Pediatric Hand Burns

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Disclosure

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

All other planners, faculty, and others in control of content (either individually or as a group) have no relevant financial relationships with ineligible companies.

All of the relevant financial relationships listed have been mitigated.

Objectives

- List common mechanisms of pediatric hand burn injury
- Recognize accidental versus inflicted patterns of pediatric hand burn injury.
- Describe initial management of a pediatric hand burn.

Overview

- Depth, size and ABA referral criteria
- Anatomical considerations
- Initial management
- Surgical management
- Types of hand burns
- Our experience
- Summary

Depth, Size and ABA Referral Criteria

Depth of Burn Injuries

2nd DEGREE

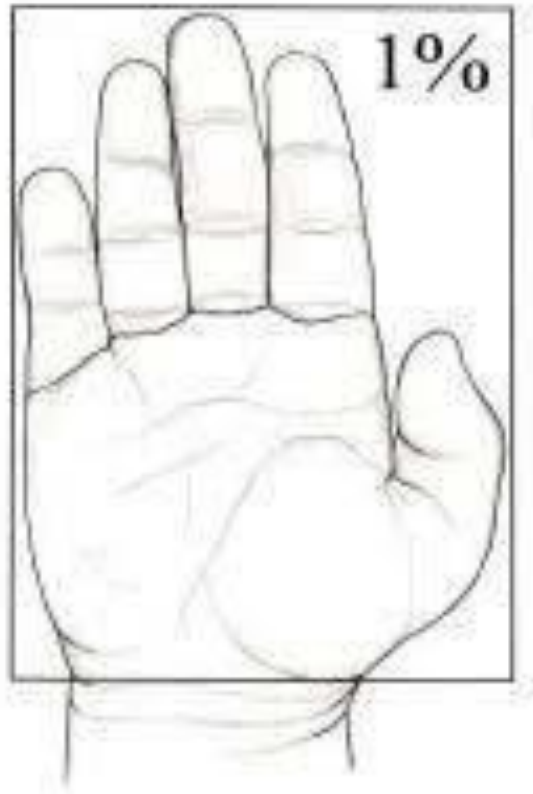
- Involves superficial to deep dermis
- Hallmark is blister
- Painful, moist
- Most heal in ≤ 21 days

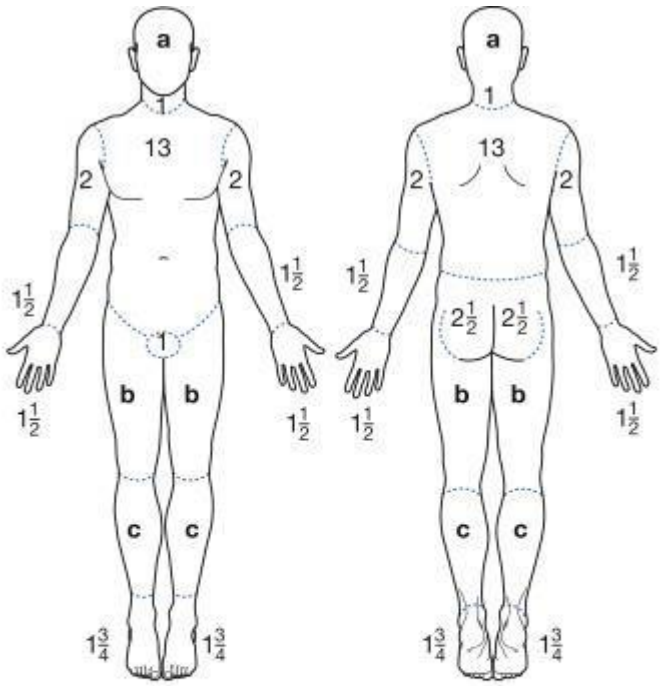
3rd DEGREE-FULL THICKNESS

- Burn into subcutaneous tissue
- Dry, leathery, and insensate
- Exposed fatty tissue
- Does not blanch
- Will need grafting

How to Calculate % TBSA

- Only include 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 - ½ of head	9½	8½	6½	5½	4½	3½
b - ½ of one thigh	2¾	3¼	4	4¼	4½	4¾
c - ½ of one leg	2½	2½	2¾	3	3¼	3½

ABA Burn Referral Criteria

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

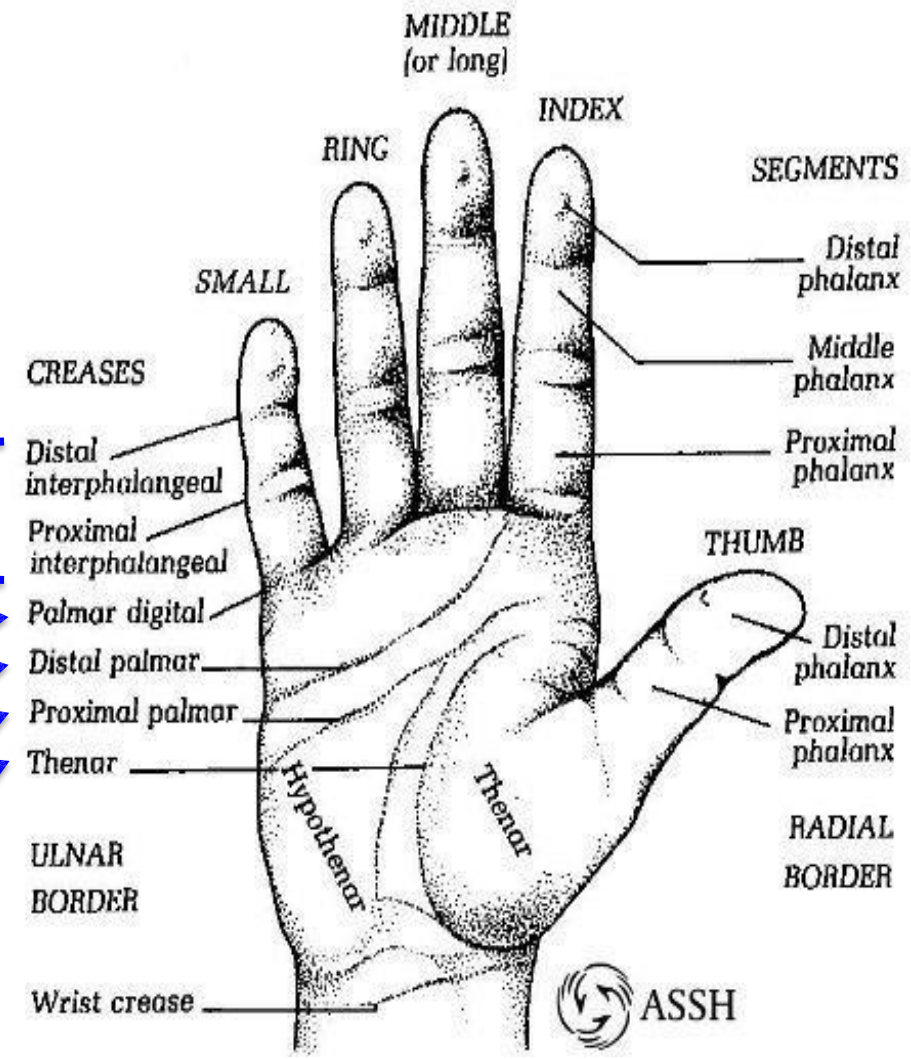
Children's Hospital: ages 0 – 18 (≤ 60% TBSA)

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

Anatomical Considerations

Anatomical Considerations

- Joints:
  - Interphalangeal joints
  - MCP joints
  - Wrist
- Creases:
  - Interphalangeal
  - Palmar digital
  - Distal palmar
  - Proximal palmar
  - Thenar crease



Anatomical Considerations

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

- Biomechanical Forces
  - Power of the flexor tendons

Initial Management

ED and Outpatient Management

- Pre-medicate for pain
  - Small burn (1-2%)
    - Intra-nasal fentanyl (1.5 mcg/kg/dose)
    - PO acetaminophen + oxycodone
  - Moderate size burn (>3%)
    - IV narcotic or OR
  - Avoid NSAIDs if considering surgery
- Manage anxiety
  - Child-Life
  - Anxiolytic
    - Lorazepam

ED and Outpatient Management

- Blisters
  - If FLAT, leave them INTACT
  - If RAISED, then window or debride with 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
- Discharge with oral pain medication (narcotic)
  - Dressing changes, physical activity, sleep

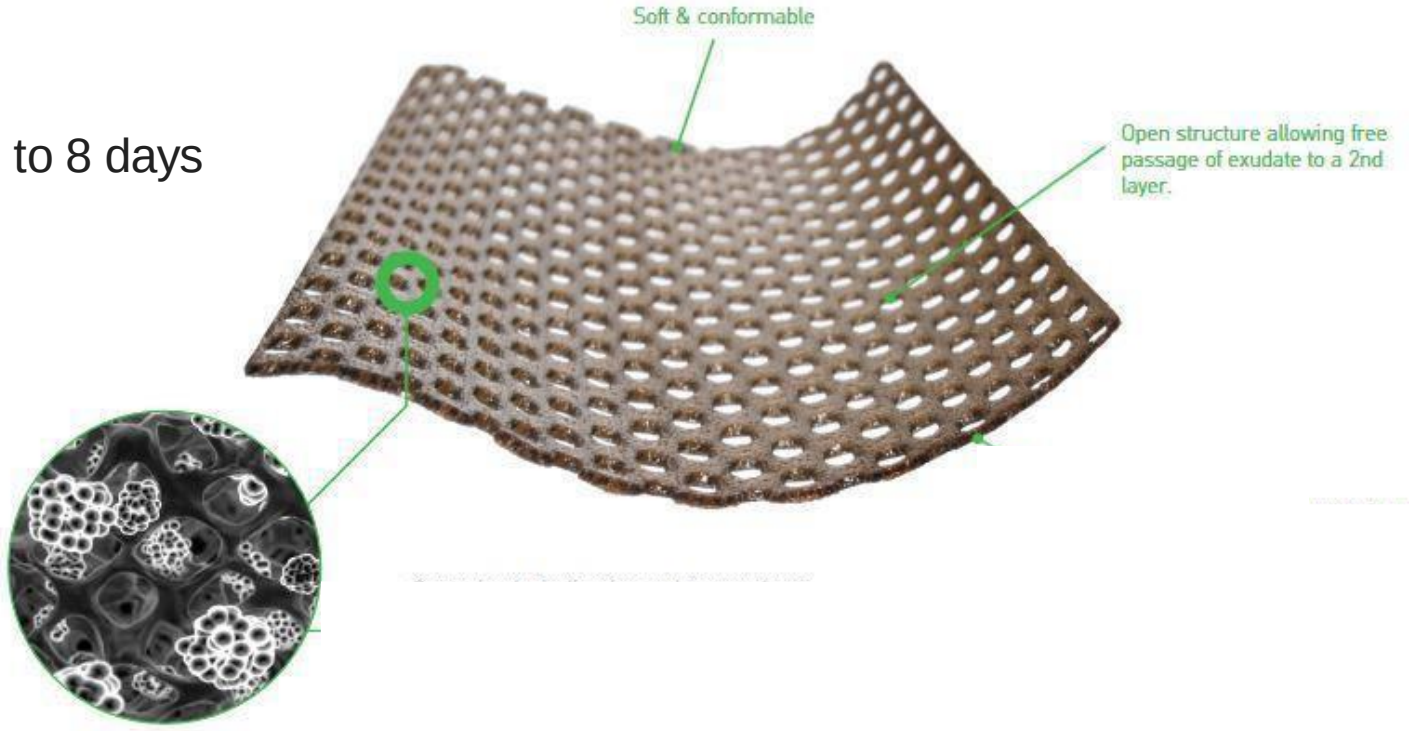
Conformable, Silver Sulfate Dressing

Indications

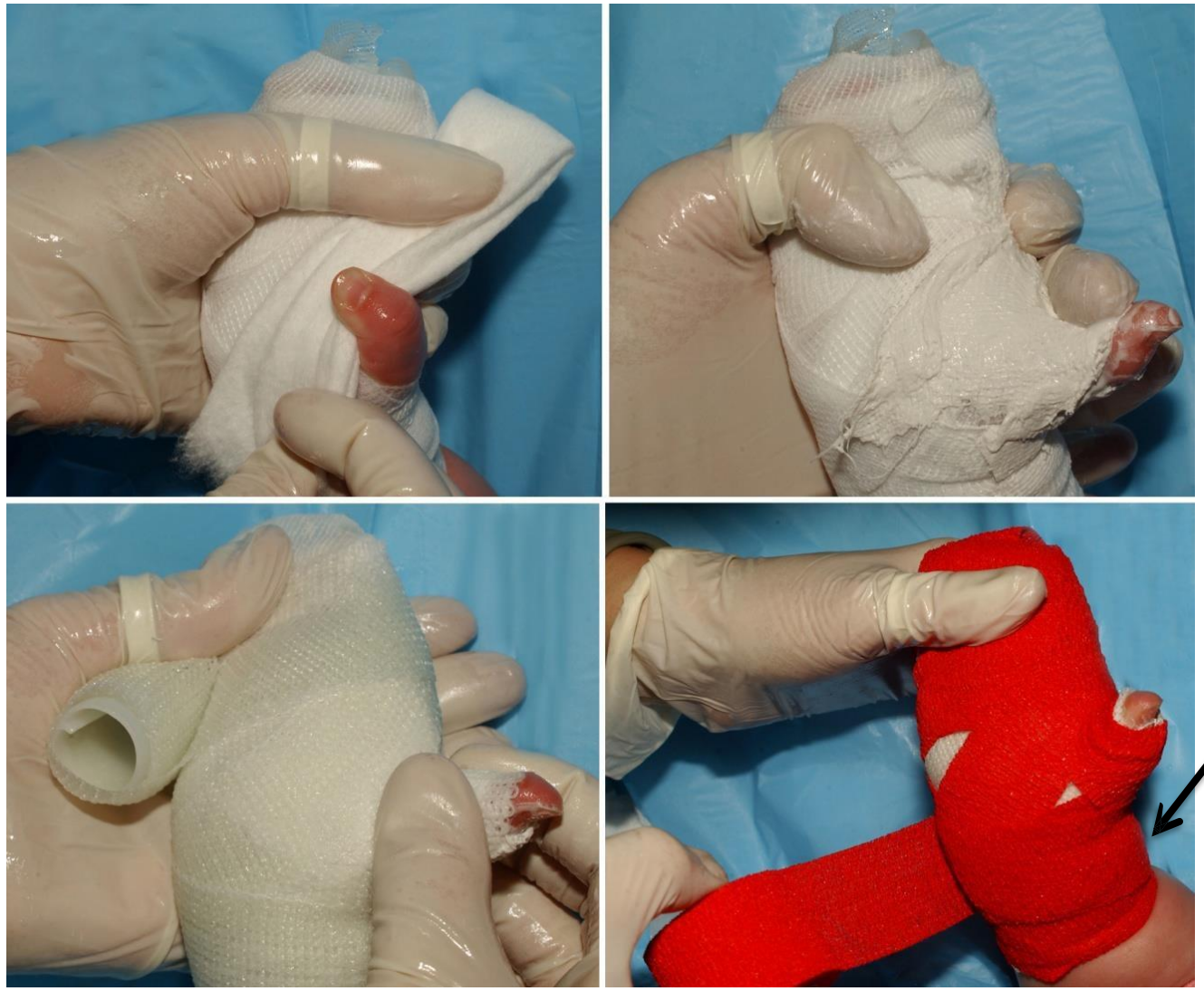
- Indicated for the management of lightly to moderately exuding wounds such as leg and foot ulcers, pressure injuries and partial-thickness burns.

Benefits

- Minimizes pain and trauma at dressing change
  - Silicone-based adhesive
- 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 blisters
2. Cover open areas with TAO impregnated non-adherent dressing
3. Wrap with 1 and/or 2-inch rolled gauze, bring proximal to wrist



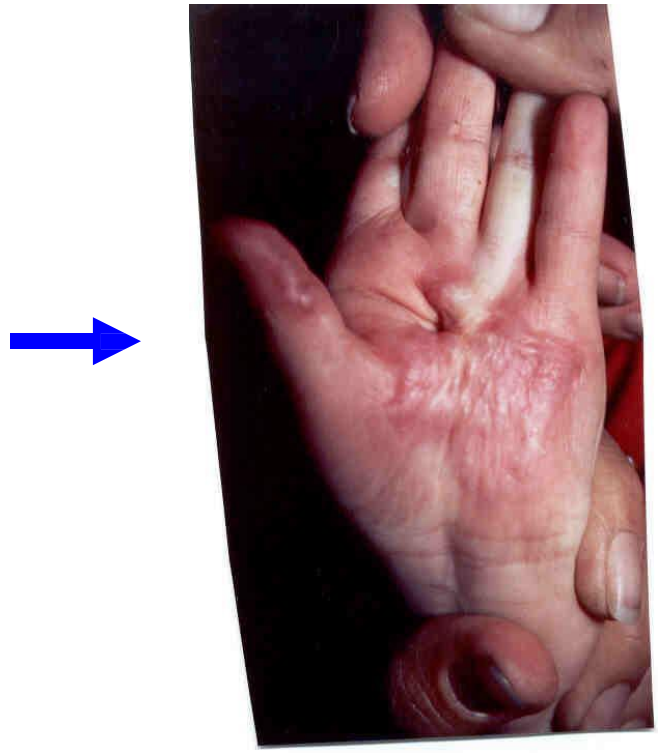
Wrap proximal to wrist to prevent early removal

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

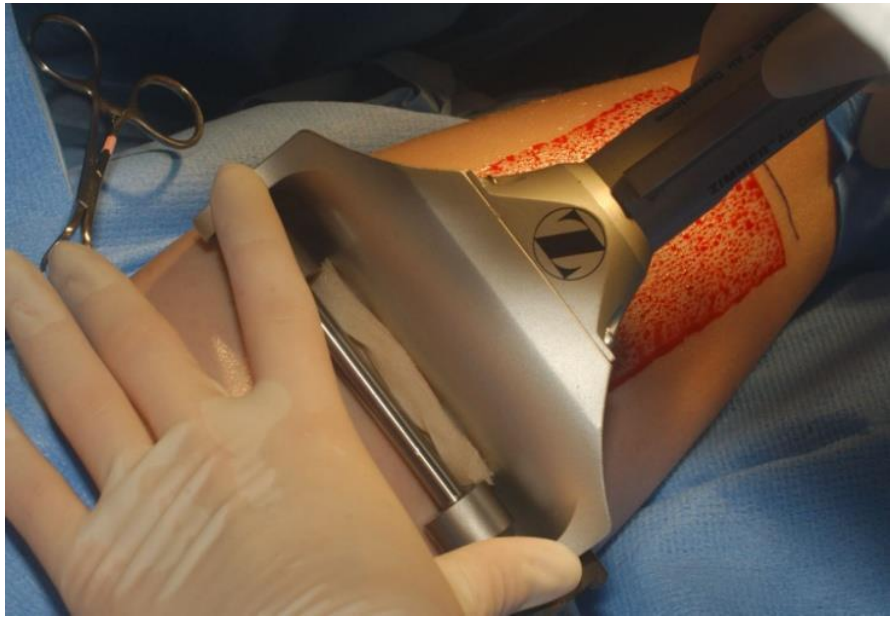
Follow the 14 Day Rule to Preserve….

- 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



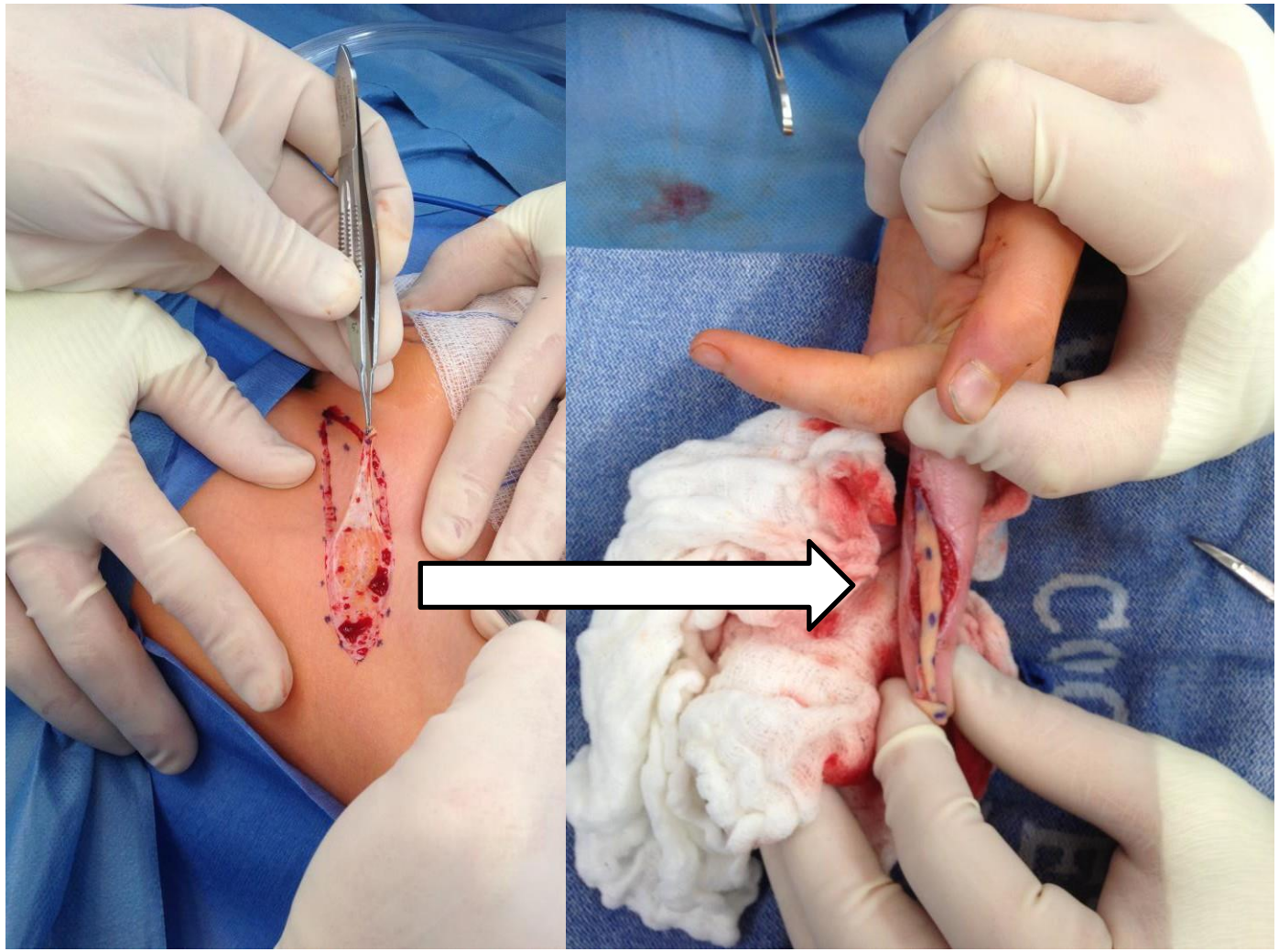
Split Thickness Skin Grafting

- 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
  - Soft, flexible 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

Full Thickness Skin Grafting

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

Specific Types of Hand Burns and Their Management

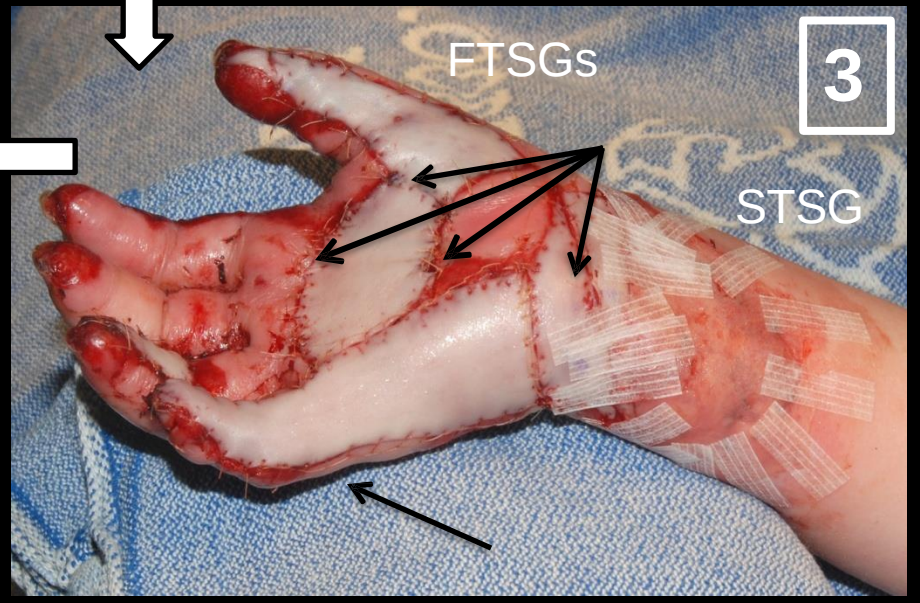
Heat Contact Type Injuries

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

20 month old male fell into campfire with hot embers

After 2 weeks of casting

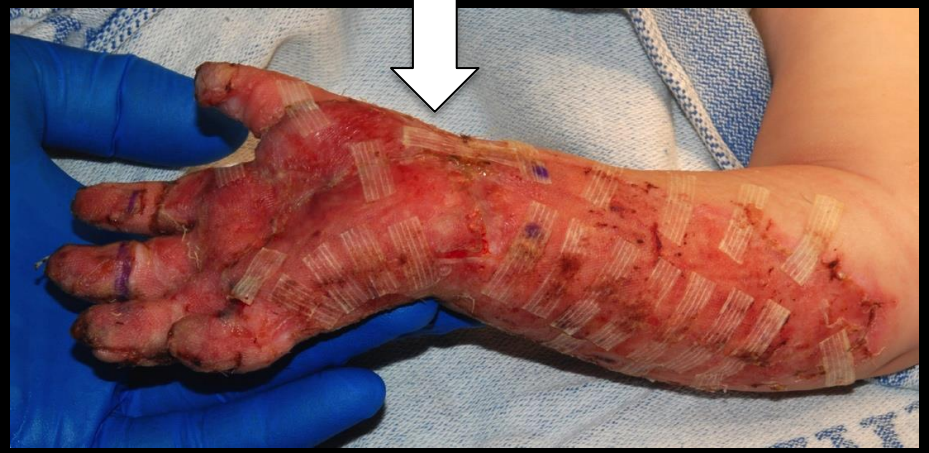
Harvesting full thickness grafts

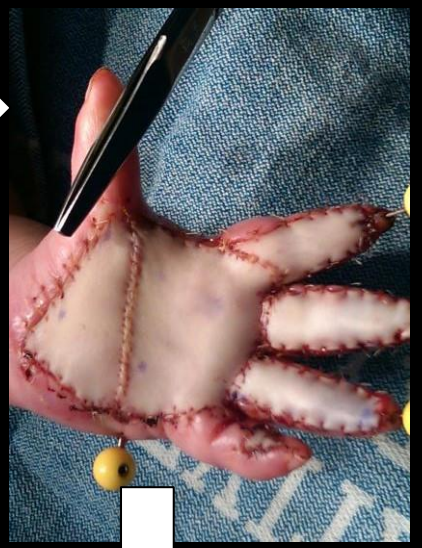


Intra-op full thickness and STSGs

One week post-op

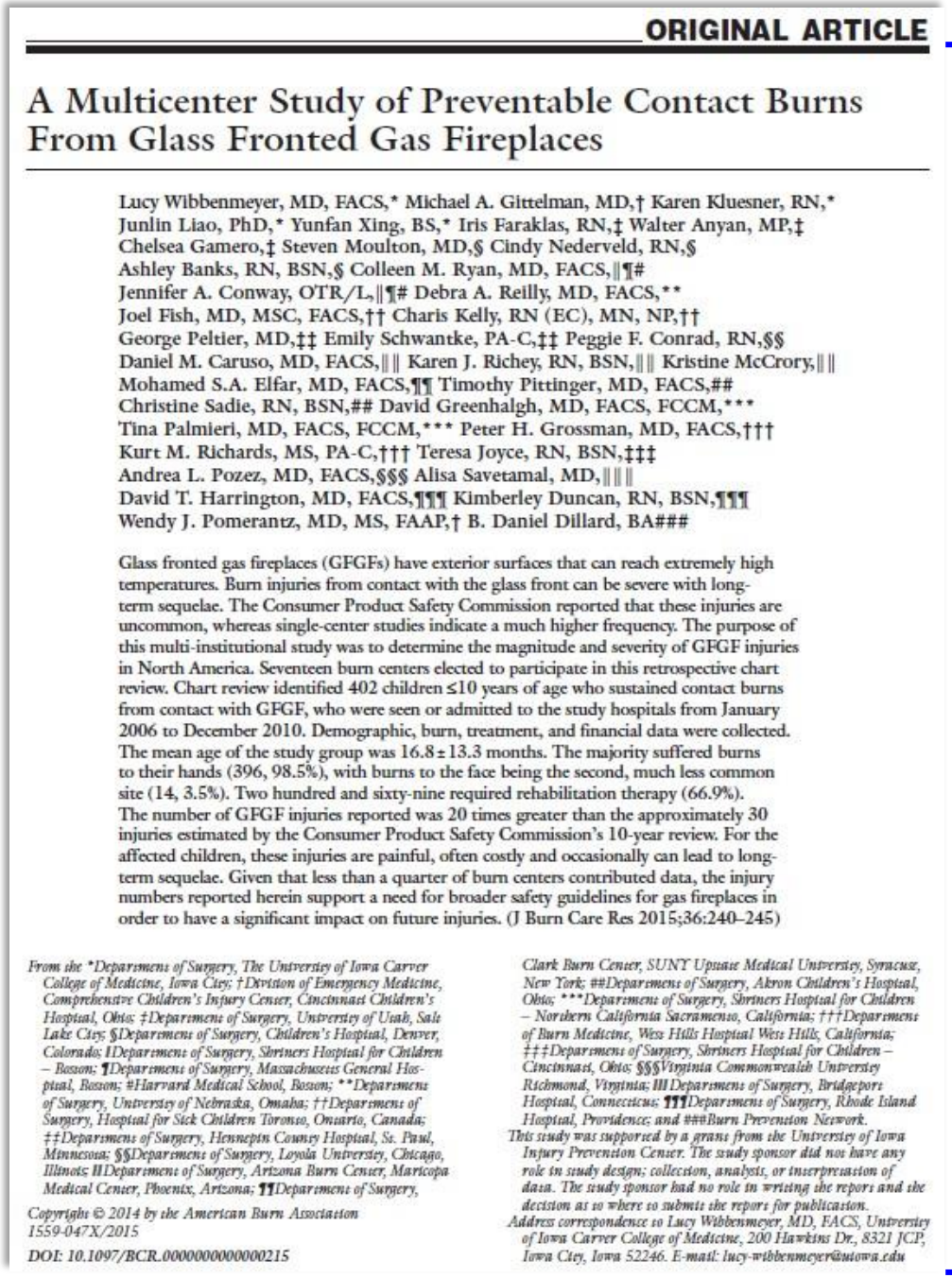
Hot Glass Fronted Gas Fireplace (GFGF) Burn Injuries





25 months post-burn

Ten Year Follow-up in August 2021



ORIGINAL ARTICLE

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 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
  - 25% of US burn centers contributed
    - 80/year [20x > CPSC (4/yr)]

Flame Injuries

- Fireworks
- Campfires
- House fires

Friction Type Injuries

- 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 Type Injuries

- Flow or spill pattern
  - Accidental?
  - NAT?
    - Telltale signs

Partial thickness flow pattern burns

- Immersion burns
  - Accidental?
  - NAT?
    - Telltale signs

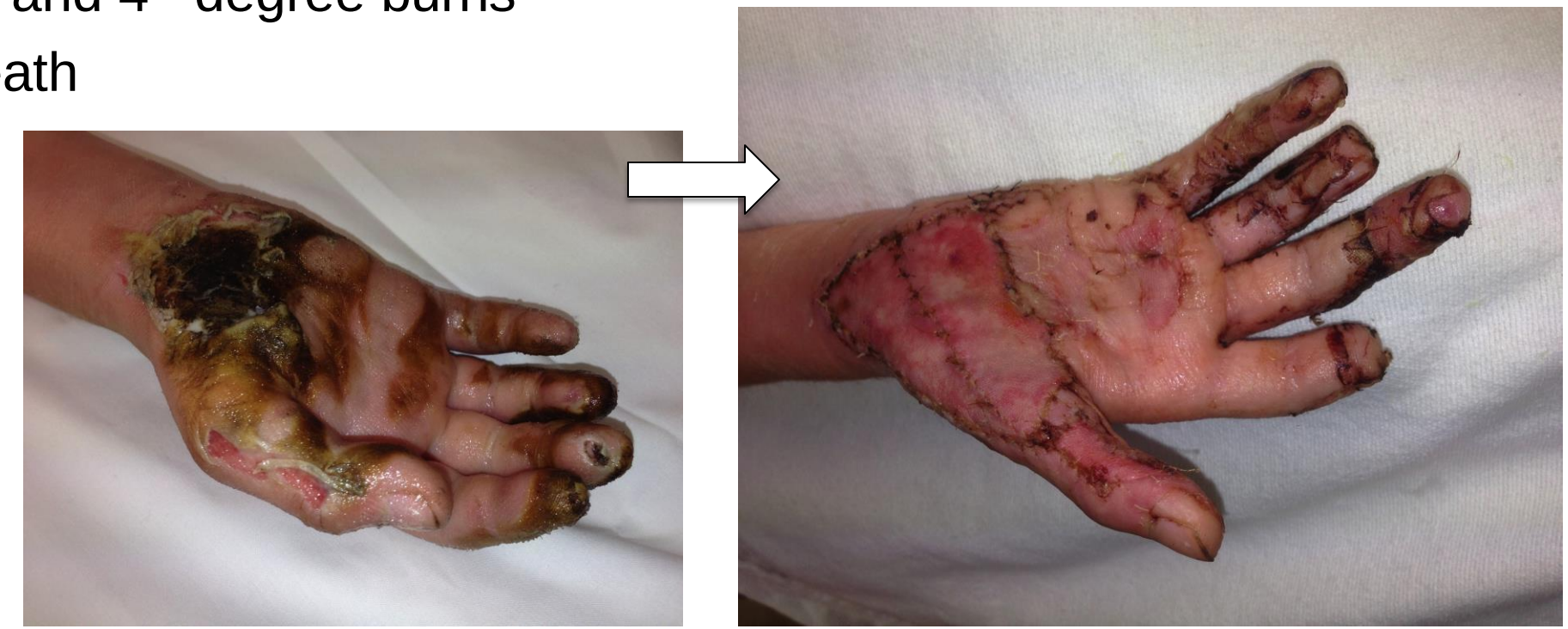
Deep partial to full thickness immersion pattern burns

Scald Type Injuries

- 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 < 120^0

Electrical Type Injuries

- 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



IV Infiltrate Injury

- 2 MO with biliary atresia
- Dressing changes
- PID 20 excised forearm to wrist, closed
- Casted for 3 weeks
- Scar management

IV Infiltrate Injury

- 20 MO w/ absent corpus callosum, Sz's
- OR for escharotomy
- At 2 weeks excised Ca^{2+} central area f/b wound closure
- Casted in wrist flexion
- Scar management

IV Infiltrate Injury

- 26 week pre-term male
- Dressing changes
- Casted
- No skin loss
- Healed

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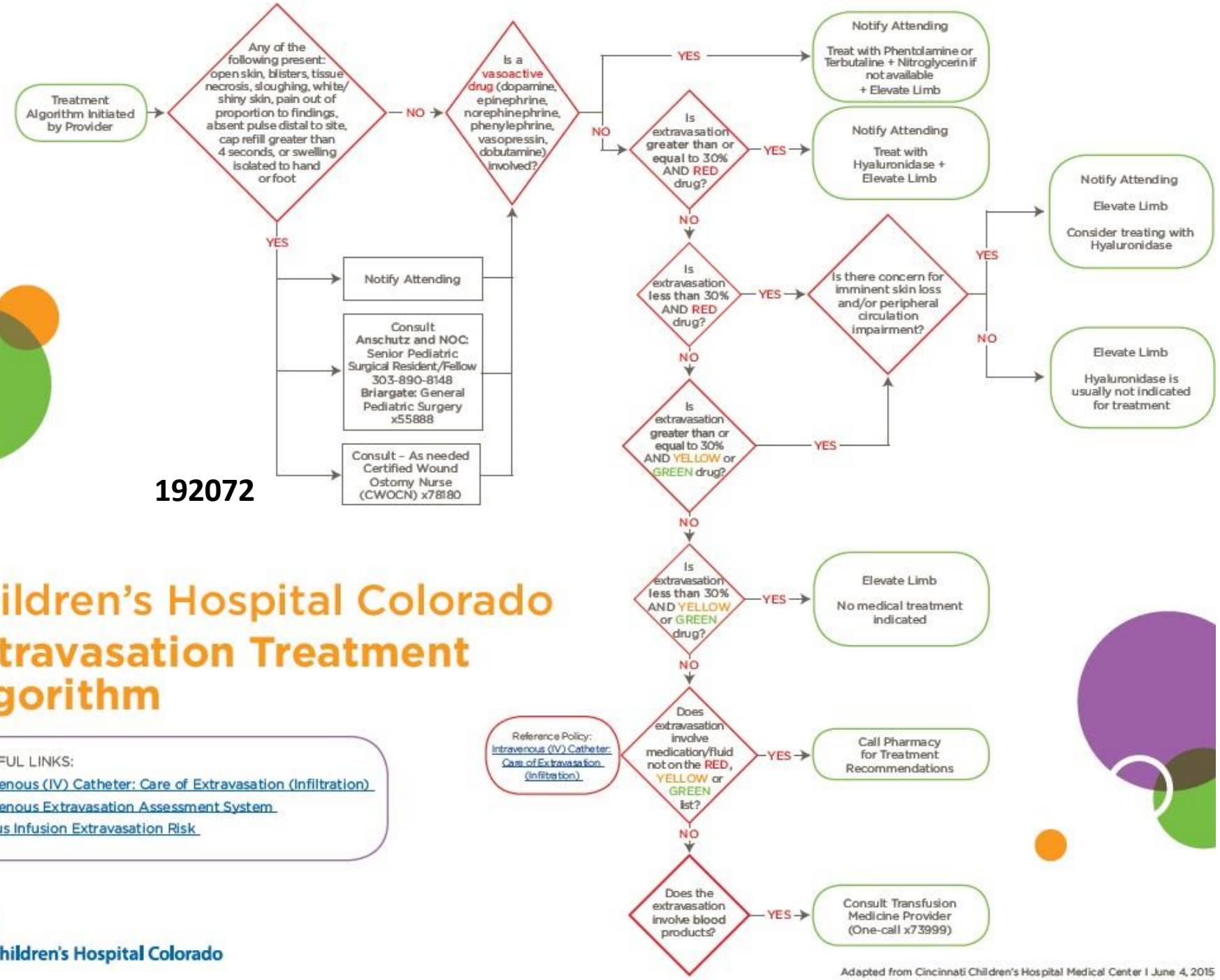
Children's Hospital Colorado Extravasation Treatment Algorithm



HELPFUL LINKS:

Intravenous (IV) Catheter: Care of Extravasation (Infiltration)

Intravenous Extravasation Assessment System

Venous Infusion Extravasation Risk

Children's Hospital Colorado

Adapted from Cincinnati Children's Hospital Medical Center | June 4, 2015
NA_140447_2015-06

Pediatric Burn Injury Patterns Suspicious of Abuse or Neglect

Non-Accidental 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

Non-Accidental 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 bone survey
  - Consider ophthalmologic exam if < 2
- Anger or resent toward child?
  - Inappropriate affect?

Non-Accidental 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: spill/splatter vs. flow 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; pending trial.

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 burns?
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 burns? 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?

Dorsal and palmar burns

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.

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

Our Experience Managing Pediatric Hand Burns at CHCO

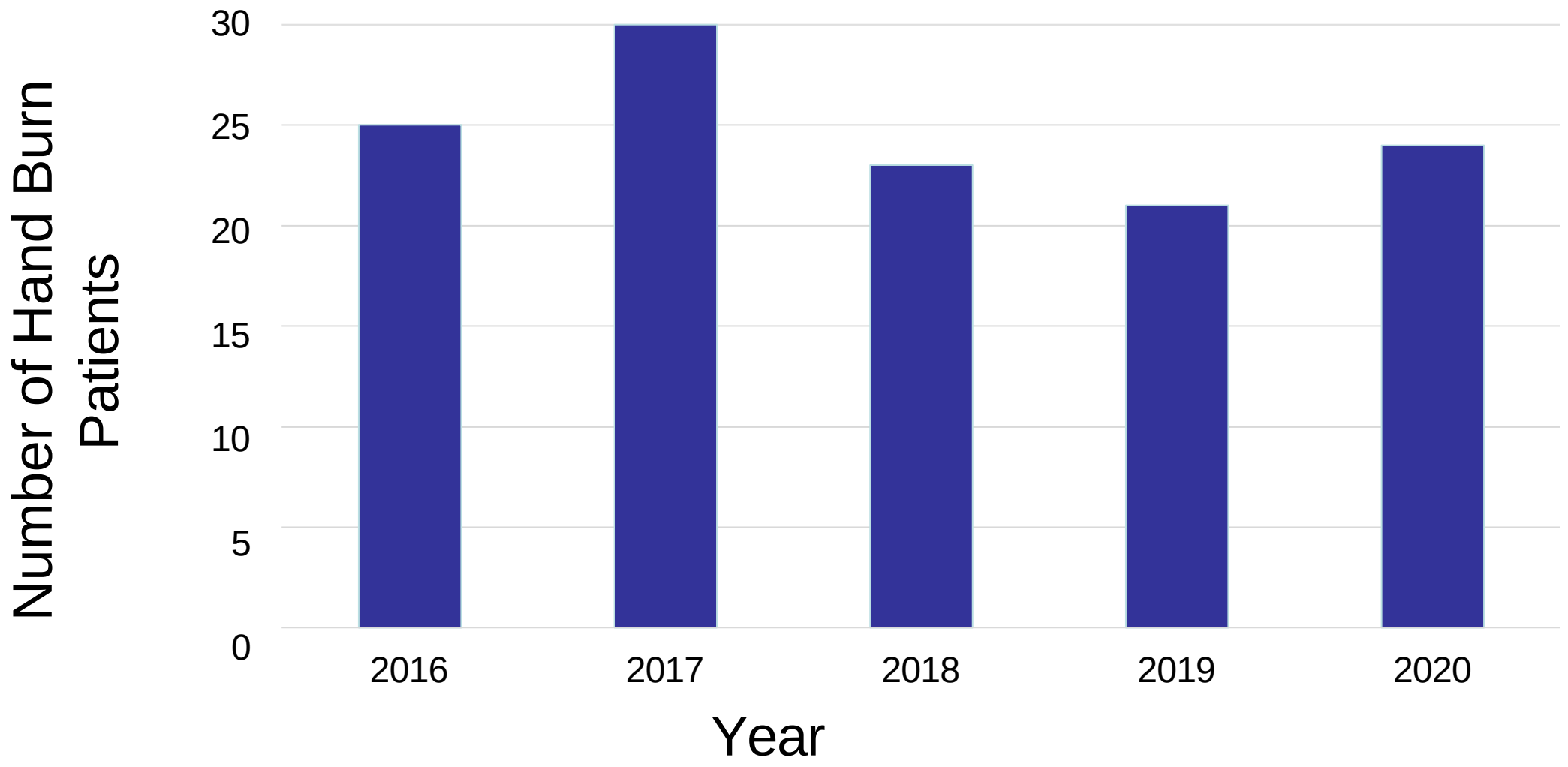
Retrospective Review of Hand Burns

- Children ages 0-18 yrs. Old, managed in the outpatient (ED and clinic) or inpatient settings between 2016 and 2020

• 1980 (94.3%) outpatient • 120 (5.7%) inpatient	**Hand Burns** (n=2100)	**Operative*** (N=123, 1.1%)
Chemical	21 (1.0%)	3 (11.1%)
Contact	1270 (60.5%)	30 (2.4%)
Electrical	81 (3.9%)	2 (2.5%)
Fire/Flame	165 (7.9%)	15 (9.1%)
Grease	68 (3.2%)	3 (4.4%)
Road Rash/Friction	156 (7.4%)	61 (39.1%)
Scald	315 (15.0%)	7 (2.2%)
Other	7 (0.3%)	0
Unknown	17 (0.81%)	2 (11.8%)

*Percentages are representative of total number of patients burned by that mechanism

Yearly Hand Burn Cases Requiring Grafting



Characteristics of Surgical Patients

	Operative Population
Age (years)	3.80 (3.94)
Gender	
Male	80 (65.04%)
Female	43 (34.96%)
Race	
White	74 (60.16%)
Black	8 (6.50%)
Hispanic	29 (23.58%)
Asian	5 (4.07%)
Native American Indian	1 (0.81%)
More than One	2 (1.63%)
Other	4 (3.25%)

- 123 patients required skin grafting for their hand injury

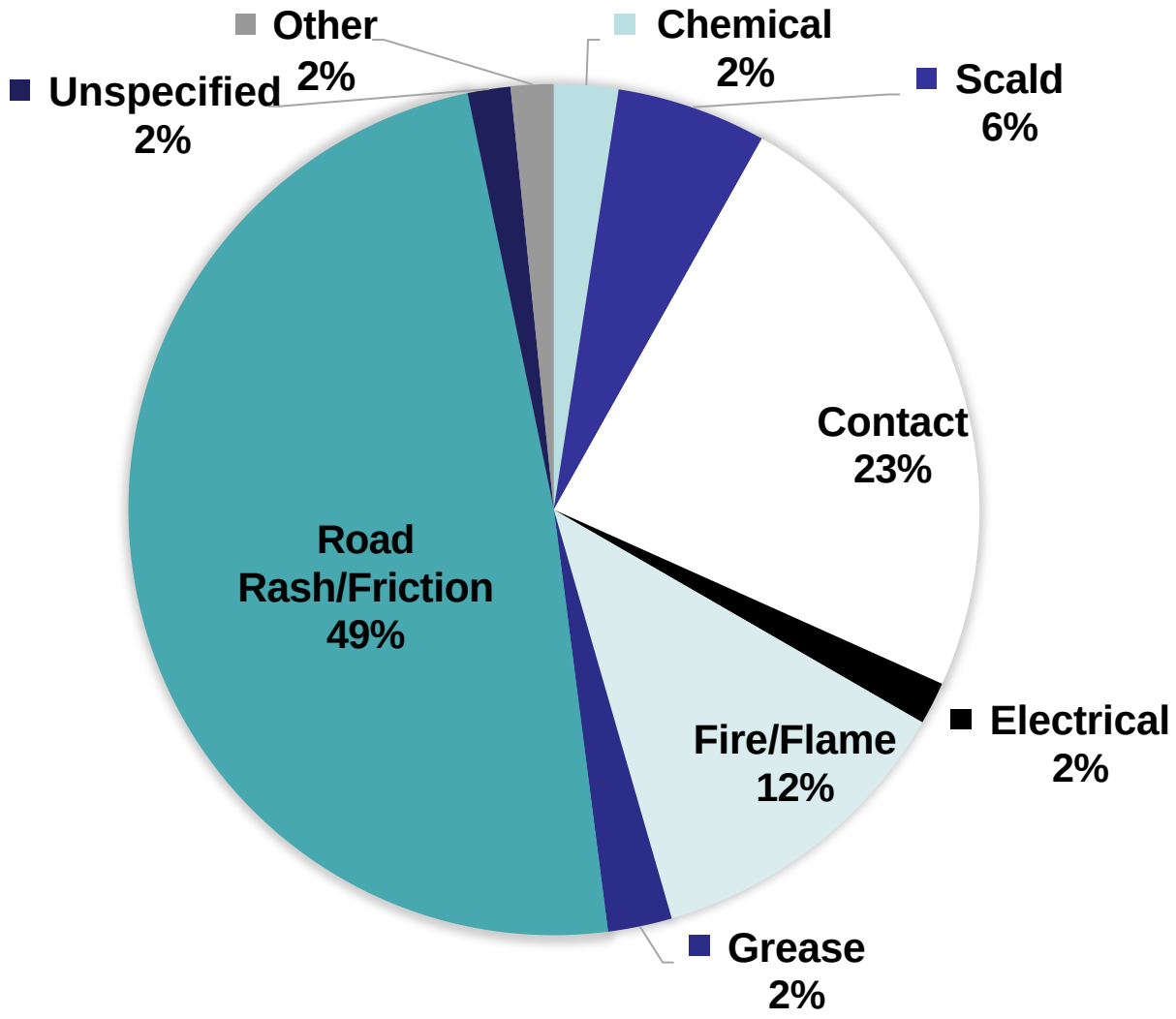
Seen as Outpatient First	Operative Population
Yes	107 (86.99%)
No (Admitted from ED)	16 (13.01%)
ED Disposition (n=16)	
PICU	9 (56.25%)
Floor	7 (43.75%)

Characteristics of Surgical Patients

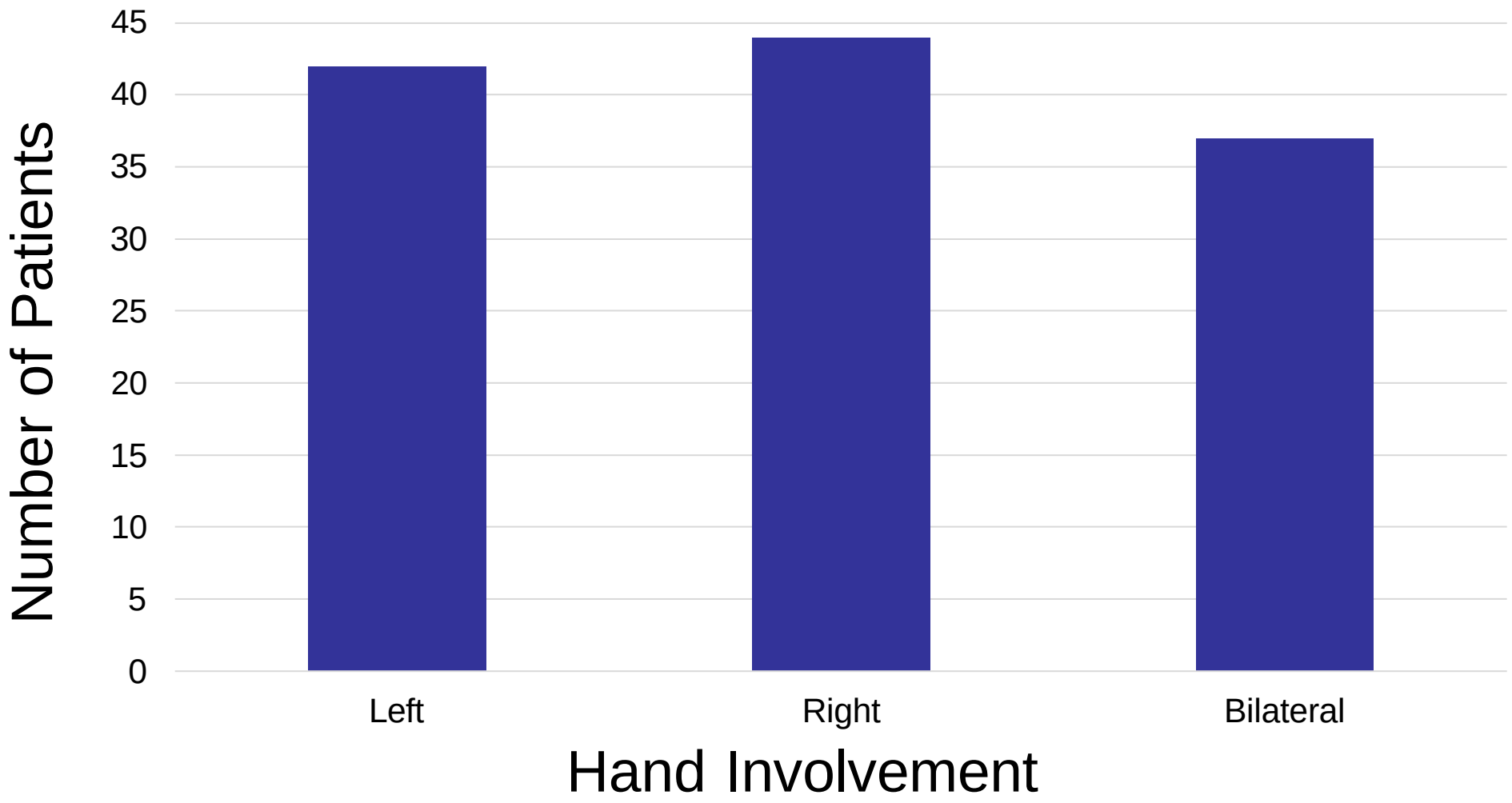
	Operative Population
Time from Burn Injury to First Clinic Visit (days)	4.14 (3.43)
Number of Clinic Visits Before Skin Graft	1.93 (1.15)
1st Primary Dressing Layer	
Antibiotic Impregnated	56 (45.53%)
Nystatin Impregnated	10 (8.13%)
Active silver	48 (39.02%)
Unknown	9 (7.32%)
Outer Dressing	
Soft Dressing	38 (30.89%)
Soft cast	81 (65.85%)
Unknown	4 (3.25%)

Mechanisms of Full Thickness Burn Injury Requiring Surgery

Mechanism	Operative Population (n=123)
Chemical	3 (2.44%)
Scald	7 (5.69%)
Contact	29 (23.58%)
Electrical	2 (1.63%)
Fire/Flame	15 (12.20%)
Grease	3 (2.44%)
Road Rash/Friction	60 (48.78%)
Unspecified	2 (1.63%)
Other	2 (1.63%)
TBSA	
Average (SD)	4.46 (10.51)
Median (Range)	1 (0.75, 69)



Hand Involvement



Operative Data

	Operative Population
Average Time from Burn Injury to Skin Graft	11.63 (5.44)
Number of Operations Needed Total	1.68 (1.61)
Type of Operation	
Split Thickness Graft	28 (22.76%)
Full Thickness Graft	90 (73.17%)
Both ST and FT Graft	5 (4.07%)
Time to Post Op Visit	11.21 (2.73)
Incomplete Graft Take	5 (4.07%)
Second Operation	0
Post-Op Infection	1 (0.81%)
Prophylactic Fluconazole	39 (31.71%)

Patients with Delayed Presentation

- 7 patients presented to clinic after hand burns had healed requiring scar contracture release with skin grafting

	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	
Contact	6 (85.7%)
Road Rash/Friction	1 (14.3%)

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

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 24h/day
- Burn clinic (Monday - Friday)

  720-777-6604
- Patient transfers

  720-777-8838
- JFS and Burn Camps

  720 777-8295

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