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OCCUPATIONAL THERAPIST'S MANAGEMENT OF UPPER EXTREMITY BURNS



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2/9/17

Objectives

- Identify burn wound characteristics, surgical options, and therapy priorities to promote wound closure, skin healing and functional recovery
- Appreciate the purpose and use of orthotics throughout phases of burn healing and scar formation
- Identify biomedical and topical wound coverings that may be useful in treating hand and upper extremity burns from wound through scar

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DISCLOSURES

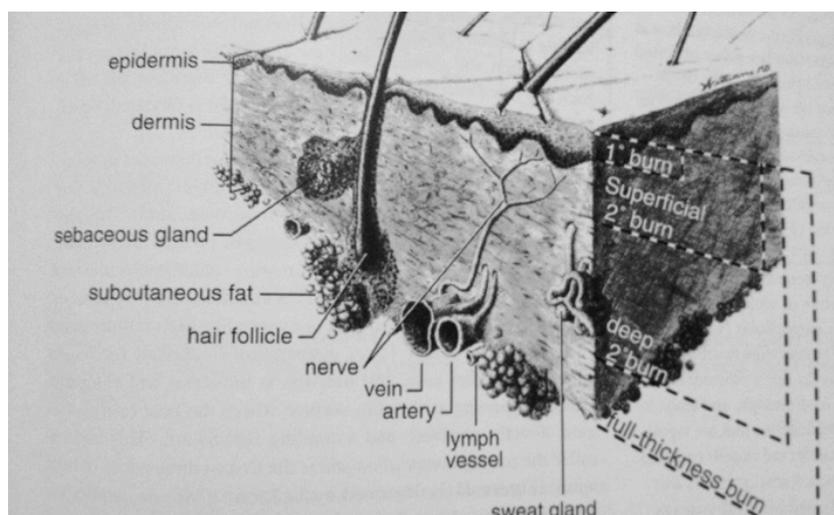
- NO FINANCIAL DISCLOSURES
- NO PREFERENCE TO MENTIONED PRODUCTS

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Burn Depth

- 1st Degree —> Epidermis (.05mm-1mm in adult)
 - Non-vascular, stratified epithelial cells
 - Capable of rapid regeneration
- 2nd Degree—> Dermis (10 times thicker than epidermis)
 - Vascular layer containing collagen strands with nerve endings, hair follicles, oil & sweat glands, lymph spaces
 - Epidermal cells line deep structures in dermis
- 3rd Degree—> Subcutaneous tissue
 - Adipose tissue & fibrous connective tissue
- 4th Degree—> Muscle or bone

Depths of Burn Injury



BURN DEPTH

SUPERFICIAL THICKNESS

- 1st degree burn
- Epidermis only
- Pink or red
- Erythema due to vasodilation
- Painful
- Characterized by cell damage without cell death
- Complete scarless healing within 7 days via re-epithelialization



BURN DEPTH

PARTIAL THICKNESS

(Superficial)

- 2nd degree burn
- Epidermis, superficial dermis**
- Pink or red
- Blistering
- Wet, weepy
- Soft, blanchable
- Very painful
- Rapid, complete healing
- Relatively little scarring



BURN DEPTH

PARTIAL THICKNESS (Deep)

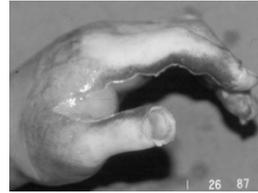
- 2nd degree, potential conversion to 3rd degree
- Most of dermis
- Red with overlying eschar
- Relatively insensate, potential for pressure
- Delayed healing potential (poor quality)
- Copious scarring



BURN DEPTH

FULL THICKNESS

- 3rd or 4th degree burn
- White, brown, tan, black or red
- Dry and leathery
- Firm, non-blanchable
- Insensate
- No potential for healing
- Profuse scarring if closes without excision, grafting (3rd)
- Elaborate debridement/reconstruction/amputation (4th)



Electrical

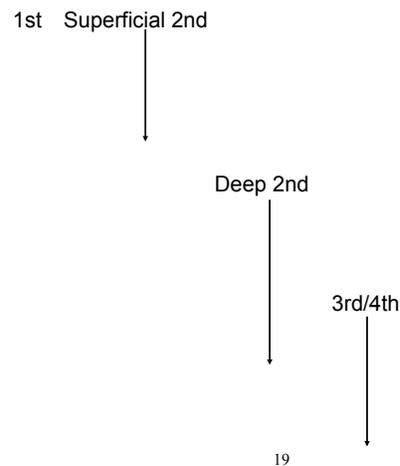


Chemical



BIOLOGICAL DRESSINGS & WOUND COVERAGE Commonly Used with UE Burns

- Petrolatum topical
- Petrolatum gauze
- Transparent film
- Foam/Hydrofibers
- Active Leptospermum
- Antimicrobials
- Silver cream
- Negative Pressure Wound Therapy (NPWT)



PETROLATUM TOPICAL

PROS:

- Easy, comfortable
- Inexpensive, OTC
- Under glove

CONS:

- Acne, ? reaction
- Thick, greasy



PETROLATUM GAUZE

PROS:

- Relatively easy
- Comfortable
- Allows relative mobility

CONS:

- Can be difficult under compression
- Cannot be used if wound bed already moist

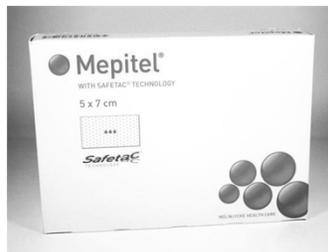


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TRANSPARENT FILM

PROS:

- Preserves injured epithelium
- Painless
- Perforated- allows fluid drainage
- Can be removed and reused



CONS:

- Does not lower risk of infection

FOAM

PROS:

- Used on any size area
- Can be left in place 4-7 days
- Donor sites
- Easy application
- Highly absorptive
- Includes antimicrobial agents



Allevyn



CONS:

- Costly

HYDROFIBERS

PROS:

- Easy application
- Does not require daily dressing change
- Moderate to heavy exudative wounds
- Absorbs wound fluid, forms hydrophilic gel
- Contains antimicrobial agents
- Conforms to wound surface



Aquacel Ag

CONS:

- Adherence over joint can interfere with movement
- Not compatible with oil based products

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ACTIVE LEPTOSPERMUM

PROS:

- Helps lower wound pH and improve O₂ transport
- Draws fluid from wound, minimizes edema
- Increases autolytic debridement
- Useful on wounds containing slough and devitalized tissue
- Effective antimicrobial agent against wide range of organisms
- Can be used in combination with NPWT



Medihoney

CONS:

- Slower acting
- Not recommended for full thickness wounds

ANTIMICROBIALS

Pros:

- Effective vs. MRSA, VRE
- 7-Day Dressing
- Used on grafts and synthetics



Acticoat

Cons:

- Difficult to use on large wounds
- Must be kept moist
- Not transparent
- Silver chloride stain

SILVER SULFADIAZINE

“Silvadene”

PROS:

- Broad spectrum
- Not painful
- Lower cost
- 24 hour microbial coverage

CONS:

- Limited diffusion into eschar



EMERGENT PHASE

(Initial 72 hours post-burn)

Major UE Considerations

- Edema
- Escharotomy
- Positioning
- Orthosis Intervention
- Motion
- Patient/family education



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Post-Burn Edema



Escharotomy/Fasciotomy



Positioning



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ORTHOSIS INDICATIONS

- Purpose: immobilize, support, position
- Characteristics: nonconforming, nonconstrictive
- Not standardized across burn units
- Many parameters for initiating orthotic use
- General indicators:
 - Sedated patient unable to participate
 - Significant edema resulting in digital clawing
 - Unable to actively achieve intrinsic plus position
 - Circumferential hand burn
 - Anterior elbow burn

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ORTHOSIS INTERVENTION

- Dorsal Hand Burn
 - Intrinsic Plus: MCPs 70-90, IPs 0, thumb mid-radial/palmar ABduction
- Volar Hand Burn
 - Resting Pan: digit extension, full thumb ABd
- Circumferential Hand Burn
 - Alternate Intrinsic Plus and Pan Orthoses
 - Modify Pan for slight MCP flexion in deep dorsal hand burn to prevent clawing

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Intrinsic Plus Orthosis



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Motion

- Preserve motion, prevent deformity
- Promote tendon gliding, active muscle function
- AROM as soon as awake, participating
- Full available motion in superficial dorsal hand injuries
- Protected ROM in deep dorsal hand burns
- Digital ABd/ADd considered safe for all depths
 - Activates intrinsics, mobilizes fluid
- ROM permitted after escharotomy/fasciotomy
- PROM in sedated patients

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Cutaneous Functional Units (CFUs)

- Fields of skin associated with normal movement
- Skin recruited serially as joint ROM increases
- Most skin motion occurs at skin crease of joint but skin recruited beyond joint itself
- Contracture risk regardless if skin crease involved
- Isolated MCP vs composite flexion
 - No difference in recruitment of uninjured dorsal hand skin (excludes digits)

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Elbow extension



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Composite Fisting



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ACUTE PHASE

(Emergent Phase through Wound Closure)

Major UE Considerations

- Motion
- Tendon Integrity
- Persistent Edema
- Orthosis Intervention
- Functional use/ADL participation and modifications

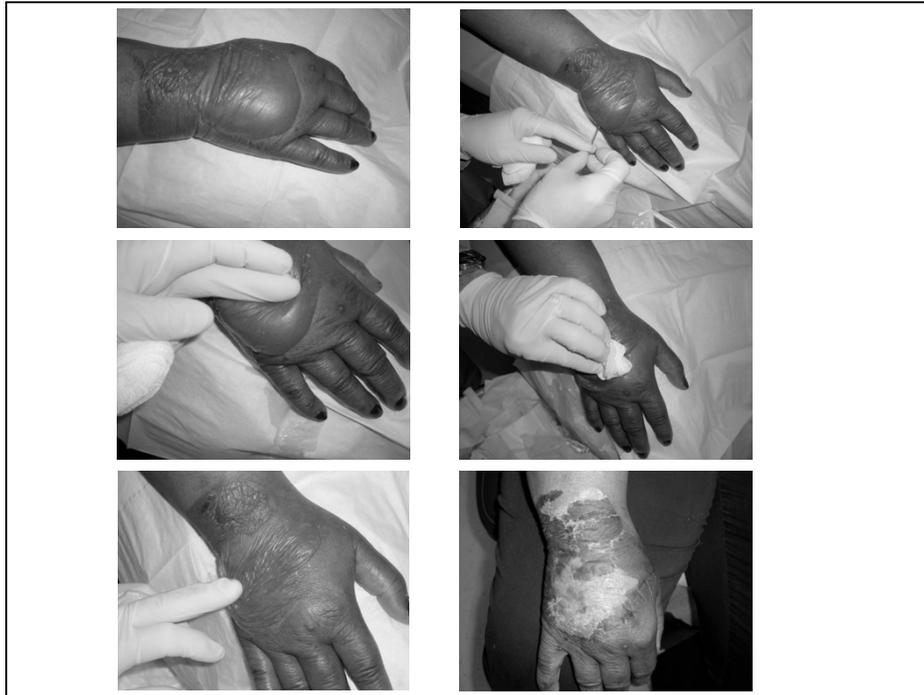
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Motion

- Minimize scar contraction, promote function
- Daily monitoring for loss of motion or limitations, initial deformity, maladaptive positioning
- Challenges in acute phase: pain, fibrous edema, increasing tautness, inelastic eschar
- What is limiting AROM? functional use?
- Disruption of the coordinated interplay of intrinsic and extrinsic muscles, tendons and joint is the underlying cause of most post-burn functional hand disturbances

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TENDON INTEGRITY

- Continual wound assessment/ inspection for exposed tendons
- Most common locations for extensor tendon exposure: PIP joint, dorsal hand
- Treat deep dorsal wound as if exposed until confirmed otherwise, skin healed or tissue covered
- Extensor tendon rupture/ attenuation
 - Delayed healing dorsal digital wounds



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PERSISTENT EDEMA

- Restricts motion, causes stiffness
- Can lead to tissue ischemia, fibrosis, progressive scar formation, deformity
- Compromised blood flow to hand, digits
 - Contributes to intrinsic tightness
- Fibrosis + thickened eschar can lead to delayed tissue death, “crushing effect” on extensor mechanism
- Treatment options/combinations
 - Fluff wrap, Coban, gloves
 - AROM, functional use

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PERSISTENT EDEMA



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STATIC ORTHOSES

- Purpose: prevent contracture
- Adjust for edema changes, dressing bulk
- Indications/Schedule:
 - Continue at night for optimal position
 - Limited use daytime if awake, participating
 - Intermittent daytime use with prolonged sedation or decreased functional use, maladaptive positioning
 - Uninterrupted use with digital tendon exposure
 - Position ET on slack to prevent rupture but prevent excessive shortening



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PIN FIXATION

- Deep, non-healing wounds unresponsive to orthosis
- Likely tendon/joint exposure with loss of extensor mechanism
- K-wire pins driven through MCPs in maximal flexion, IPs in 0 degrees extension
- Pins kept in place up to 6 weeks for temporary positioning, >6 weeks for permanent positioning until pseudo-arthrodesis via scarring

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K-Wire Pinning



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Delayed Pin Removal



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MOBILIZATION ORTHOSES

- Adjunct to active exercise, manual stretching
- Force application amount determined by tissue response
- Dynamic traction used for early stiff hand, elbow
 - “Subtle suggestiveness”
 - Ideal when PROM responds to stretch, inflammation subsiding
- Cautious use of composite digital mobilization orthoses until dorsal wounds closed



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CONTRACTURE IN BURN INJURY (at time of hospital discharge)

- Most common large joints
 - Shoulder 38%, elbow 34%, knee 22%
- Statistically significant predictors of contracture development
 - Length of stay, extent of burn, graft
- Statistically significant predictors of contracture severity
 - Graft size, amputation, inhalation injury

Contractures in Burn Injury: Defining the Problem
J Burn Care & Research 2006

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CONTRACTURE IN BURN INJURY (at time of hospital discharge)

- Small joints
 - 23% at least 1 wrist or hand joint contracture
- Statistically significant predictors of contracture development
 - Concomitant medical problems, TBSA grafted, presence of hand burn and hand grafting
- Statistically significant predictors of contracture #
 - Length of stay, concomitant medical problems, burn size, presence of hand burn and hand grafting

Contractures in Burn Injury Part II: Investigating Joints of the Hand
J Burn Care & Research, 2008

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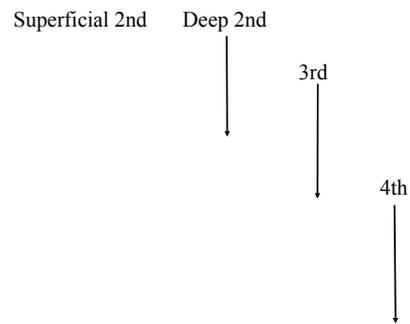
OPERATIVE MANAGEMENT/ SKIN GRAFTING

- Continual monitoring for signs of healing or conversion
 - Time & color
- Early predictors
 - Location, mechanism, age/health, occupation
- Early excision & grafting
 - Limits/negates acute phase
 - Shortens fibroblastic stage
 - Speeds up healing, discharge and return to work/school
 - Best functional outcome



WOUND COVERAGE (SURGICAL) Commonly Used with UE Burns

- Xenograft
- Homograft
- Autograft
- NPWT
- Integra
- Flap



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XENOGRAFT

Pigskin

- Temporary wound coverage
- Minimizes fluid loss
- Controls pain via nerve ending coverage
- Stimulates re-epithelialization



HOMOGRAFT/ALLOGRAFT

Cadaver

- Extended temporary wound coverage
- Tests recipient bed for viability
- Decreases pain
- Protective covering/seals wound
 - Reduces heat loss
 - Prevents infection
 - Minimizes fluid loss



AUTOGRAFT

Patient's Own Skin

- Permanent coverage
- No risk of rejection
- Skin depth and color matching
- Sheet for optimal cosmesis, durability
- Meshed for enlarged coverage area
- Donor site can be reharvested



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SPLIT-THICKNESS SKIN GRAFT (STSG)

- Most commonly used autograft
- Includes epidermis and part of dermis
- Vascular ingrowth within 24-28 hours
- Typically harvested from ipsilateral anterior thigh
- Donor site requires wound care, dressing
- Initial sensibility 4-6 weeks



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FULL-THICKNESS SKIN GRAFT (FTSG)

- Less common but standard of choice for palmar wounds
- Includes epidermis and dermis
- Advantages
 - Increased depth-->higher quality coverage
 - Less contraction within wound bed
- Disadvantages
 - Harvest site requires skin graft



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AUTOGRAFT POST-OPERATIVE CARE

- Bulky post-op dressing to immobilize hand, digits and prevent shearing
- Dressing removed POD#3 for STSG, POD#5 for FTSG
- Assessed for “take” (%)
 - Adherence to wound bed
 - Viability
 - Presence of fluid pockets or hematoma



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AUTOGRAFT (STSG) POST-OPERATIVE CARE

- Therapist role
 - POD#3-5
 - Trim excess autograft
 - Dressing to control edema, allow mobility
 - Xeroform, gauze, Coban
 - Resume gentle AROM** (fibrin glue)
 - POD#5 and beyond
 - Progress to limited dressing and edema glove
 - Intermediate pressure glove once little to no dressing
 - Advance to aggressive AROM, PROM and orthosis use as necessary, unrestricted ADL including shower



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Autograft Trimming



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NPWT/VAC

Advantages:

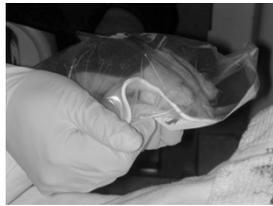
- Enhances granulation tissue
- Less dressing changes
- OR or bedside

Disadvantages:

- Unable to visualize wound
- Difficult application to smaller hands



WOUND VAC APPLICATION

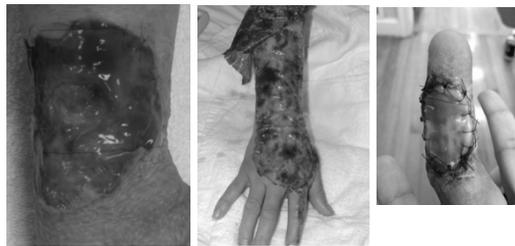
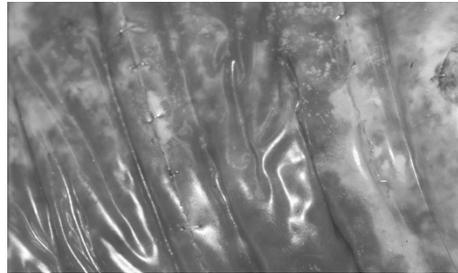


WOUND VAC



INTEGRA

- Bilayer matrix wound dressing
- Inner porous matrix allows rebuilding of blood supply, replaces dermis
- Outer silicone layer acts as epidermis, removed after dermal ingrowth for thin epidermal skin graft
- Closely monitored for infection
 - Serum collection removed daily to prevent failure, loss



FLAP

- Used for traumatic defects involving soft tissue loss
- Provides wound coverage/closure
- Local skin flap uses nearby skin and subcutaneous tissue
 - Rotational
 - V-Y Advancement
 - Cross-Finger



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FLAP

- Used for traumatic defects involving extensive soft tissue loss, exposed bone/tendon, inefficient blood supply
- Axial flap for reconstruction of distal UE injuries
 - Groin flap
- Secure at 5 days, PROM initiated



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REHABILITATION PHASE

(Wound Closure through Scar Maturation)

Major UE Considerations

- Chronic edema
- ROM/Strength
- Skin integrity
- Scar characteristics
- Orthosis Intervention
- Physical Agents
- Deformity/contracture
- Return to work/school



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CHRONIC EDEMA

- Source of progressive scar formation & restriction of motion
- Compounded by lymphatic/vessel damage
- Contributes to intrinsic, extrinsic tightness
 - Due to ischemia, fibrosis, ROM limitations
- Treatment options
 - Compression gloves, sleeves
 - Jobst compression pump (home)



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ROM/STRENGTH

- Manual examination to determine which structures limit motion
 - Multiple positions, target tissue on slack & tension
- Must consider soft tissue structures beyond skin/scar
 - Intrinsic/extrinsic tightness, joint stiffness
- Resistive exercise in burn recovery



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SKIN INTEGRITY

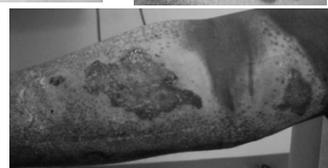
- Recurrent exposed tendons/
joints
- Assess readiness for
pressure
- Protect bony prominences
from shearing, blistering in
garments and with return to
activity



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SCAR

- Burn tissue healing
 - Prolonged inflammation
 - Overlap between healing phases
 - Synthesis-lysis imbalance
 - Problem healing: hypertrophy, keloid
- Stiffness due to increased collagen synthesis, lack of elastin in dermal layer
- Increased firmness in *burn* scar?
 - GAG chondroitin 4-sulfate 6x higher burn scar vs. normal skin (only GAG found in bone)
- Once mature, non-surgical treatment ineffective



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SCAR ASSESSMENT

- Vancouver Scar Scale (VSS)
 - Most commonly used
- Patient and Observer Scar Assessment Scale (POSAS)
 - Developed in the Netherlands
 - Patient scale: color, pliability, thickness, relief, itching, pain
 - Observer scale: vascularization, pigmentation, pliability, thickness, relief
 - Concurrent validity with VSS
 - Suitable for rating burn scars

VSS

Pliability	0	Normal
	1	Supple
	2	Yielding
	3	Firm
Height	4	Adherent
	0	Normal
	1	1-2 mm
	2	3-4 mm
Vascularity	3	5-6 mm
	4	>6 mm
	0	Normal
	1	Pink
Pigmentation	2	Red
	3	Purple
	0	Normal
1	Slightly <input type="checkbox"/> / <input type="checkbox"/>	
2	Moderately <input type="checkbox"/> / <input type="checkbox"/>	
3	Severely <input type="checkbox"/> / <input type="checkbox"/>	

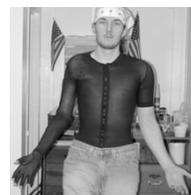
	Consistency	Reliability
VSS	.49	.69
POSAS	.76 (P) .69 (O)	.73 (O)

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SCAR MANAGEMENT

Pressure

- Alters disposition of collagen fibers in dermal hypertrophic healing
- Custom fitted pressure garments
 - Measured when remaining wounds no larger than quarter
 - “Intermediate” gloves/garments used in interim to control scar/edema, prepare skin
 - 2 sets for laundering
 - Worn 23 hours/day
 - Modifications for enhanced grip



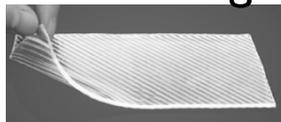
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SCAR MANAGEMENT

- Inserts



- Silicone gel



- Otoform



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ORTHOSIS INDICATIONS

- Purpose:
 - Reduce non-surgical contracture
 - Prevent/reduce deformity
 - Maintain/promote natural body contours
 - Complement pressure treatment
- Goal:
 - Maintain sustained stretch to scar tissue
 - Maintain range achieved with stretch/ROM
 - Immobilize joint at end-range
 - Avoid pressure, excessive stretch

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ORTHOSIS INTERVENTION

- Static
 - Thumb webspacer: 1st webspace tightness
 - PIP gutter: Boutonniere
 - DIP gutter: Mallet



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ORTHOSIS INTERVENTION

- Static progressive
 - Significant resistance at end of passive stretch
 - Tension applied with joint at maximum range, adjusted when tissue response allows repositioning to new length
 - MCP extension contractures



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ORTHOISIS INTERVENTION

- Serial static (casting)
 - Resistive joint, firm to hard end-feel
 - Joint immobilized in stationary position, cast remolded at new maximum length after tissue accommodation
 - Fixed flexion contracture: digital PIP, elbow, wrist



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PHYSICAL AGENTS

- Paraffin with sustained stretch
 - Most commonly used PAM burns (cooler temp)
 - Softens skin, promotes increased motion prior to exercise
- Iontophoresis (slow delivery)
 - Saline or iodine for scar softening
- Fluidotherapy
- Ultrasound: limited success treating burn scar
- Laser: multiple types for delayed scar treatment, prophylactic prevention hypertrophic scar w/o good evidence



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DEFORMITY/CONTRACTURE

- Claw hand deformity
- PIP flexion contractures
- MCP HE contractures
- Flattened hand/loss of arches
- Boutonniere deformities
- Swan neck deformities
- Mallet deformities
- Nail bed deformities
- Palmar cupping
- Webspace contractures/Syndactyly



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Boutonniere deformities

- More likely with deep burn to dorsal hand, digits, thumb
- Mechanism of injury
 - Immediate: direct thermal injury to central slip
 - Delayed: tendon ischemia
 - Chronic: Scar banding &/or ORL tightness
- Arthrodesis is primary surgical correction option
 - Unsatisfactory tenoplasty options
 - No soft tissue coverage needed



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Swan neck deformities

- MF incidence most prominent
- Causes for PIP hyperextension
 - EDC adherence
 - Intrinsic ischemic contracture
 - Joint stiffness/improper immobilization
 - Burn scar contracture



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Mallet deformities

- Mechanism of injury
 - Immediate: direct thermal injury to terminal slip
 - Delayed: tendon ischemia (crushing of tendon between dorsal surface eschar and P3 base)
 - Increased during PIP flexion



Nail bed deformities

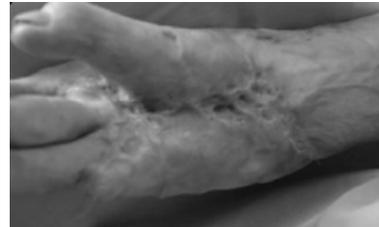
- Mechanism of injury
 - Dorsal scarring over DIP with distortion of eponychial fold, eponychium retraction, proximal nail exposure
- Consequences of injury
 - Limits finger stability with pinching, fine motor dexterity
 - Cosmetically disabling
- Surgical treatment
 - Tightness w/o retraction= skin release, graft
 - Tightness with retraction= proximally based lateral skin flaps



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Palmar cupping

- Mechanism of injury
 - Deep palmar burn (peds, contact)
- Consequences of injury
 - Thumb MCP HE contractures
 - Sensory deficits
 - Loss of stable grasping surface
- Surgical treatment
 - Multiple reconstruction procedures and extensive therapy



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Web-space contractures

- Mechanism of injury
 - Adjacent digits burned (fingers fuse together)
 - Digital skin granulation or contractures allow distal web migration
- Consequences of injury
 - Limits digital ABduction and thumb opening
 - Cannot place thumb away from palmar plane
- Surgical treatment
 - Z-plasty variations (lowest recurrence rate)
 - FTSG if not sufficient skin



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RECONSTRUCTION OPTIONS

- Scar resurfacing
- Web-space release
- Dorsal MCP release with autograft
- Excess skin or scar removal with primary closure
- Arthrodesis



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RETURN TO WORK/SCHOOL

- Collaborative effort
- Referral to work-hardening program
- Strongest indicators
 - RTW time: % TBSA, grafting requirements, B hand involvement
 - Successful school re-entry: tutors during hospitalization, school environment/personnel & peer preparedness
- MHQ: hand function deterioration 68%
- Most affected: ADL 76%, work 59%



RESOURCES & PROGRAMS For Burn Survivors

- Phoenix Society www.phoenix-society.org
 - Survivors Offering Assistance & Recovery
 - Image enhancement
 - Local support groups
- American Burn Association www.ameriburn.org
- International Association of Firefighters
 - Regional Burn Camps
- Adaptive Sports Center, Crested Butte CO
 - Burn specific adaptive sports, outdoor programs

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RESOURCES For Therapists

- American Burn Association Rehabilitation Committee, Special Interest Group
www.ameriburn.org
- BurnTherapist.com
- Textbooks
 - Burn Care and Rehabilitation: Principles and Practice (Richard, RL)
 - Total Burn Care (2nd ed. Herndon)
 - Rehabilitation of the Hand and Upper Extremity (6th ed. Skirven et al)

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Management of Upper Extremity Trauma

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<u>Mon 2/6</u>	Understanding Multi-Trauma Hand and Upper Extremity Injuries Carol Recor, OTR/L, CHT
<u>Tues 2/7</u>	Wrist Detective: Investigating Traumatic Wrist Injuries Rachel Pigott, OTR/L, CHT
<u>Wed 2/8</u>	Management of Upper Extremity Nerve Injury Christine Novak, PhD, PT
<u>Thurs 2/9</u>	Occupational Therapist's Management of Upper Extremity Burns Nora Barrett, MS, OTR/L, CHT
<u>Fri 2/10</u>	Tendon Trauma: Keys to Optimal Outcomes Rebecca Neiduski, PhD, OTR/L, CHT