	80	35%	< 0.001
Shoulder ER	18	34	19%	33	33	19%	31	48	27%	0.026
Shoulder flexion	124	53	23%	181	58	25%	130	73	32%	<0.001
Ankle dorsiflexion	71	19	32%	69	19	34%	58	22	37%	0.14
Ankle plantarflexion	67	27	45%	56	27	48%	29	23	39%	0.25



Positioning



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Positioning/Splinting

Clinical practice recommendations for positioning of the burn patient

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ABSTRACT

The objective of this review was to systematically examine whether there is clinical evidence to support recommendations for positioning patients with acute burn. Review of the literature revealed minimal evidence-based practice regarding the positioning of burn patients in the acute and intermediate phases of recovery. This manuscript describes recommendations based on the limited evidence found in the literature as well as the expert opinion of burn rehabilitation specialists. These positioning recommendations are designed to guide those rehabilitation professionals who treat burn survivors during their acute hospitalization and are intended to assist in the understanding and development of effective positioning regimens.

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2. Recommendation

Burn rehabilitation emphasizes the importance of mobility and function, however there are times during recovery that periods of immobility are needed to protect vulnerable areas or mitigate the formation of scar contractures. During these times, the following are positioning recommendations:

- **Head:** the head should be positioned above the level of the heart.
- **Neck:** the neck should be positioned in the midline (no rotation or side bend) between neutral (0°) and 15° extension.
- **Shoulder:** the shoulder should be positioned in about 90° abduction and 15–20° horizontal flexion.
- **Elbow:** the elbow should be positioned in extension. Care should be given not to lock the elbow in full extension (about 5–10° from full extension) in order to prevent further joint trauma.
- **Forearm:** the forearm should be positioned in neutral (zero degrees) or in about 10° supination.
- **Wrist:** the wrist should be positioned in neutral to about 10–15° extension.
- **Hand:** the metacarpophalangeal (MCP) joints of digits 2–5 should be positioned in about 70–90 flexion, the interphalangeal (IP) joints should be positioned in full extension. The thumb should be positioned in a combination of palmar and radial abduction at the carpometacarpal (CMC) with the MCP and IP joints in full extension.
- **Hip:** the hip should be positioned in neutral (zero degrees), no rotation and approximately 10–15° abduction.
- **Knee:** the knee should be positioned in extension. Care should be given not to lock the knee in full extension (about 3–5° from full extension) in order to prevent joint capsular tightness.
- **Foot and Ankle:** the foot and ankle should be positioned in the neutral position (zero degrees plantarflexion/dorsiflexion flexion and zero degrees inversion/eversion).

Splinting

Name	Position of function splint			
	Wrist extension	MP Joint flexion	PIP Joint position	Thumb position
1. Position of function (optimum)	Not specified	45°	45° Flexion	Opposed
2. Position of function	45°	30°	30° Flexion	Abducted
3. Position of function	Slight	60°-80°	Slight flexion	Not specified
4. Positioning splint	Neutral to 35°	Some flexion	Extended	Maintain span
5. Position found most effective	30°-35°	55°-60°	Extended	Full palmar abduction
6. Modification of Willis	15°	Flexed	Extended	Opposed
7. Not specified	0°-30°	45°-70°	Extended	Abducted extended
8. Functional pan splint	Neutral to 20°-30°	45°-70°	Extended	Slight extension, abducted
9. Not specified	15°	60°	Extended	Abducted, opposed
10. Modified position of function (intrinsic positive position)	20°-30°	40°-50°	Extended	Open web
11. Functional position	30°-45°	70°-90°	Extended	Opposed large web space
12. Modified functional position	Dorsi-flexion	Maximum	Extended	Radial-palmar abduction
13. Not specified	Neutral or few degrees	30°	Extended	Extended, abducted on palm
14. Volar positioning splint	15°	40°-60°	Extended	Not specified
15. Modified volar positioning splint	Neutral	30°	20°	Not specified
16. Position of function	Not specified	More extension than antideformity 35	More flexion than antideformity 35	Less extension, abduction than antideformity
17. Optimal resting hand splint	20°-40°	Flexed	Extended	Palmar abduction, extension

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Splinting

Splinting

A review on static splinting therapy to prevent burn scar contracture: Do clinical and experimental data warrant its clinical application?

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Scar
(Myo)fibroblast
Collagen
Contraction

ABSTRACT

Background: Static splinting therapy is widely considered an essential part in burn rehabilitation to prevent scar contractures in the early phase of wound healing. However, scar contractures are still a common complication. In this article we review the information concerning the incidence of scar contracture, the effectiveness of static splinting therapy in preventing scar contractures, and specifically focus on the – possible – working mechanism of static-splinting, i.e. mechanical load, at the cellular and molecular level of the healing burn wound.

Method: A literature search was done including Pubmed, Cochrane library, CINAHL and PEDRO.

Results: Incidence of scar contracture in patients with burns varied from 5% to 40%. No strong evidence for the effectiveness of static splinting therapy in preventing scar contracture was found, whereas in vitro and animal studies demonstrated that mechanical tension will stimulate the myofibroblast activity, resulting in the synthesis of new extracellular matrix and the maintenance of their contractile activity.

Conclusion: The effect of mechanical tension on the wound healing process suggests that static splinting therapy may counteract its own purpose. This review stresses the need for randomised controlled clinical trials to establish if static splinting to prevent contractures is a well-considered intervention or just wishful thinking.

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Early Mobilization

PRACTICE GUIDELINES

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

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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)

Early Mobilization

Table 3. Expert opinion–based rehabilitation-specific algorithm for early ambulation of lower extremity grafts

Postoperative Early Ambulation Protocol
- Patients to be excluded from early ambulation protocol:
  - Patients with associated fractures precluding early ambulation.
  - Patients with preinjury inability to walk.
  - Wounds >300 cm²
  - Overriding social or psychiatric conditions.
  - Medical status prohibiting mobilization.
  - Plantar surface of the foot grafted.
- Prior to initiating ambulation:
  - Must apply external compression. Examples include support boot (eg, Unna's boot), two layers of tubular elastic bandage (eg, Tubigrip™), self-adhesive elastic wrap (eg, Coban™), two layers of figure of 8-wrapped, elastic bandage (eg, Ace™).
  - If the graft crosses a joint (ankle or knee), a low-temperature thermoplastic or plaster orthosis should be applied to immobilize the joint and worn continuously. When treating children, the application of a plaster/fiberglass cast should be considered. The orthosis or cast should be discontinued at the first dressing change if the graft take is considered acceptable. Continuation of the positioning plan may be required to maintain range of motion (ROM), although the wearing schedule may be intermittent.
- Ambulation:
  - Should be encouraged immediately postoperatively, after recovery from anesthetic and after external support has been applied.
  - Have patient begin by sitting at the edge of the bed and dangle feet for approximately 10 min. While sitting, assess for orthostatic hypotension (light-headedness). Also assess active ROM (if body surface not immobilized), pain, etc. of the extremity to ensure it is safe for ambulation. This determination must be based on the therapist's clinical judgment.
  - If orthostatic hypotension occurs, use tilt table to increase tolerance for upright position.
  - Proceed to standing if dangling is well tolerated. Assess for adequate standing balance.
  - If unstable when standing, have the patient try walking with an appropriate walking aid, reducing to a less supportive aid or no assistive devices as soon as stability improves.
  - Perform weight bearing as tolerated. Full weight bearing allowed (unless otherwise specified by surgeon for other reasons).
  - If stable when standing, have patient try walking (therapist to determine if standby one-person assist or two-person assist or walking aid is most appropriate).
  - If graft crosses the ankle, a rocker bottom boot may be worn. The orthosis or cast should be worn under the rocker boot if the rocker boot does not immobilize the ankle.
  - If graft crosses the knee, patient may need a walking aid to ambulate with the orthosis. If graft take is considered acceptable when evaluated at days 5–7 postoperatively, walking aid may be discontinued at that time.
  - Follow-up at 3–7 d for dressing change and wound evaluation.
  - Patient instructed to elevate the affected extremity when not mobilizing. This should occur on a regular basis.
- Activities of daily living:
  - Gradually increase static standing time as tolerated.
  - Return to normal activities as tolerated.
  - Return to normal shower/bath as wound healing permits.
  - Return to work or school recommendations should be based on individual patient work/school demands and circumstances.
- Scar management:
  - At first dressing change, replace initial compression with:
    - New support boot/cast or
    - Compression
      - Double tubular elastic bandage, eg, Tubigrip™ or
      - Self-adhesive elastic wrap, eg Coban™ or
      - Double-layer elastic bandage, eg, Ace™ or
      - Interim garment

105 . Post-Operative Early Range of Motion of Hand Grafts

S. K. Shingleton, MS, RN, I. R. Driscoll, MD, W. S. Dewey, PT, B. T. King, MD, J. L. McCorcle, PA-C, J. C. Graybill, MD, J. C. Pamplin, MD, R. Richard, PT, MS

U.S. Army Institute of Surgical Research, Fort Sam Houston, TX; Brooke Army Medical Center, Fort Sam Houston, TX

Results: 17 patients from OCT 2014 to JUN 2015 for a total of 34 patient visits were reviewed. One patient had a small area of SG movement noted POD1 without SG loss. No SG disruption occurred during ROM or dressing changes. The order set was utilized 76% of the time. Post-op LOS decreased from 5 days in the 1st quarter to 4 in the 3rd quarter (Graph).

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Scar Massage

- Burn therapists from six countries achieved consensus defining skills used in clinical practice
- Ten techniques:
  - Tissue mobilization
  - Tissue friction

http://journals.lww.com/burncareresearch/Pages/videogallery.aspx?videoId=5&autoPlay=true

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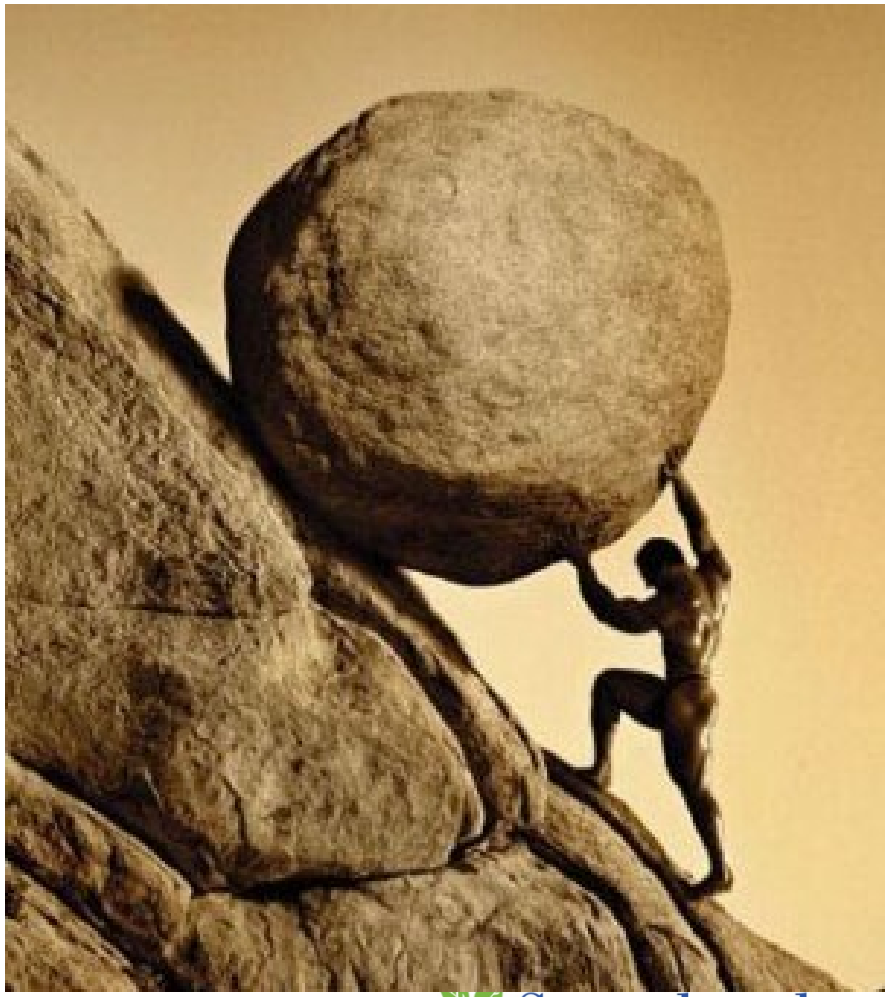
Prescription

- Treatment: dose x timing/frequency x duration = effect – side effects



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Functional Range of Motion

Table 3. Reported spread of normal "functional" range of motion of the elbow, forearm, and wrist in degrees

	Elbow		Forearm		Wrist	
	Flexion n = 8	Extension n = 6	Pronation n = 6	Supination n = 4	Flexion n = 5	Extension n = 5
Upper limit	144 Hand to occiput[26]	0 Eating dinner[13]	90 Eating breakfast, lunch, dinner[13]	59 Eating with a fork[37] Eating with a spoon[37]	54 Toileting[36]	63 Rising from a chair[11]
Lower limit	16 Palm to shoe[26]	101 Eating with a spoon[37]	−14 Eating with a spoon[24] Lifting a 4-kg bag[24]	−20 Eating dinner[13]	−17 Using a hammer[36]	−19 Hand to shirt (chest)[11]
Mild contracture[2,3]	93–140	0–45*	53–80	53–80	41–59	41–59
Moderate contracture[2,3]	46–92	46–92*	26–52	26–52	21–40	21–40
Severe contracture[2,3]	<45	>93*	<26	<26	0–20	0–20

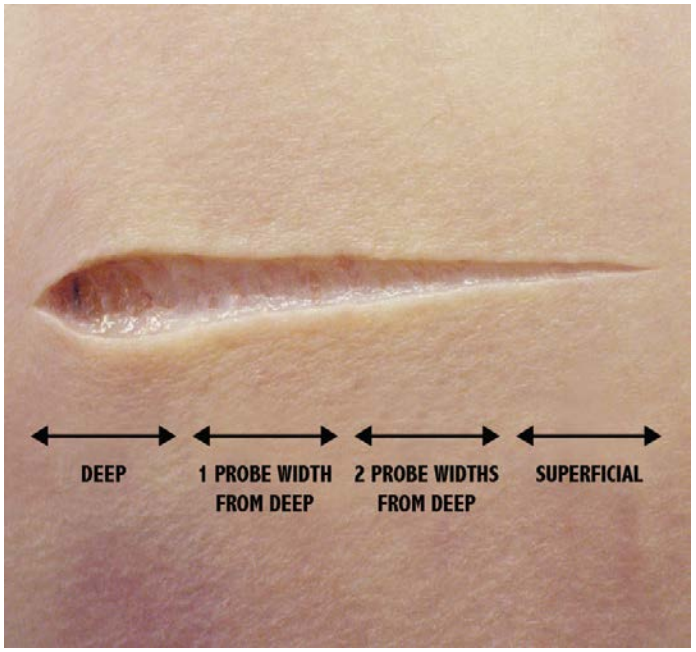
* Schneider et al[2] report terminal elbow extension as −140°. This report has modified the information to reflect 0° for terminal elbow extension for ease of comparison to other studies.

Hypertrophy

- Surface erythema
- Raised from wound surface
- Lack of elasticity
- Painful and itchy
- “Red, raised, rigid”
- Influences contracture
- Deformity

Hypertrophy

- Risk Factors:
  - Tension on the wound
  - Excess inflammation/ infection
  - Wound open for more than 3 weeks
  - Involvement of dermal elements
    - 33% depth? 0.5 mm?
  - Genetic predisposition



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Pressure Garments

- Pressure may reduce:
  - Clustering of collagen
  - Interstitial space
  - Local metabolism
- Local hypoxia
  - Capillary occlusion pressure
- Prescription

Silicone

PRACTICE GUIDELINES

Practice Guidelines for the Application of Nonsilicone or Silicone Gels and Gel Sheets After Burn Injury

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Colleen M. Ryan, MD,** Michael A. Serghiou, OTR, MBA,††
Jeffrey C. Schneider, MD,**‡‡ Patricia A. Sharp, OTD, MS, OTR/L,§§
Ana de Oliveira, BSc,† and Jill Boruff, MLIS‖‖

The objective of this review was to systematically evaluate available clinical evidence for the application of nonsilicone or silicone gels and gel sheets on hypertrophic scars and keloids after a burn injury so that practice guidelines could be proposed. This review provides evidence based recommendations, specifically for the rehabilitation interventions required for the treatment of aberrant wound healing after burn injury with gels or gel sheets. These guidelines are designed to assist all healthcare providers who are responsible for initiating and supporting scar management interventions prescribed for burn survivors. 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.[1] (J Burn Care Res 2015;36:345–374)

PHYSIOLOGICAL SKIN CHANGES

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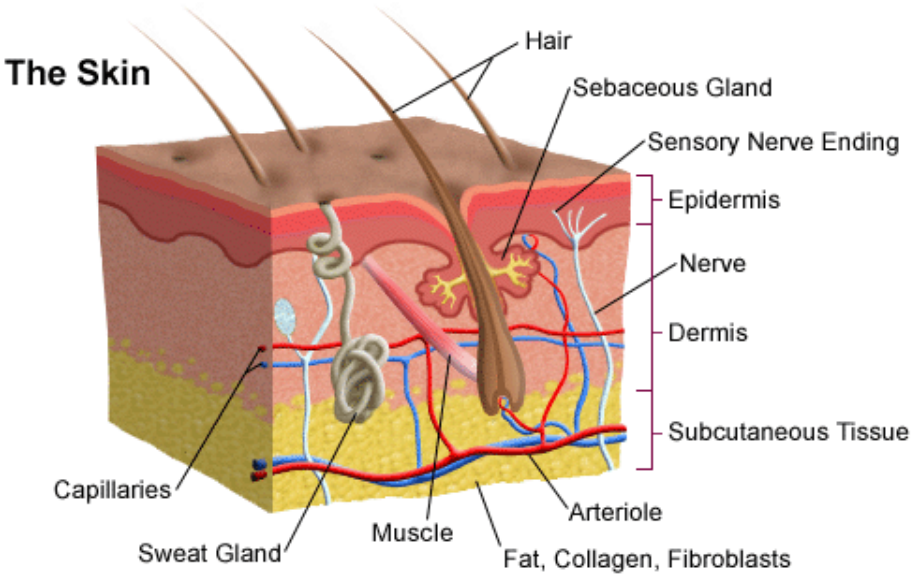
Loss of protective layer

- Cause:
  - Loss of sweat glands
  - Loss of oil glands
  - Skin dryness, chemical sensitivity
  - Pruritis*
- Treatment:
  - Lotion
  - Medications
  - Protection?



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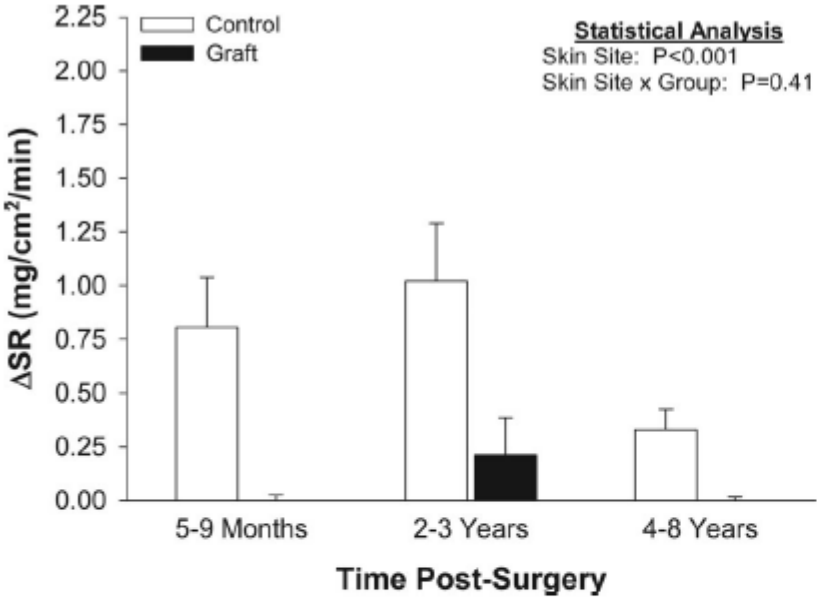

Figure 4. Maximal sweat rate (ΔSR) from baseline after administration of 1×10^{-1} M acetylcholine in grafted (graft) and adjacent noninjured (control) skin in groups 5 to 9 months postsurgery (n = 12), 2 to 3 years postsurgery (n = 12), and 4 to 8 years postsurgery (n = 12). Values are expressed as means ± SEM. Significant main effect for skin site demonstrates attenuated sweating responses to exogenous administration of acetylcholine at the grafted sites regardless of the duration postsurgery ($P < 0.001$).

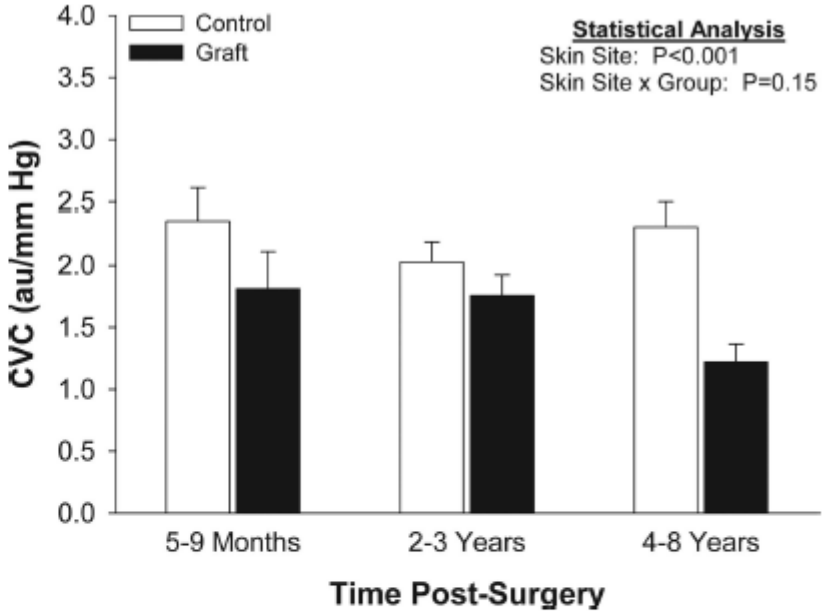

Figure 2. Increases in cutaneous vascular conductance (CVC) expressed in absolute units during local heating in grafted (graft) and adjacent noninjured (control) skin in groups 5 to 9 months postsurgery (n = 13), 2 to 3 years postsurgery (n = 13), and 4 to 8 years postsurgery (n = 13). Values are expressed as means ± SEM. Significant main effect for skin site demonstrates attenuated vasodilator responses to local heating at the grafted sites regardless of the duration postsurgery ($P < 0.001$).

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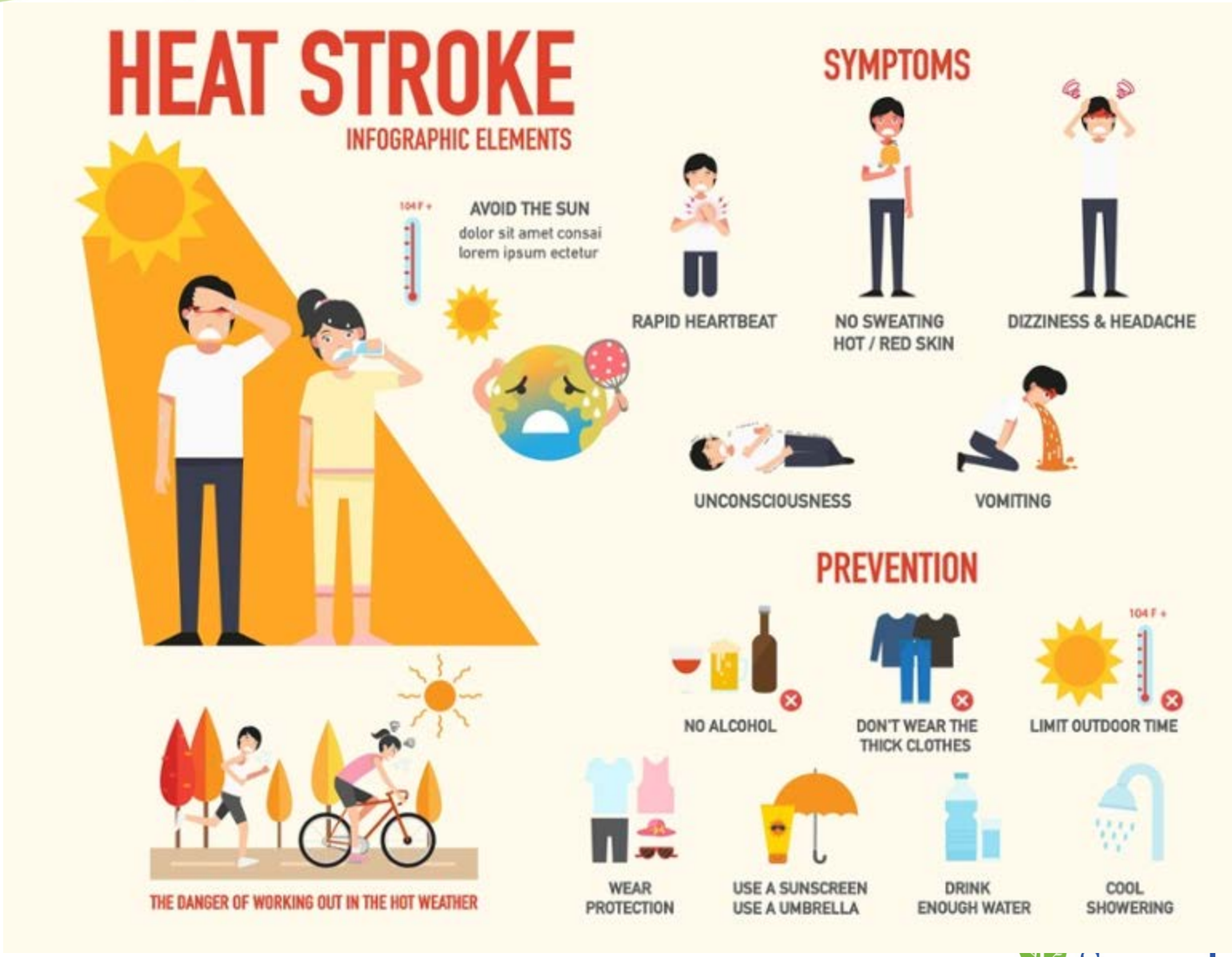


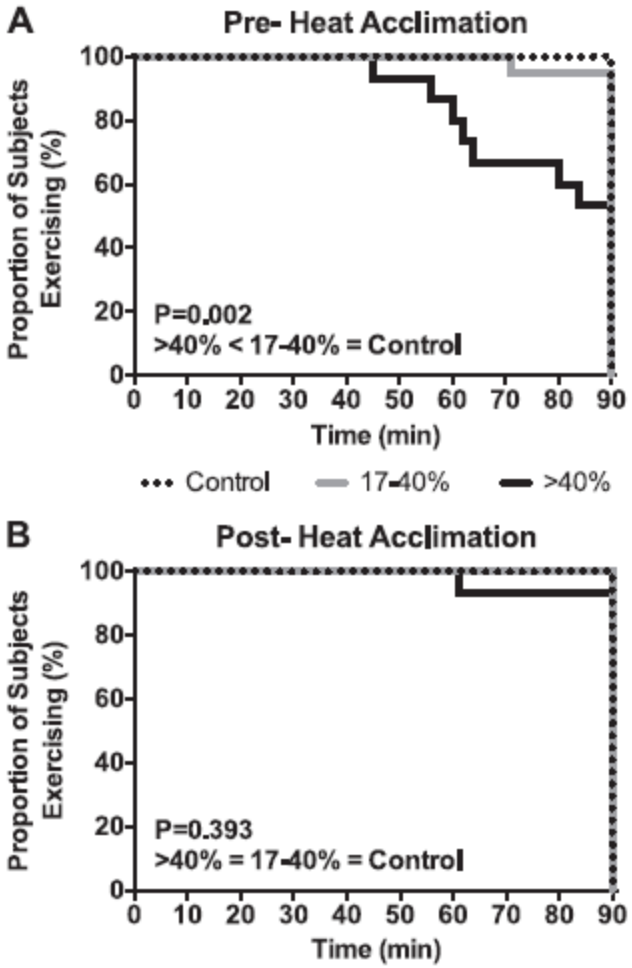
Source: alaskafamilymedical.com

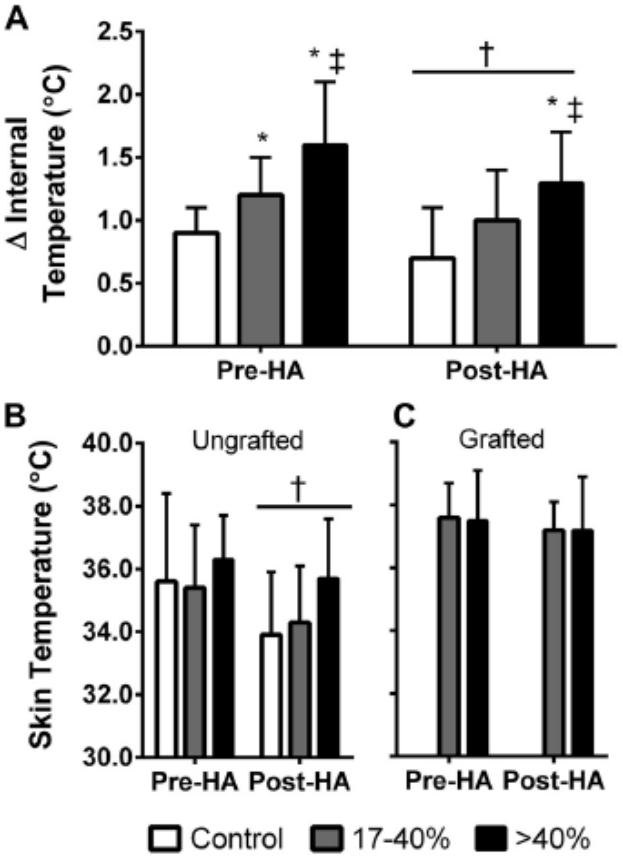
Long-term Outcomes

Conditions	Since Burn, N (%)	Now, N (%)
Problems in hot temperature	73 (74)	72 (73)
Itching	82 (84)	71 (72)
Raised scars	72 (73)	65 (66)
Problems in cold temperature	58 (59)	52 (53)
Sensory loss	51 (52)	52 (53)
Fingernail deformities	50 (51)	41 (42)
Fragile burn	30 (31)	36 (37)
Shooting pain in scars	50 (51)	32 (33)
Painful scars	56 (57)	29 (30)
Open wounds	44 (45)	25 (25)
Skin rash	32 (33)	23 (23)
Wear compression garments	78 (80)	12 (12)
Lubricate skin	89 (91)	78 (80)

Holavanahalli et al., 2010

Heat Tolerance





Schlader et al., 2015

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Peripheral Nerve Injury

- Overall reported incidence 2-84%
- Risk Factors
  - Thermal >20% TBSA
  - Degree of full thickness
  - >40 years-old
  - ICU >20 days
- Mononeuritis multiplex
  - Upper extremity > lower extremity
  - Median, ulnar, peroneal, radial sensory particularly at-risk

Peripheral Nerve Injury

Table 3. Logistic regression model—mononeuropathy

	B	SE	Wald	Exp (B)
Age	0.0076	0.0114	0.4508	1.0077
Sex	0.5963	0.5214	1.3079	1.8155
Alcohol abuse	0.8282	0.7797	3.9777	2.2893*
Flame	−0.4337	0.4478	0.9380	0.6481
Electrical	1.4115	0.5555	6.4568	4.1022†
% FT burn	0.0407	0.0232	3.0763	1.0415
% PT burn	0.0030	0.0153	0.0397	1.0031
No. days in ICU	0.0447	0.0122	13.4139	1.0457‡

B, estimated coefficient; *SE*, standard error; *Wald*, Wald statistic; *Exp (B)*, odds ratio; *FT*, full thickness; *PT*, partial thickness; *ICU*, intensive care unit.

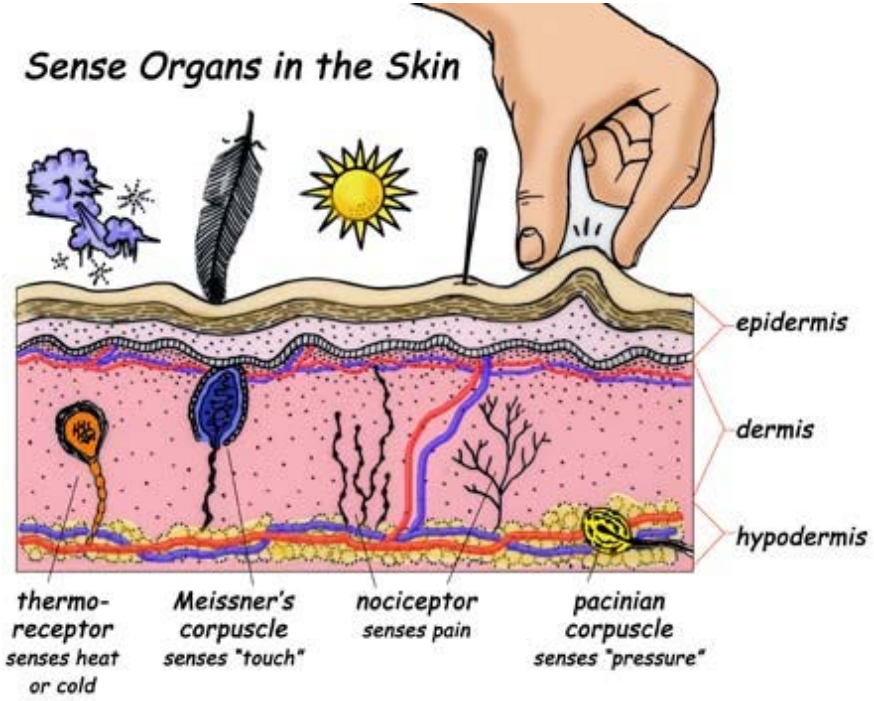
* $P < .05$.

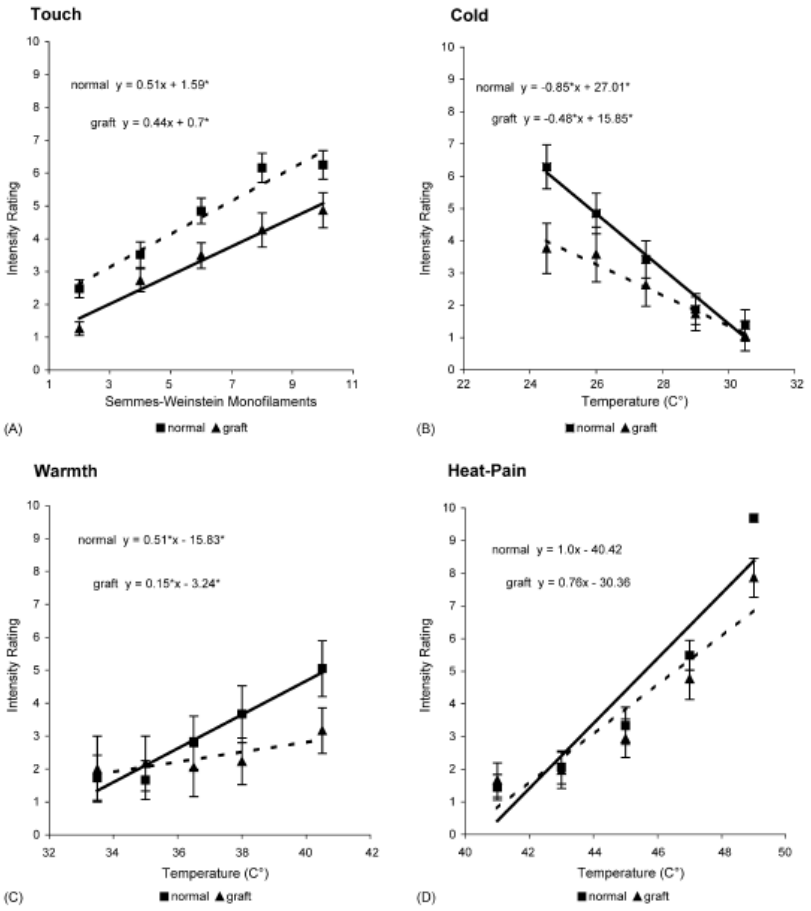
† $P < .01$.

‡ $P < .001$.

Source: Kowalske, 2001.

Superficial Innervation





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SPECIAL CONSIDERATIONS

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Heterotopic Ossification

- Progressive abnormal soft tissue bone formation
- Progressive loss of ROM
  - Disability
  - Pain
  - Nerve entrapment

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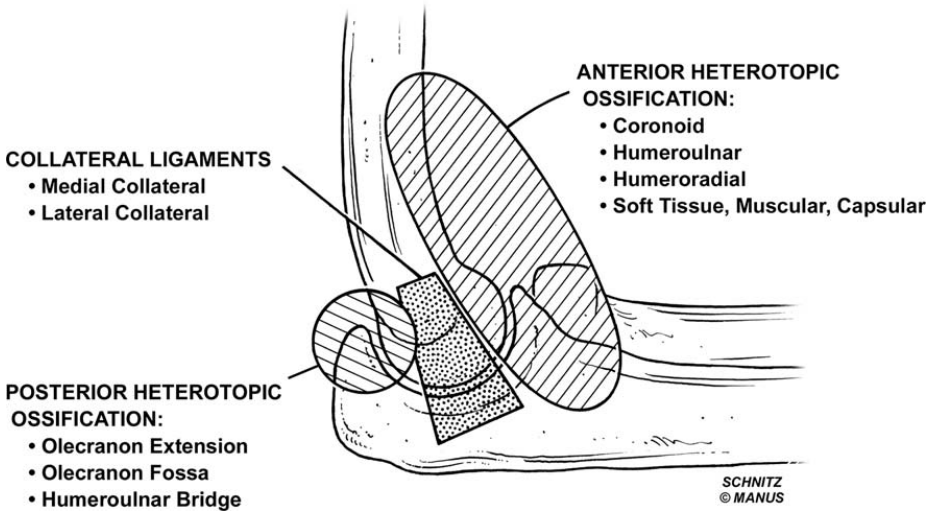
Heterotopic Ossification

- In burns, occurs in 1-3% of cases, associated with:
  - Larger (>20%TBSA) burns
  - Burned extremity
  - Delayed excision and grafting
  - Aggressive mobilization of stiff joints?



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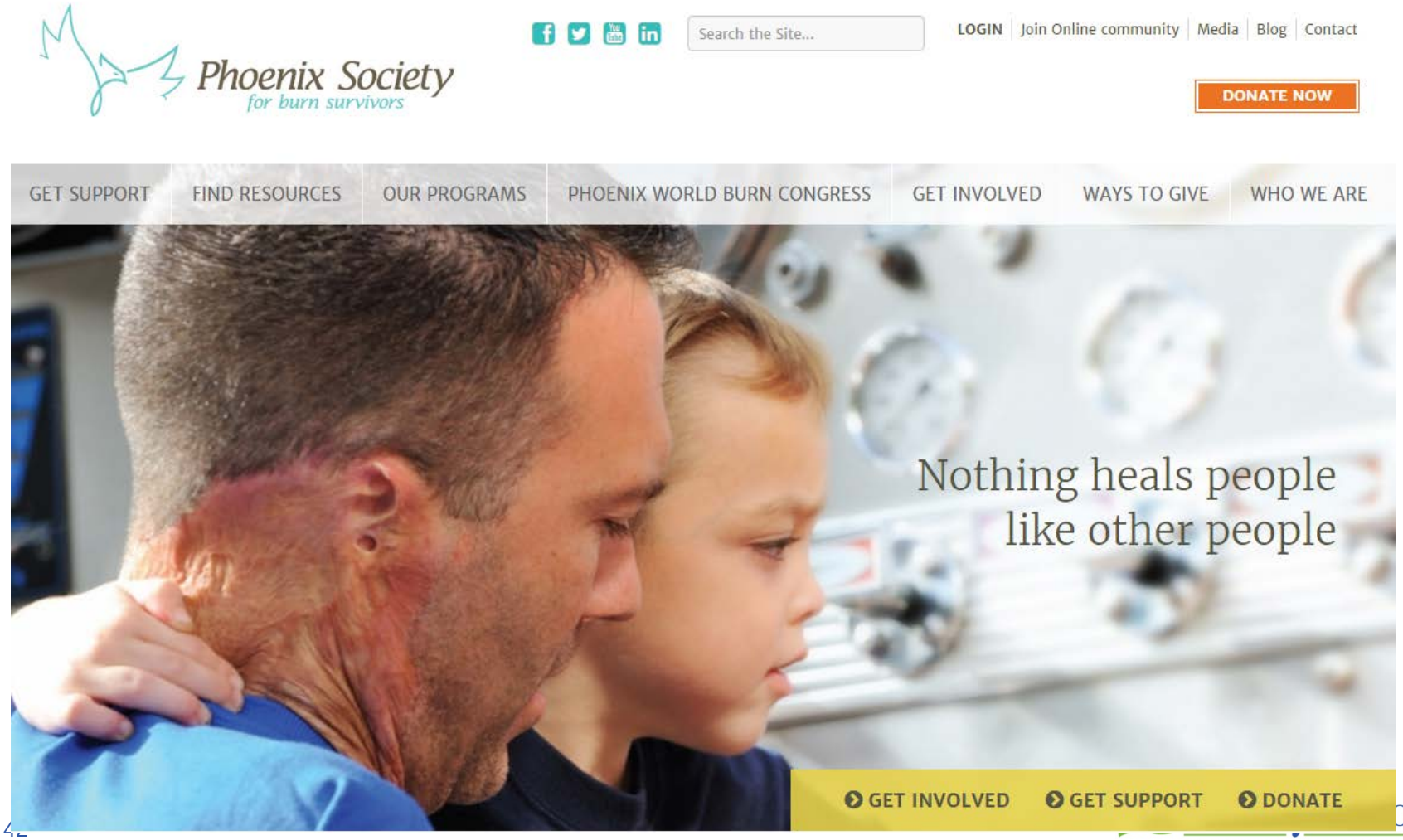
Psychological Impact



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At-Risk Population

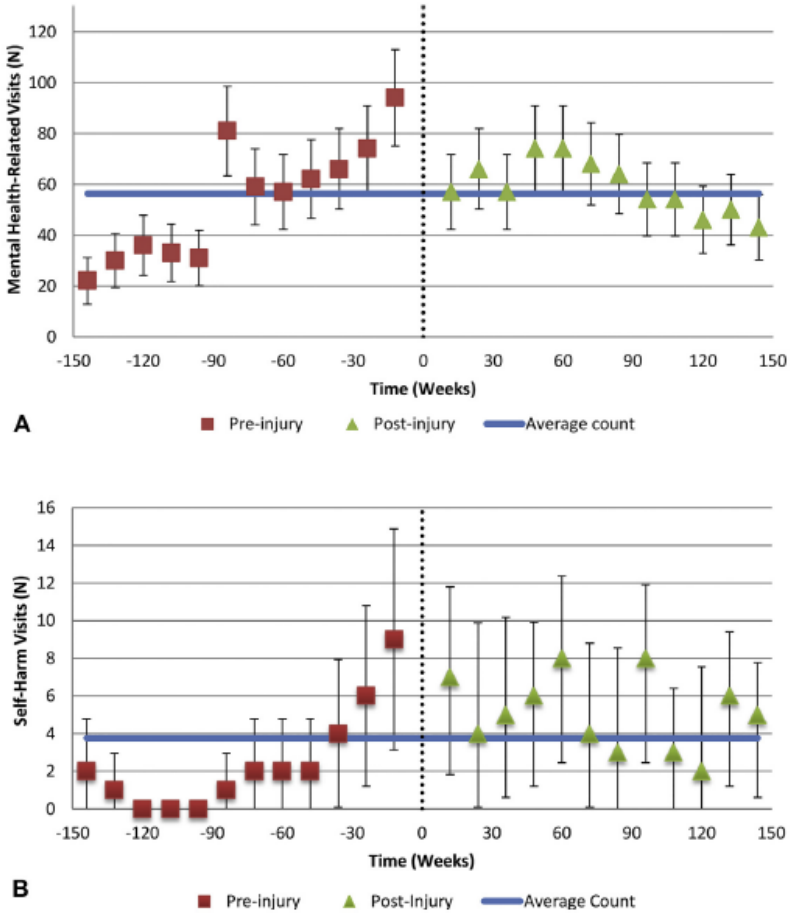

Figure 1. (A) Distribution of all mental health visits, and (B) distribution of self-harm visits. Each interval represents a 13-week time period; error bars represent 95% CIs. Dashed line represents time of burn injury.

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Return to Work

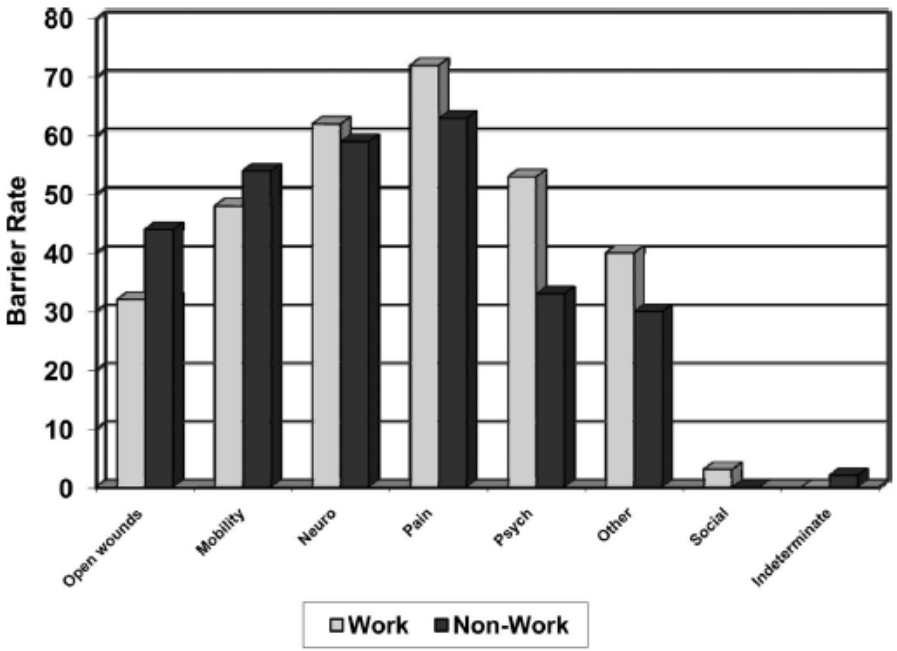

Figure 2. Frequency of unemployment barriers: subjects burned at work vs burned outside of work.

Table 1. Barriers to Return to Work

Barriers	Subcategories
Open wounds	
Impaired mobility	Contractures
	Amputation
	Heterotopic ossification
	Hypertrophic scar resulting in contracture
	Fracture
Neurologic problems	Pruritis
	Mononeuropathy
	Polyneuropathy
	Blindness/visual impairment
	Hearing loss
	Seizures
	Tremors
Pain	Allopathic pain
	Neuropathic pain
Psychiatric issues	Insomnia
	Depression
	Posttraumatic stress
	Anxiety
	Body image/deformity
	Drug and alcohol dependence
Other medical issues	Temperature intolerance
	Edema
	Infection
	Metabolic problems
	Endocrine problems
	Dry eyes
	Cardiac problems
Social issues	Lack of social support
	Martial/relationship issues
Indeterminate	

Conclusions

- Common issues and interventions
  - Contracture
  - Hypertrophy
  - Altered skin physiology
- Complications
  - Peripheral and distal nerve injury
  - Heterotopic ossification
  - Adjustment and post-trauma recovery
- Research
  - Defining problems, severity, and measurements
  - Defining prescriptions a primary goal for the future