

Pediatric Hand Burns

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Disclosure

Dr. Moulton, faculty for this session, is a co-founder at Impact Vitals, Inc. and ezalife, LLC.

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Objectives

- List common mechanisms of pediatric hand burn injury
- Recognize inflicted vs. accidental patterns of pediatric hand burn injury
- Describe non-operative methods for the management of a pediatric hand burn injury

Overview

- Depth, size and ABA referral criteria
- Anatomical considerations
- Mechanisms of hand burn injury
- Inflicted vs. accidental patterns of hand burn injury
- Non-operative management
- Surgical management
- Our experience
- Summary

Depth, Size and ABA Referral Criteria

Depths of Burn Injury

1st DEGREE

- Redness of the skin (sunburn)

2nd DEGREE

- Hallmark is a blister
- Involves superficial to deep dermis
- Painful; moist if blister ruptured
- Most heal in \leq 21 days



3rd DEGREE

- Burn into subcutaneous tissue
- Often dry, pale, leathery, and insensate
- Does not blanch
- Later, exposed fatty tissue
- Unless small, will need grafting

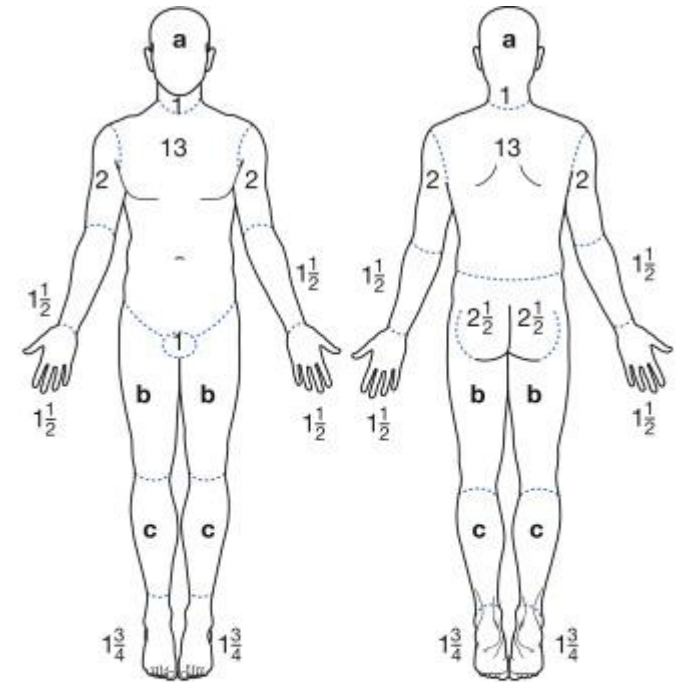
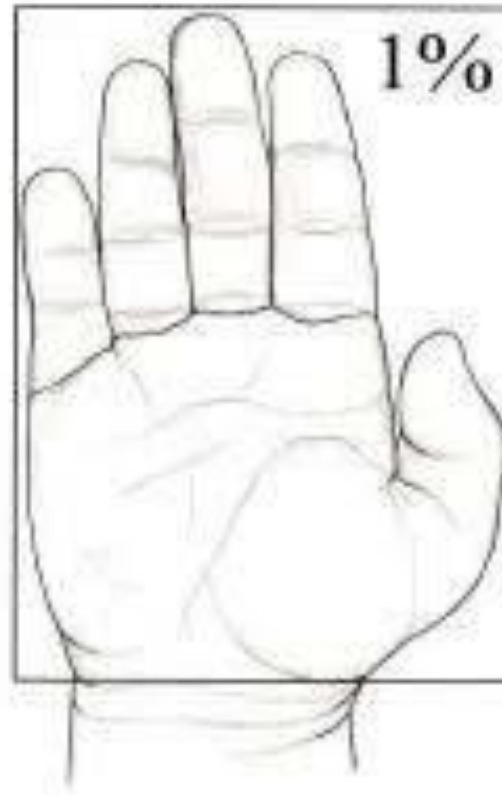


4th DEGREE

- Involves fascia, bone, cartilage
- May need temporizing dermal matrix

Calculate % TBSA to Determine Disposition

- Do not include 1st degree burns (red skin)
- Only include blistering 2nd, 3rd, and 4th degree burns
- Palmar surface (hand + fingers + thumb) is ~1% TBSA
- Use Lund Browder for larger burns



	Age in years					
	0	1	5	10	15	Adult
a - $\frac{1}{2}$ of head	$9\frac{1}{2}$	$8\frac{1}{2}$	$6\frac{1}{2}$	$5\frac{1}{2}$	$4\frac{1}{2}$	$3\frac{1}{2}$
b - $\frac{1}{2}$ of one thigh	$2\frac{3}{4}$	$3\frac{1}{4}$	4	$4\frac{1}{4}$	$4\frac{1}{2}$	$4\frac{3}{4}$
c - $\frac{1}{2}$ of one leg	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{3}{4}$	3	$3\frac{1}{4}$	$3\frac{1}{2}$

ABA Burn Referral Criteria

University Hospital: ages ≥ 15 (any size burn injury)

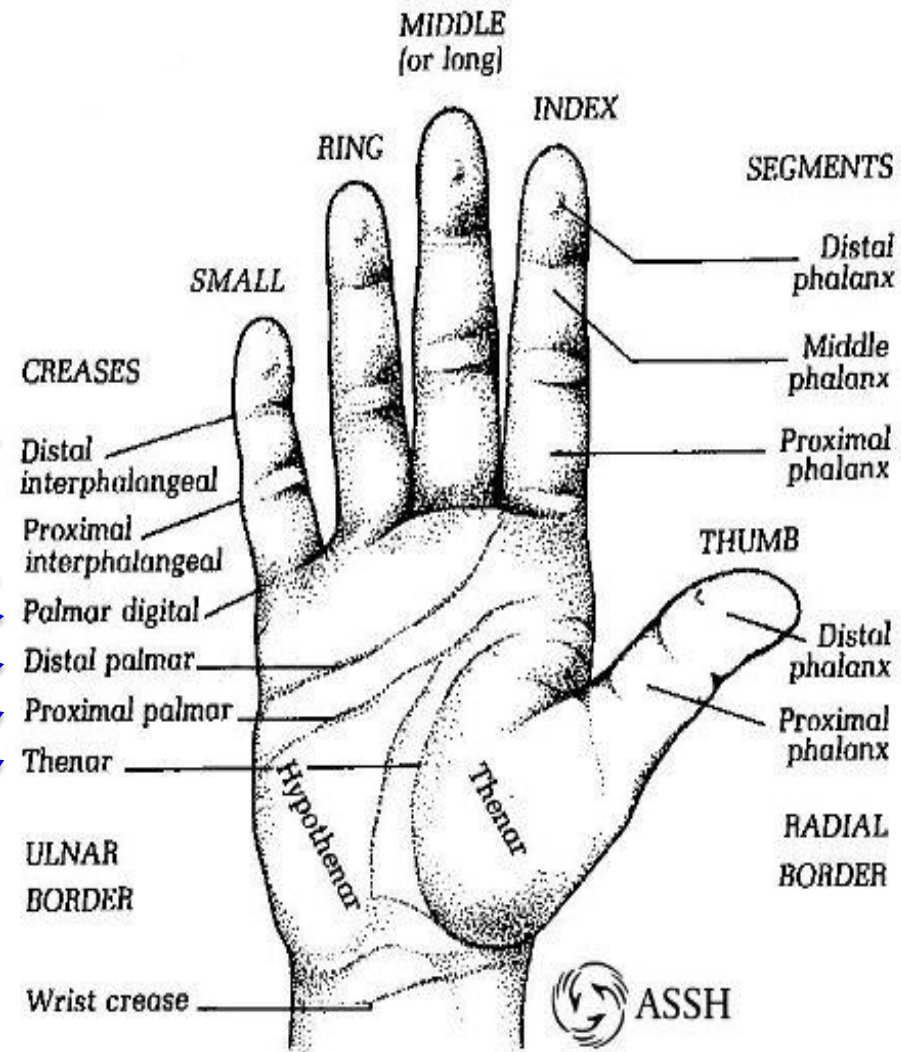
Children's Hospital: ages 0 – 18 ($\leq 60\%$ TBSA)

- (Partial thickness, age < 2 , $\geq 5\%$ TBSA)
- Partial thickness, age ≥ 2 , $\geq 10\%$ TBSA
- Burns of: face, hands (if burns cross joints and/or are deep), feet, genitalia, perineum, major joints
- Full thickness burns
- Electrical (incl. lightning) and chemical burns
- Special: infant, trauma/NAT, etc.

Anatomical Considerations

Anatomical Considerations

- Joints (mobility):
 - Interphalangeal joints
 - MCP joints
 - Wrist
- Creases (cosmesis):
 - Interphalangeal
 - Palmar digital
 - Distal palmar
 - Proximal palmar
 - Thenar crease



Anatomical Considerations

- Skin and sensation
 - Cutaneous sensation
 - Elasticity of the dorsal skin
 - Thickness and stability of the palmar skin and palmar fascia

- Biomechanical Forces
 - Power of the flexor tendons
 - Soft casting to heal at maximal stretch



Mechanisms of Hand Burn Injury

Heat Contact Burns

- Most common cause of hand burns among children
 - Firepits (hot coals)
 - Stovetops
 - Glass fronted gas fireplaces
 - Oven doors
 - BBQs/smokers
 - Irons
 - Curling
 - Clothes



A Multicenter Study of Preventable Contact Burns From Glass Fronted Gas Fireplaces

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Glass fronted gas fireplaces (GFGFs) have exterior surfaces that can reach extremely high temperatures. Burn injuries from contact with the glass front can be severe with long-term sequelae. The Consumer Product Safety Commission reported that these injuries are uncommon, whereas single-center studies indicate a much higher frequency. The purpose of this multi-institutional study was to determine the magnitude and severity of GFGF injuries in North America. Seventeen burn centers elected to participate in this retrospective chart review. Chart review identified 402 children ≤ 10 years of age who sustained contact burns from contact with GFGF, who were seen or admitted to the study hospitals from January 2006 to December 2010. Demographic, burn, treatment, and financial data were collected. The mean age of the study group was 16.8 ± 13.3 months. The majority suffered burns to their hands (396, 98.5%), with burns to the face being the second, much less common site (14, 3.5%). Two hundred and sixty-nine required rehabilitation therapy (66.9%). The number of GFGF injuries reported was 20 times greater than the approximately 30 injuries estimated by the Consumer Product Safety Commission's 10-year review. For the affected children, these injuries are painful, often costly and occasionally can lead to long-term sequelae. Given that less than a quarter of burn centers contributed data, the injury numbers reported herein support a need for broader safety guidelines for gas fireplaces in order to have a significant impact on future injuries. (J Burn Care Res 2015;36:240-245)

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- GFGFs temps 400 – 1,000 F (200-500 C)
 - Instantaneous 3rd degree burn 172 C
- 5-year multicenter retrospective study
 - 17 pediatric burn centers
 - 402 hot GFGF burn injuries
 - Mean age 16.8 months
 - 98.5% hand(s), 3.5% face
 - 3-11% required surgery
 - Successful outcomes: OTx with splinting, casting
 - 80/year [20x > CPSC (4/yr)]
 - Est >\$10M/yr costs
 - Excludes emotional pain/suffering
 - Preventable injuries

Flame Burns

- Fireworks
- Campfires
- House fires



Friction Burns

- Causes
 - Treadmills
 - Vacuum Cleaners
- Usually very deep
 - Exposed tendon/joint
 - Neurovascular bundle
- Areas of concern
 - Flexion contractures, which pull on landmarks
 - Proximal and distal palmar creases

Example Case 1

Straightforward



Example Case 2

Complex



Exposed joint capsules
Disrupted flexor tendon 5th finger

Scald Burns

- Flow pattern scald burns

- Accidental?
- NAT?



Partial thickness flow pattern burns

- Immersion pattern scald burns

- Accidental?
- NAT?



Deep partial to full thickness immersion pattern burns

Scald Burns

- Spill pattern scald burns
 - Caused by
 - Reaching for coffee, tea, soup, ramen noodles
 - Hot showers
 - Keep:
 - Children out of the kitchen
 - Hot liquids up high, away from counter edge
 - Pots and pans on rear burners
 - Your water heater $< 120^{\circ}$



Electrical Burns

- Low voltage ≤ 1000 volts
 - Frequent cause of cardiac dysrhythmia
 - If ECG normal, no further evaluation needed
- High voltage > 1000 volts
 - 3rd and 4th degree burns
 - Death



**Inflicted vs.
Accidental Patterns
of Hand Burn Injury**

Inflicted Burn Injuries

- Burns represent about 10% of NAT cases
 - 10-20% of pediatric burn admissions
- Children are intentionally burned for different reasons
- Intentional burns often leave characteristic patterns
- Scald type burns are most common inflicted burn
 - Often overlooked as accidental
- History, psychosocial risk factor assessment and pattern of injury are critically important

Inflicted Burn Injuries

- Explanation consistent with injury?
 - Contradictory or varying accounts among witnesses?
 - Burn attributed to a sibling?
- Delay in seeking care?
- Other injuries present?
 - Look for bruising!!
 - Consider skeletal survey
 - Consider ophthalmologic exam if < 2 years old
- Anger or resent toward child?
 - Inappropriate affect?

Inflicted Burn Injuries

- Physical findings associated with NAT
 - History incompatible with physical exam
 - Anatomic location of burn injury; sparing of flexion creases
 - Presence or absence of clothing at time of injury
 - Scald: flow vs. spill vs. immersion pattern
 - Heat contact burns are usually branding type; mirror object
 - Burn incompatible with developmental age
 - Location of child at time of burn
 - Sharply delineated burn margins
 - Localized burns of perineum, genitalia, buttocks
 - Burns older than history given
 - Other injuries
 - Cigarette burns, bruises, fractures



4 year old male
Step MOC soaking his hands in warm water
She left room to care for other child
Pt reportedly turned on hot water burning hand
Seen in ED, unexplained facial and other bruises
Child very quiet in room w/ FOC and Step MOC

Type of burn?
History consistent with injury?



4 year old male
Step MOC soaking his hands in warm water
She left room to care for other child
Pt reportedly turned on hot water burning hand
Seen in ED, unexplained facial and other bruises
Child very quiet in room w/ FOC and Step MOC

Type of burn? **Scald, flow pattern.**
History consistent with injury? **No**
Discharged to foster care



3 year old female in kitchen with mom making dinner
Mom steps away to answer phone, MGMOC remains in kitchen
Child pulls chair up to stove to check boiling water in pot on stove
Mom hears crying, notes child with burns

Type of burn?

History consistent with injury?



Fingertips spared

Flow pattern, palmar surface deeper than dorsal



3 year old female in kitchen with mom making dinner
Mom steps away to answer phone, MGMOC remains in kitchen
Child pulls chair up to stove to check boiling water in pot on stove
Mom hears crying, notes child with burns

Type of burn? **Scald, flow pattern (finger tips are spared, palmar deeper).**
History consistent with injury? **No**
Child in custody of mom; MGMOC removed from home, DHS monitoring.



4 year old female
Father claims she touched hot pot
Father later claims she touched hot
stovetop

Type of burn?
History consistent?





4 year old female
Father claims she touched hot pot
Father later claims she touched hot
stovetop

Type of burn? **Heat contact.**
History consistent? **No, palm/dorsum.**
Mom later confessed, jailed.

Dorsal and palmar burns





2 year old male in c/o father's GF
Potty training; later playing in toilet
GF washed his hands, skin peeling
GF believes chemicals in toilet water
O/E in ED, blood in both ears, bruises
and abrasions

Type of burn?
History consistent?





2 year old male in c/o father's GF
Potty training; later playing in toilet
GF washed his hands, skin peeling
GF believes chemicals in toilet water
O/E in ED, blood in both ears, bruises
and abrasions

Type of burn? **Scald, flow pattern**
History consistent? **No**
Placed in foster care



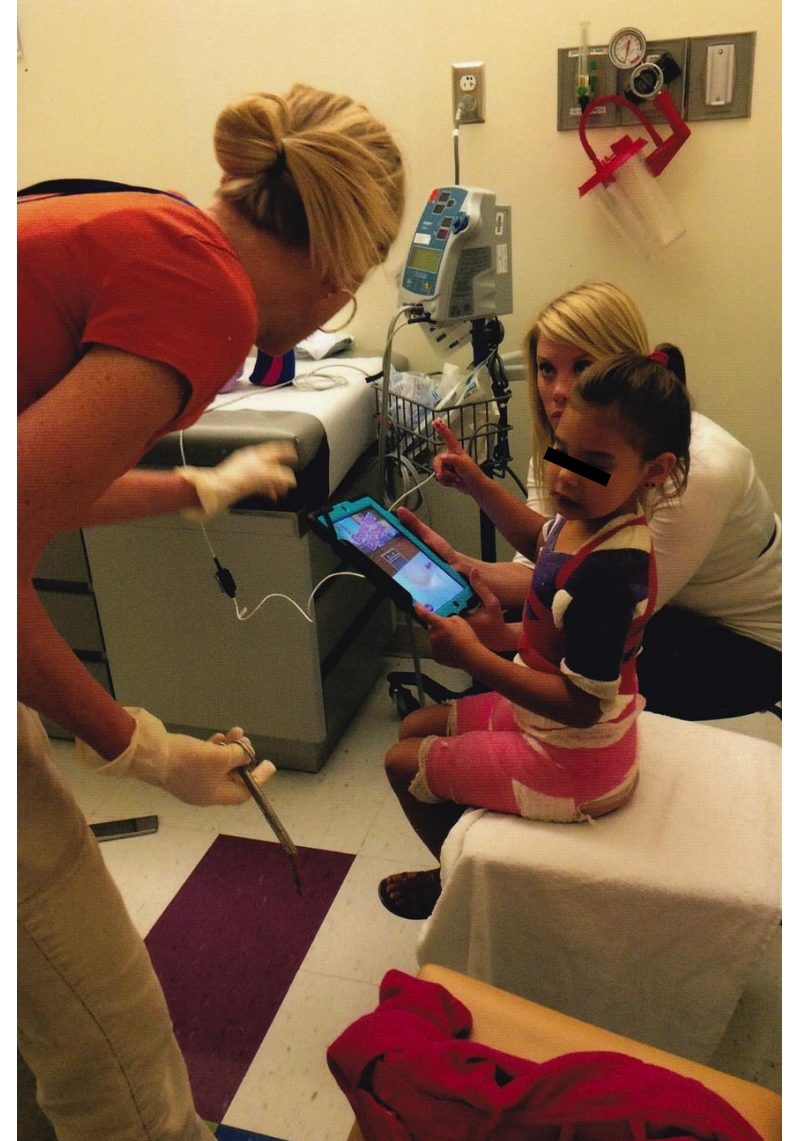
Sparing of palms and fingertips



Non-operative Management

ED and Outpatient Management

- Pre-medicate for pain
 - Small burn (1-2%)
 - Intra-nasal fentanyl (1.5 mcg/kg/dose), or
 - PO acetaminophen or ibuprofen +/- oxycodone
 - Moderate size burn ($\geq 3\%$)
 - IV narcotic or go to operating room
 - Avoid NSAIDs if considering surgery
- Manage anxiety
 - Child-Life
 - Anxiolytic
 - Lorazepam



ED and Outpatient Management

- Blisters
 - If FLAT, we leave them INTACT
 - If RAISED, then we window or debride with fine scissors
- Dressings
 - TAO or Bacitracin in a non-adherent dressing
 - Inexpensive, easy to apply/remove; change once or twice per week
 - Switch to Nystatin (almost healed) at 7-10 days
 - Switch an active silver dressing with silicone adhesive (deep partial to full thickness) once drainage slows or stops
- Rarely prescribe oral pain medication (narcotic)
 - Unless needed for dressing changes, physical activity, sleep

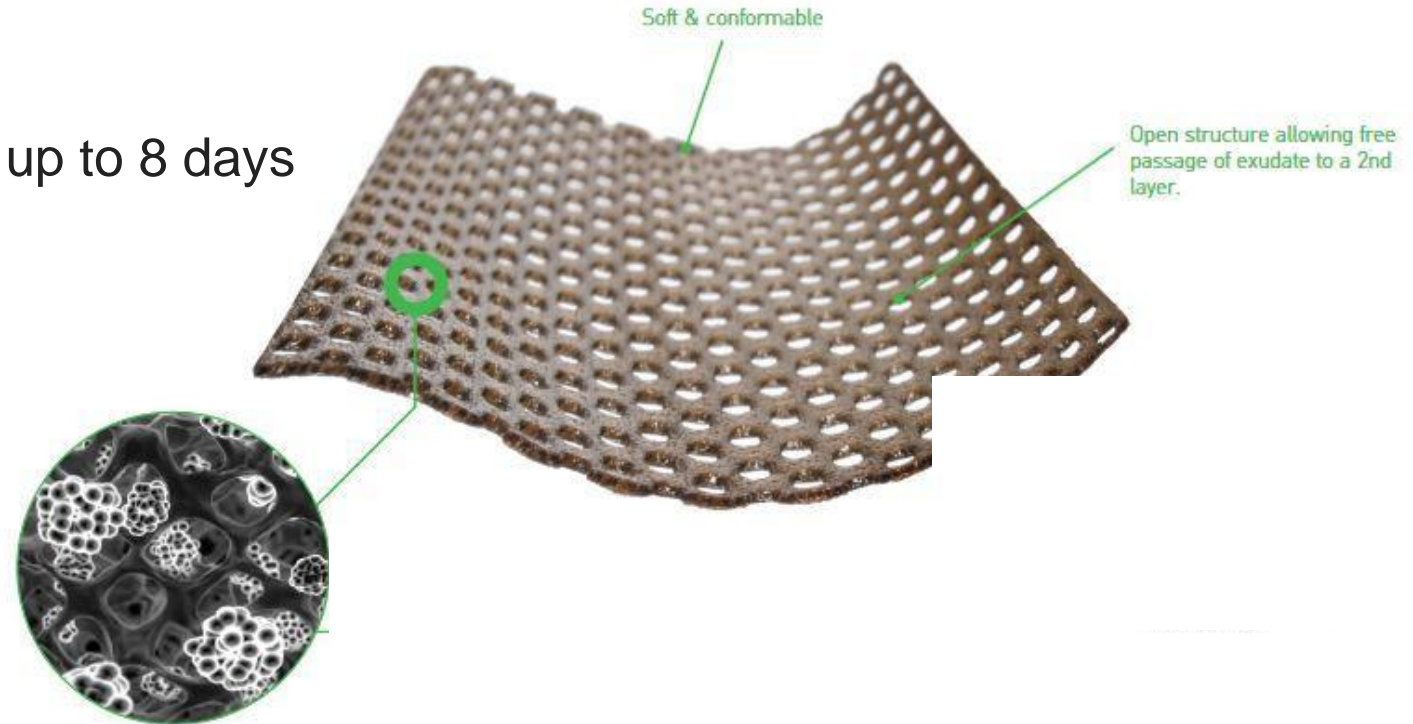
Conformable, Silver Sulfate Dressing

Indications

- Indicated for the management of lightly to moderately exuding wounds such as leg and foot ulcers, pressure injuries and partial-thickness burns.

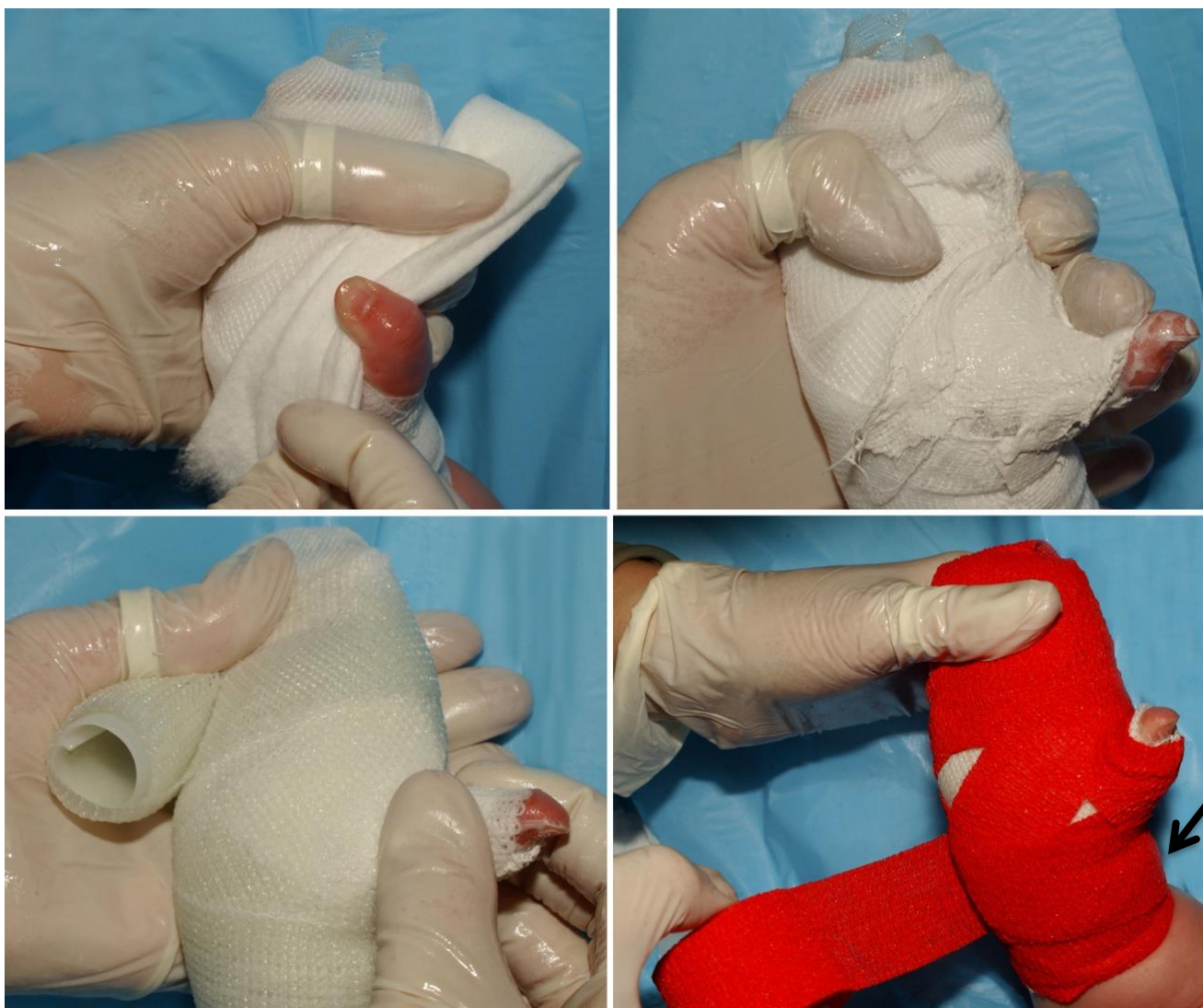
Benefits

- Silicone-based adhesive
 - Minimizes pain and trauma at dressing change
- Rapid and sustained antimicrobial activity
- Stays securely in place
- Inactivates a broad range of pathogens for up to 8 days





1. Window and/or debride blister(s)
2. Cover open areas with antibiotic ointment impregnated non-adherent dressing
3. Wrap with 1 and/or 2-inch rolled gauze, bring proximal to wrist



Wrap proximal to
wrist to prevent early
removal

4. Apply soft cast pad around thumb and over palm
5. Apply plaster then wrap with 1 and/or 2-inch soft cast
6. Finish with 1 or 2-inch stretch wrap

Surgical Management

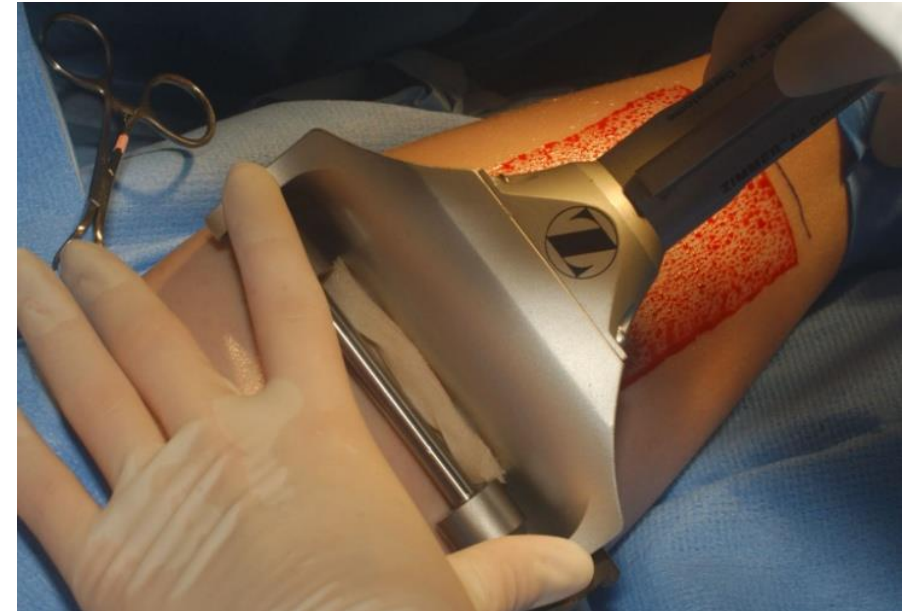
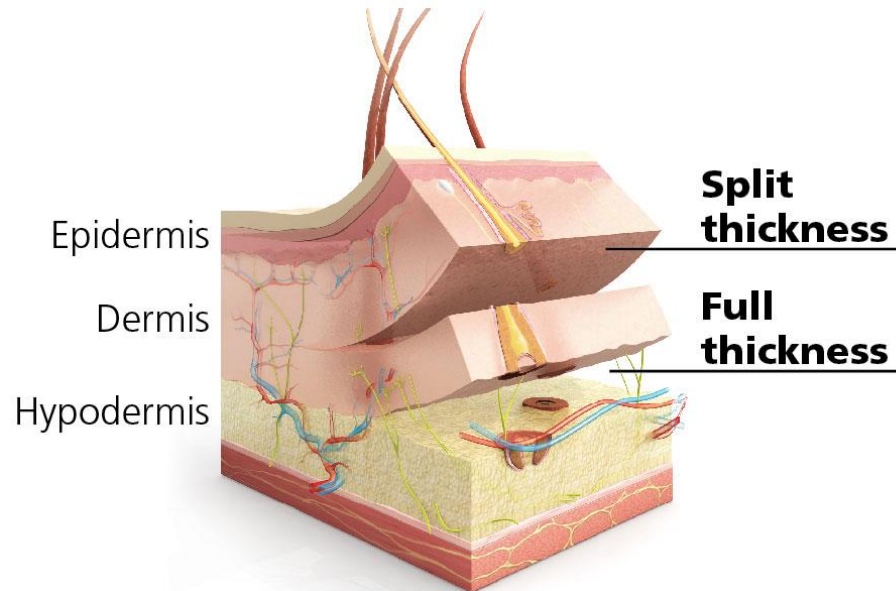
We Strive for Wound Closure 14 Days Post-injury to Prevent Scarring and Preserve....

- Normal motor development
 - Growth spurts at ages
 - 2-3 years old, girls/boys
 - 8-13 years old, girls
 - 10-15 years old, boys
- Age-appropriate activities
 - Fine motor skills
 - Developmental/gross motor skill acquisition
- Activities of daily living
 - Handwriting
 - Self feeding



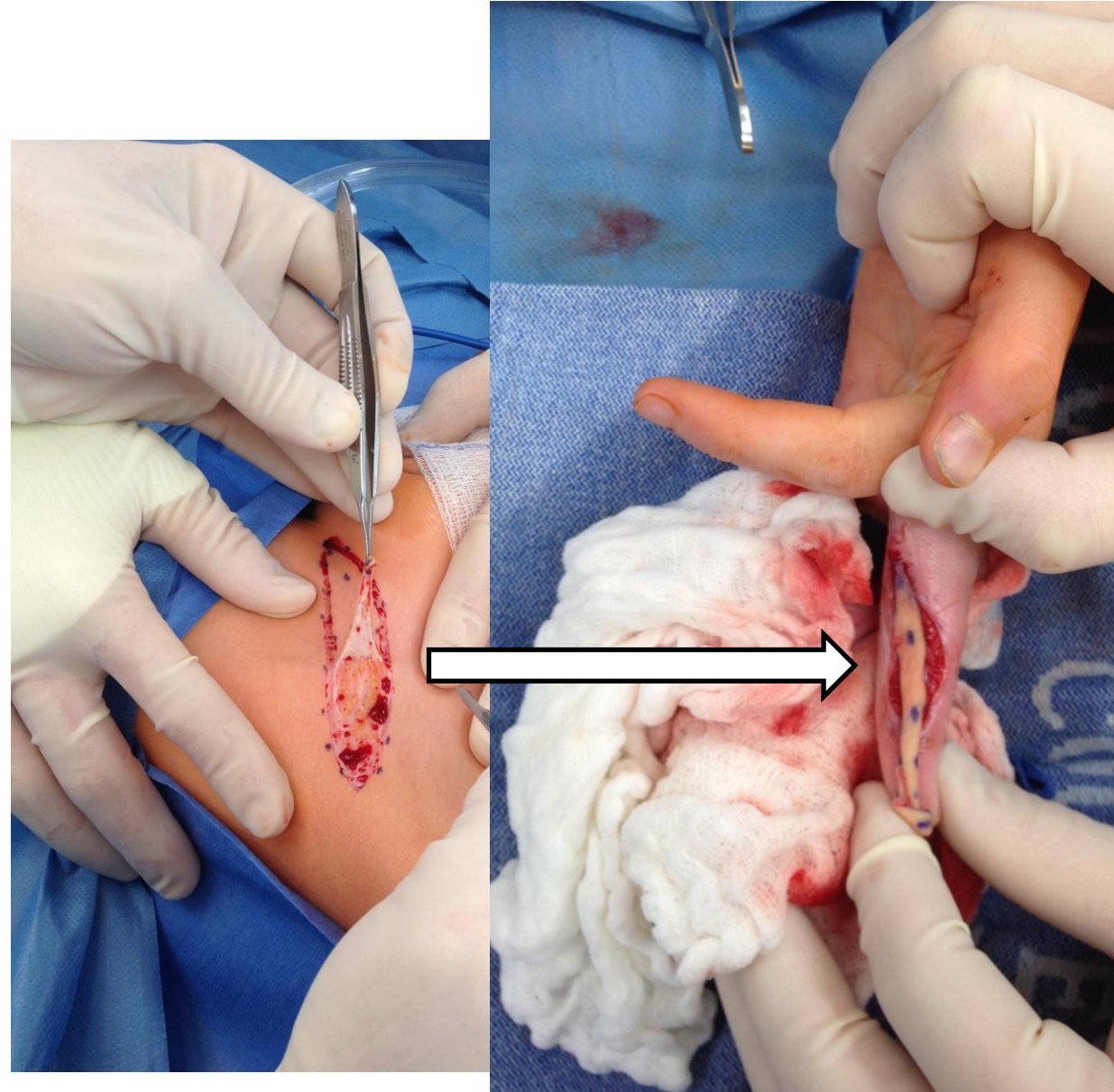
Split Thickness Skin Grafting

- Deep partial to full thickness burns
- Donor sites: upper arm/thigh/buttock
- 0.007 – 0.0085 inch thickness
- Apply to dorsum hand, fingers, thumb, forearm, wrist
- May use in combination w/ FTSG



Full Thickness Skin Grafting

- Ideal donor site
 - Flexible, soft, thin, loose skin
 - Non-hair bearing
 - Donor site easily hidden
 - Wrist crease
 - AC fossa crease
 - Lateral groin crease
 - Anterior abdominal wall
 - Thigh-buttock crease



Full Thickness Skin Grafting



Lotion massage
3-4x/day for
12-24 months

New compression garment(s) q3mo

Full Thickness Skin Grafting



Healed, FTSGs following treadmill Injury
to left middle and ring fingers

20 month old male fell into campfire with hot embers



1

After 2 weeks of casting w/ dressing changes



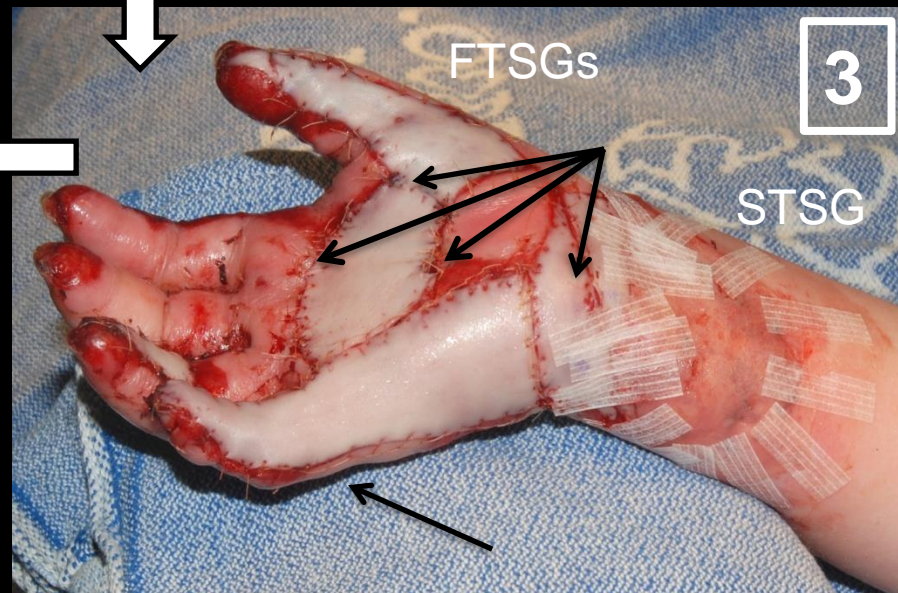
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Harvesting full thickness grafts



4

One week post-op



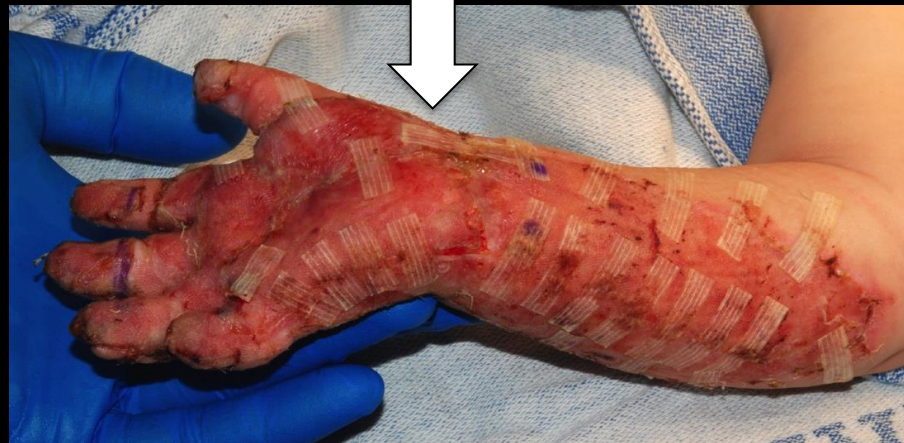
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Intra-op full thickness and STSGs

FTSGs

STSG

One Year old Female with Hot Glass Fronted Gas Fireplace (GFGF) Burn Injuries



25 months post-burn



Ten Year Follow-up in August 2021



**Our Experience
Managing Pediatric
Hand Burns**

7 Year Experience with Pediatric Hand Burns

From 2016-2022 we managed 4,094 children with a burn injury, of which **2707 (66%)** sustained a burn injury to one or both hands, resulting in 170 (6.3%) skin grafting procedures to the hand(s)

	Operative Patients (N=170, 6.3%)
Chemical	3 (1.8%)
Scald	8 (4.7%)
Contact	47 (27.6%)
Electrical	3 (1.8%)
Fire/Flame	24 (14.1%)
Grease	7 (4.1%)
Road Rash/Friction	74 (43.5%)
Unspecified	2 (1.2%)
Other	2 (1.2%)

Characteristics of the Surgical Patients

Operative Population	
Age (years)	3.92 (4.19)
Gender	
Male	109 (64.1%)
Female	61 (35.9%)
Race	
White	102 (60.0%)
Black	11 (6.5%)
Hispanic	38 (22.4%)
Asian	6 (3.5%)
Native American	1 (0.06%)
Indian	
More than One	3 (1.8%)
Other	9 (5.3%)

170 pts underwent skin grafting

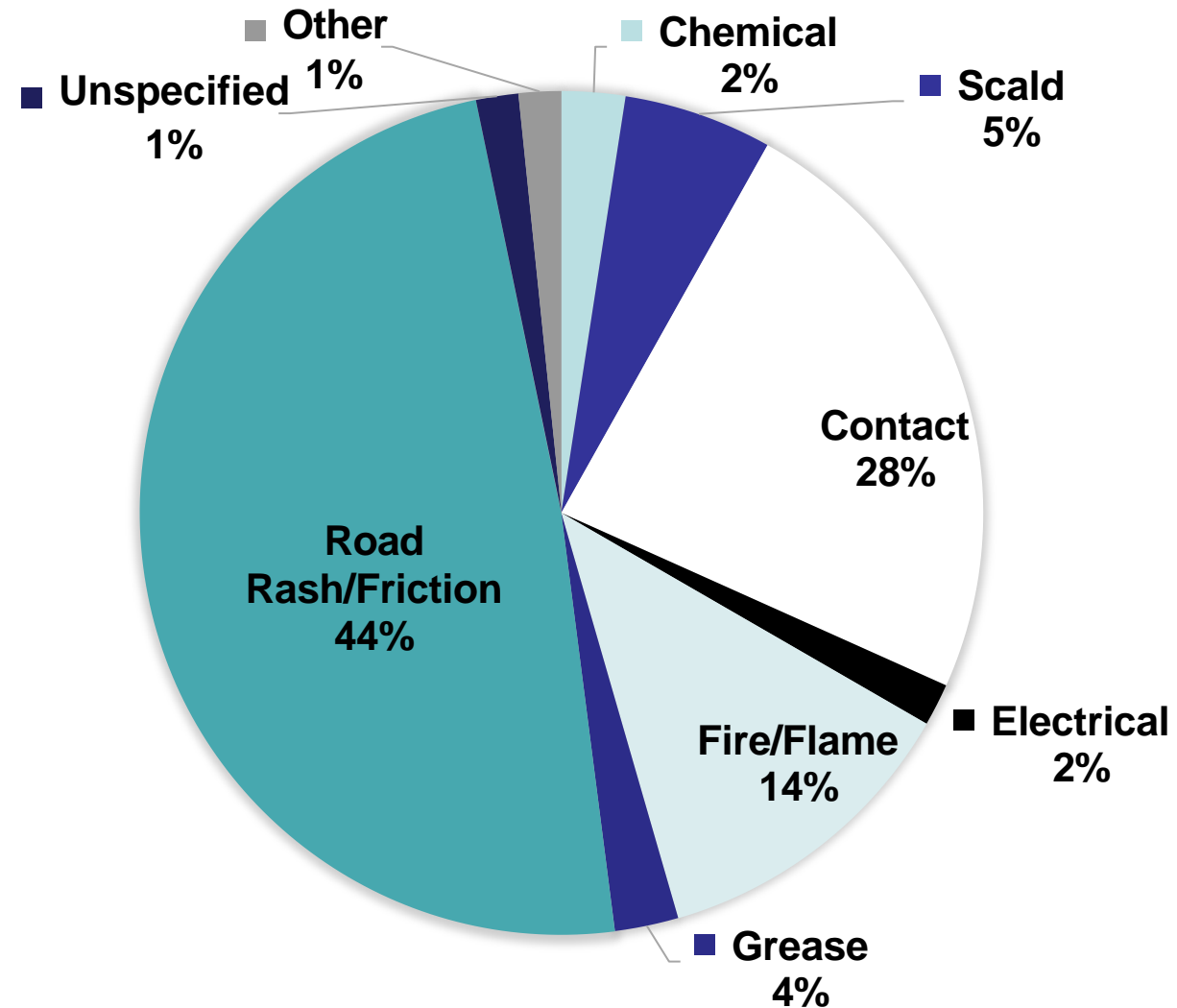
Seen as Outpatient First	Operative Population
Yes	132 (77.6%)
No (Admitted from ED)	38 (22.4%)
ED Disposition (n=38)	
PICU	14 (14.7%)
Floor	24 (25.3%)

Characteristics of the Surgical Patients

Operative Population	
Time from Burn Injury to First Clinic Visit (days)	4.26 (4.15)
Number of Clinic Visits Before Skin Grafting	1.99 (1.16)
1st Primary Dressing Layer	
Antibiotic Impregnated	87 (51.18%)
Nystatin Impregnated	12 (7.06%)
Active silver	58 (34.12%)
Unknown	13 (7.65%)
Outer Dressing	
Soft Dressing	53 (31.18%)
Soft cast	110 (64.71%)
Unknown	7 (4.12%)

Mechanisms Burn Injury Leading to Surgery

Mechanism	Operative Population (n=170)
Chemical	3 (1.8%)
Scald	8 (4.7%)
Contact	47 (27.6%)
Electrical	3 (1.8%)
Fire/Flame	24 (14.1%)
Grease	7 (4.1%)
Road Rash/Friction	74 (43.5%)
Unspecified	2 (1.2%)
Other	2 (1.2%)
TBSA	
Average (SD)	4.09 (9.84)
Median (Range)	1 (0.75, 69)



Operative Data

	Operative Population
Average Time from Hand Burn Injury to Skin Graft	11.76 (5.57)
Number of Operations Needed Total (debridement/dressing + grafting)	1.54 (1.41)
Type of Operation	
Split Thickness Graft	43 (25.3%)
Full Thickness Graft	119 (70.0%)
Both ST and FT Graft	8 (4.7%)
Time to 1st Post Op Visit	12.9 (2.75)
Incomplete Graft Take	7 (4.12%)
Second Operation	0
Post-Op Infection	1 (0.59%)
Prophylactic Fluconazole	58 (34.9%)

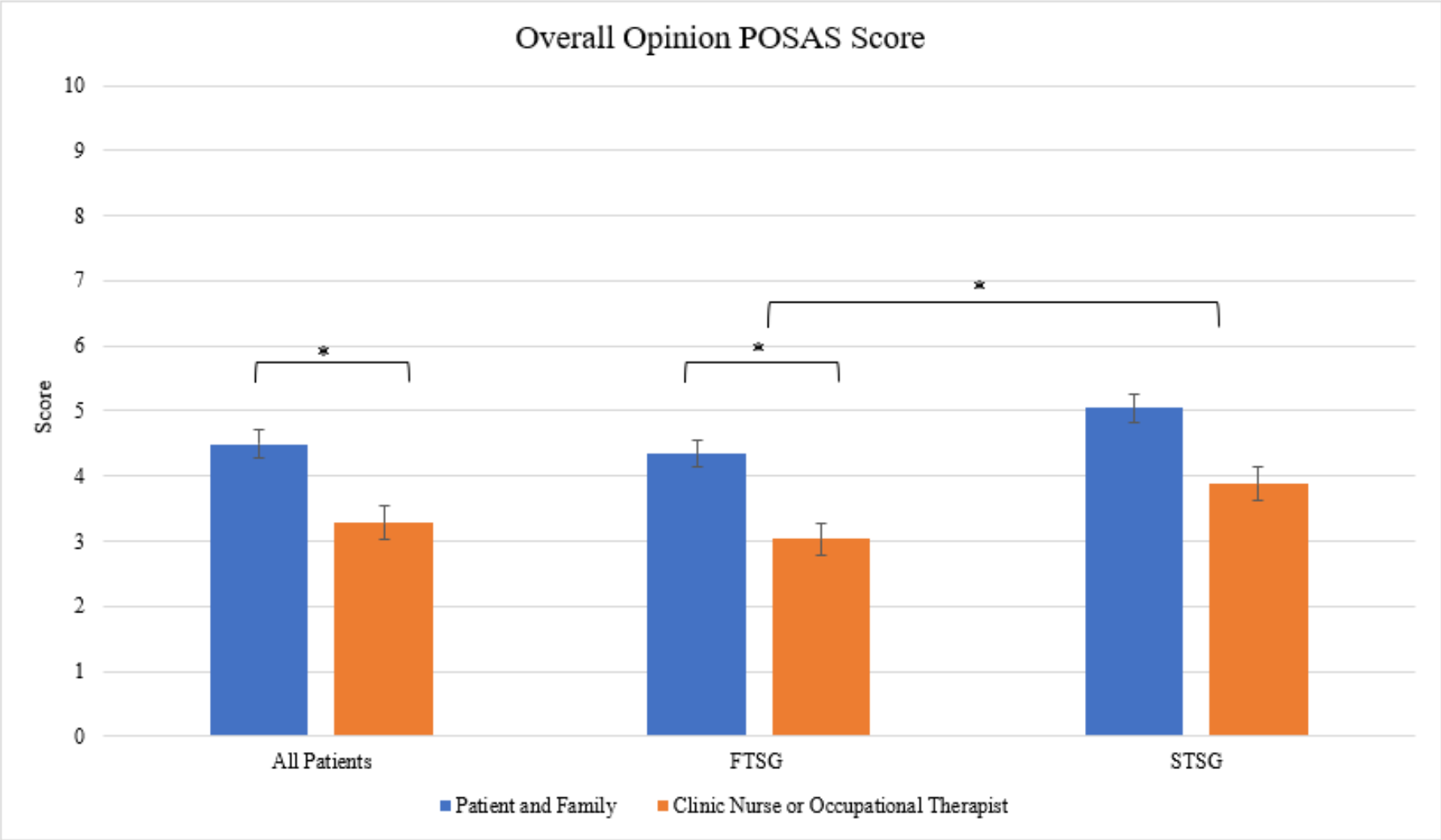
Patients with Delayed Presentation

7 patients presented with burn scar contractures

	Total Patients (n=7)
Time from Burn Injury to Burn Clinic Presentation	1.5 months – 4 years
Initially Managed by Non-Burn Clinician*	6 (85.7%)
Hospitalized for Burn	1 (14.3%)
Burn Mechanism	
Heat Contact	6 (85.7%)
Road Rash/Friction	1 (14.3%)

**Data on initial management missing for one patient seen 4 years after burn*

The Patient and Observer Scar Assessment Scale (POSAS)



Scar Quality

- Visual (e.g. color)
- Tactile (e.g. pliability)
- Sensory (e.g. pain, itch)

Key Points for Managing Pediatric Hand Burns

- Know your center's limitations (when to keep vs. refer)
- Critically evaluate the circumstances and pattern of every pediatric burn injury (be skeptical)
- Outpatient management
 - The vast majority (~ 95%) heal without surgery, however.....
 - Position and soft cast in extension (serial casting is key)
 - Frequency of dressings and primary layer must match wound needs
- Parent education (no tub baths, no showers, hi cal/protein diet)
- Scar management
 - Lotion massage and pressure with garments +/- gels or putty
 - Naptime and nighttime splinting as needed
 - Long term follow up (1-2 years) is important

Caring For Children With Burn Injuries is a Team Sport



Thank You!

- Pediatric surgeon in-house 24/7
- Patient transfers: 720-777-8838
- Burn clinic (Monday - Friday): 720-777-6604
- Burn Camps: 720 777-8295 www.noordinarycamps.org

