Burn Rehabilitation

University of Toronto
November 3\textsuperscript{rd}, 2017
Matthew Godleski, MD
St. John’s Rehab
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

<table>
<thead>
<tr>
<th>REGION</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAED</td>
<td></td>
</tr>
<tr>
<td>NECK</td>
<td></td>
</tr>
<tr>
<td>ANT. TRUNK</td>
<td></td>
</tr>
<tr>
<td>POST. TRUNK</td>
<td></td>
</tr>
<tr>
<td>RIGHT ARM</td>
<td></td>
</tr>
<tr>
<td>LEFT ARM</td>
<td></td>
</tr>
<tr>
<td>BUTTOCKS</td>
<td></td>
</tr>
<tr>
<td>GENITALIA</td>
<td></td>
</tr>
<tr>
<td>RIGHT LEG</td>
<td></td>
</tr>
<tr>
<td>LEFT LEG</td>
<td></td>
</tr>
<tr>
<td>TOTAL BURN</td>
<td></td>
</tr>
</tbody>
</table>

RELATIVE PERCENTAGE OF BODY SURFACE AREA AFFECTED BY AGE

<table>
<thead>
<tr>
<th>AREA</th>
<th>AGE 0</th>
<th>1</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>ADULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A = 1/2 OF HEAD</td>
<td>9 1/2</td>
<td>8 1/2</td>
<td>6 1/2</td>
<td>5 1/2</td>
<td>4 1/2</td>
<td>3 1/2</td>
</tr>
<tr>
<td>B = 1/2 OF THIGH</td>
<td>2 3/4</td>
<td>3 1/4</td>
<td>4</td>
<td>4 1/2</td>
<td>4 1/2</td>
<td>4 3/4</td>
</tr>
<tr>
<td>C = 1/2 OF ONE LOWER LEG</td>
<td>2 1/2</td>
<td>2 1/2</td>
<td>2 3/4</td>
<td>3</td>
<td>3 1/4</td>
<td>3 1/2</td>
</tr>
</tbody>
</table>
Cause

• Thermal
  – Flame/flash
  – Scald
    • Children, impaired mobility
  – Contact
    • Altered level of consciousness, restrained

• Chemical

• Electrical
  – All thermal complications, multiple additional issues
Depth

The Skin

- Hair
- Sebaceous Gland
- Sensory Nerve Ending
- Epidermis
- Nerve
- Dermis
- Subcutaneous Tissue
- Capillaries
- Sweat Gland
- Muscle
- Arteriole
- Fat, Collagen, Fibroblasts
Depth

Superficial

Partial Thickness

Full Thickness
Rehabilitation

LOSS

RECEPTION

The Skin

- Hair
- Sebaceous Gland
- Sensory Nerve Ending
- Epidermis
- Nerve
- Dermis
- Subcutaneous Tissue
- Capillaries
- Sweat Gland
- Muscle
- Arteriole
- Fat, Collagen, Fibroblasts
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
Location

Burn Assessment Lund & Browder Chart

<table>
<thead>
<tr>
<th>AREA</th>
<th>AGE 0</th>
<th>1</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>ADULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A - ½ of HEAD</td>
<td>9½</td>
<td>8½</td>
<td>6½</td>
<td>5½</td>
<td>4½</td>
<td>3½</td>
</tr>
<tr>
<td>B - ⅓ OF ONE THIGH</td>
<td>2½</td>
<td>3⅓</td>
<td>4</td>
<td>4½</td>
<td>4½</td>
<td>4⅓</td>
</tr>
<tr>
<td>C - ⅓ OF ONE LEG</td>
<td>2½</td>
<td>2⅔</td>
<td>2⅔</td>
<td>3</td>
<td>3⅓</td>
<td>3⅓</td>
</tr>
</tbody>
</table>

LUND and Browder CHARTS

RELATIVE PERCENTAGE OF BODY SURFACE AREA AFFECTED BY GROWTH

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

IGNORE SIMPLE ERYTHEMA
Mean ROM losses by burn severity category.

<table>
<thead>
<tr>
<th>Impaired joint movement</th>
<th>TBSA &lt; 20%</th>
<th></th>
<th>TBSA 20 to 40%</th>
<th></th>
<th>TBSA &gt; 40%</th>
<th></th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Contractures</td>
<td>Absolute loss (degrees), mean</td>
<td>Percent loss, mean</td>
<td>Contractures</td>
<td>Absolute loss (degrees), mean</td>
<td>Percent loss, mean</td>
<td>Contractures</td>
</tr>
<tr>
<td>Shoulder abduction</td>
<td>78</td>
<td>52</td>
<td>23%</td>
<td>110</td>
<td>52</td>
<td>28%</td>
<td>82</td>
</tr>
<tr>
<td>Shoulder ER</td>
<td>18</td>
<td>34</td>
<td>19%</td>
<td>33</td>
<td>33</td>
<td>19%</td>
<td>31</td>
</tr>
<tr>
<td>Shoulder flexion</td>
<td>124</td>
<td>53</td>
<td>23%</td>
<td>181</td>
<td>58</td>
<td>25%</td>
<td>130</td>
</tr>
<tr>
<td>Ankle dorsiflexion</td>
<td>71</td>
<td>19</td>
<td>32%</td>
<td>69</td>
<td>19</td>
<td>34%</td>
<td>58</td>
</tr>
<tr>
<td>Ankle plantarflexion</td>
<td>67</td>
<td>27</td>
<td>45%</td>
<td>56</td>
<td>27</td>
<td>48%</td>
<td>29</td>
</tr>
</tbody>
</table>

- Shoulder abduction: Shoulder ER, Shoulder flexion, Ankle dorsiflexion, Ankle plantarflexion.
Positioning

- Shoulder abducted and externally rotated
- Neck extended or hyperextended
- Forearm supinated
- Elbow extended
- Straight trunk alignment
- Hip extended with neutral rotation
- Legs abducted
- Knee extended
- Neutral ankle position
Positioning/Splinting

Clinical practice recommendations for positioning of the burn patient

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d Institute of Surgical Research, JBSA Fort Sam Houston, TX, USA

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

<table>
<thead>
<tr>
<th>Name</th>
<th>Wrist extension</th>
<th>MP Joint flexion</th>
<th>PIP Joint position</th>
<th>Thumb position</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Position of function (optimum)</td>
<td>Not specified</td>
<td>45°</td>
<td>45° Flexion</td>
<td>Opposed</td>
</tr>
<tr>
<td>2. Position of function</td>
<td>45°</td>
<td>30°</td>
<td>30° Flexion</td>
<td>Abducted</td>
</tr>
<tr>
<td>3. Position of function</td>
<td>Slight</td>
<td>60°-80°</td>
<td>Slight flexion</td>
<td>Not specified</td>
</tr>
<tr>
<td>4. Positioning splint</td>
<td>Neutral to 35°</td>
<td>Some flexion</td>
<td>Extended</td>
<td>Maintain span</td>
</tr>
<tr>
<td>5. Position found most effective</td>
<td>30°-35°</td>
<td>55°-60°</td>
<td>Extended</td>
<td>Full palmar abduction</td>
</tr>
<tr>
<td>6. Modification of Willis</td>
<td>15°</td>
<td>Flexed</td>
<td>Extended</td>
<td>Opposed</td>
</tr>
<tr>
<td>7. Not specified</td>
<td>0°-30°</td>
<td>45°-70°</td>
<td>Extended</td>
<td>Abducted extended</td>
</tr>
<tr>
<td>8. Functional pan splint</td>
<td>Neutral to 20°-30°</td>
<td>45°-70°</td>
<td>Extended</td>
<td>Slight extension, abducted</td>
</tr>
<tr>
<td>9. Not specified</td>
<td>15°</td>
<td>60°</td>
<td>Extended</td>
<td>Abducted, opposed</td>
</tr>
<tr>
<td>10. Modified position of function</td>
<td>20°-30°</td>
<td>40°-50°</td>
<td>Extended</td>
<td>Open web</td>
</tr>
<tr>
<td>(intrinsic positive position)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Functional position</td>
<td>30°-45°</td>
<td>70°-90°</td>
<td>Extended</td>
<td>Opposed large web space</td>
</tr>
<tr>
<td>12. Modified functional position</td>
<td>Dorsi-flexion</td>
<td>Maximum</td>
<td>Extended</td>
<td>Radial-palmar abduction</td>
</tr>
<tr>
<td>13. Not specified</td>
<td>Neutral or few degrees</td>
<td>30°</td>
<td>Extended</td>
<td>Extended, abducted on palm</td>
</tr>
<tr>
<td>14. Volar positioning splint</td>
<td>15°</td>
<td>40°-60°</td>
<td>Extended</td>
<td>Not specified</td>
</tr>
<tr>
<td>15. Modified volar positioning splint</td>
<td>Neutral</td>
<td>30°</td>
<td>20°</td>
<td>Not specified</td>
</tr>
<tr>
<td>16. Position of function</td>
<td>Not specified</td>
<td>More extension than antideformity</td>
<td>More flexion than antideformity</td>
<td>Less extension, abduction less than antideformity</td>
</tr>
<tr>
<td>17. Optimal resting hand splint</td>
<td>20°-40°</td>
<td>Flexed</td>
<td>Extended</td>
<td>Palmar abduction, extension</td>
</tr>
</tbody>
</table>
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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\textsuperscript{b} Department of Plastic, Reconstructive and Hand Surgery, Red Cross Hospital, Beverwijk, The Netherlands
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\textsuperscript{d} Department of Plastic, Reconstructive and Hand Surgery, Academic Medical Centre, Amsterdam, The Netherlands
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\textbf{Article Info}

Article history:
Accepted 19 June 2011

\textbf{Abstract}

\textbf{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.

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

\textbf{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.

\textbf{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.
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, MA(Physio),¶
Tanja Healey, BA(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)
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.
  - Previous or concomitant soft tissue surgery.
  - Medical status prohibiting mobilization.
  - Planter surface of the floor grafted.

Prior to initiating ambulation:
- Must apply external compression. Examples include support boot (e.g., Unna’s boot), two layers of tubular elastic bandage (e.g., Tubigrip®), self-adhesive elastic wrap (e.g., Coban®), two layers of figure of 8-wrapped, elastic bandage (e.g., 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.
  - Patient should begin by sitting at the edge of the bed and dangle feet for approximately 10 minutes.
  - While sitting, assess for orthostatic hypotension (light headaches). 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 dizziness 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 device 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

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**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. McCordle, 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).
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/burncarereresearch/Pages/videogallery.aspx?videoId=5&autoPlay=true
Prescription

• Treatment: dose \times \text{ timing/frequency} \times \text{ duration} = \text{ effect} – \text{ side effects}
## Functional Range of Motion

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

<table>
<thead>
<tr>
<th></th>
<th>Elbow</th>
<th>Forearm</th>
<th>Wrist</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flexion n = 8</td>
<td>Extension n = 6</td>
<td>Pronation n = 6</td>
</tr>
<tr>
<td>Upper limit</td>
<td>144</td>
<td>0</td>
<td>90</td>
</tr>
<tr>
<td>Hand to occiput 26</td>
<td>Eating dinner 13</td>
<td>Eating breakfast, lunch, dinner 13</td>
<td>Eating with a fork 37</td>
</tr>
<tr>
<td>Lower limit</td>
<td>16</td>
<td>101</td>
<td>–14</td>
</tr>
<tr>
<td>Palm to shoe 26</td>
<td>Eating with a spoon 37</td>
<td>Eating with a spoon 24</td>
<td>Eating dinner 13</td>
</tr>
<tr>
<td>Mild contracture 2,3</td>
<td>93–140</td>
<td>0–45*</td>
<td>53–80</td>
</tr>
<tr>
<td>Moderate contracture 2,3</td>
<td>46–92</td>
<td>46–92*</td>
<td>26–52</td>
</tr>
<tr>
<td>Severe contracture 2,3</td>
<td>&lt;45</td>
<td>&gt;93*</td>
<td>&lt;26</td>
</tr>
</tbody>
</table>

* 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
Pressure Garments

- Pressure may reduce:
  - Clustering of collagen
  - Interstitial space
  - Local metabolism

- Local hypoxia
  - Capillary occlusion pressure

- Prescription
Silicone

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

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Lisa Forbes, BMR(OT), MSc,§ Shu-Chuan Chen Hsu, MA, OTR/L, CHT,¶
Margaret McMahon, MAppSc(Physio),¶ Ingrid Parry, MS, PT,#
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
Loss of protective layer

• Cause:
  – Loss of sweat glands
  – Loss of oil glands
  – Skin dryness, chemical sensitivity
  – Pruritis*

• Treatment:
  – Lotion
  – Medications
  – Protection?
Figure 4. Maximal sweat rate ($\Delta SR$) from baseline after administration of $1 \times 10^{-1}$ 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 $\pm$ 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 $\pm$ SEM. Significant main effect for skin site demonstrates attenuated vasodilator responses to local heating at the grafted sites regardless of the duration postsurgery ($P < 0.001$).
HEAT STROKE
INFOLGRAPHIC ELEMENTS

AVOID THE SUN
dolor sit amet consai
lorem ipsum ectetur

RAPID HEARTBEAT

NO SWEATING
HOT / RED SKIN

DIZZINESS & HEADACHE

UNCONSCIOUSNESS

VOMITING

PREVENTION

NO ALCOHOL

DON’T WEAR THE
THICK CLOTHES

LIMIT OUTDOOR TIME

WEAR PROTECTION

USE A SUNSCREEN
USE A UMBRELLA

DRINK ENOUGH WATER

COOL SHOWERING

THE DANGER OF WORKING OUT IN THE HOT WEATHER

Source: alaskafamilymedical.com
## Long-term Outcomes

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

A

Pre-Heat Acclimation

Proportion of Subjects Exercising (%)

P=0.002
>40% < 17-40% = Control

Time (min)

0 10 20 30 40 50 60 70 80 90

Control 17-40% >40%

B

Post-Heat Acclimation

Proportion of Subjects Exercising (%)

P=0.393
>40% = 17-40% = Control

Time (min)

0 10 20 30 40 50 60 70 80 90

Δ Internal Temperature (°C)

A

Pre-HA Post-HA

Δ Internal Temperature (°C)

Pre-HA Post-HA

Skin Temperature (°C)

B

Ungrafted

Pre-HA Post-HA

C

Grafted

Pre-HA Post-HA

Control 17-40% >40%

Schlader et al., 2015
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

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

*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.

Superficial Innervation

- **Sense Organs in the Skin**
  - Epidermis: senses heat or cold
  - Dermis: Meissner’s corpuscle (senses touch), nociceptor (senses pain), Pacinian corpuscle (senses pressure)
  - Hypodermis

**Graphs:**

- **Touch**
  - Normal: $y = 0.51x + 1.53$
  - Graft: $y = 0.44x + 0.7$

- **Cold**
  - Normal: $y = -0.95x + 27.01$
  - Graft: $y = -0.48x + 15.85$

- **Warmth**
  - Normal: $y = 0.51x - 10.53$
  - Graft: $y = 0.15x - 3.24$

- **Heat-Pain**
  - Normal: $y = 1.8x - 40.42$
  - Graft: $y = 0.76x - 33.36$

Sunnybrook Health Sciences Centre
SPECIAL CONSIDERATIONS
Heterotopic Ossification

- Progressive abnormal soft tissue bone formation
- Progressive loss of ROM
  - Disability
  - Pain
  - Nerve entrapment
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?
Psychological Impact
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.
Return to Work

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

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