

Pediatric Burn Care



Children's Hospital Colorado
Here, it's different.™

Objectives

- 1 Review emergent needs for burn patients
- 2 Identify transport needs
- 3 Review burn patient case studies



Determinants of Burn Depth

Temperature of Source

the higher the temperature the deeper the burn
in less time

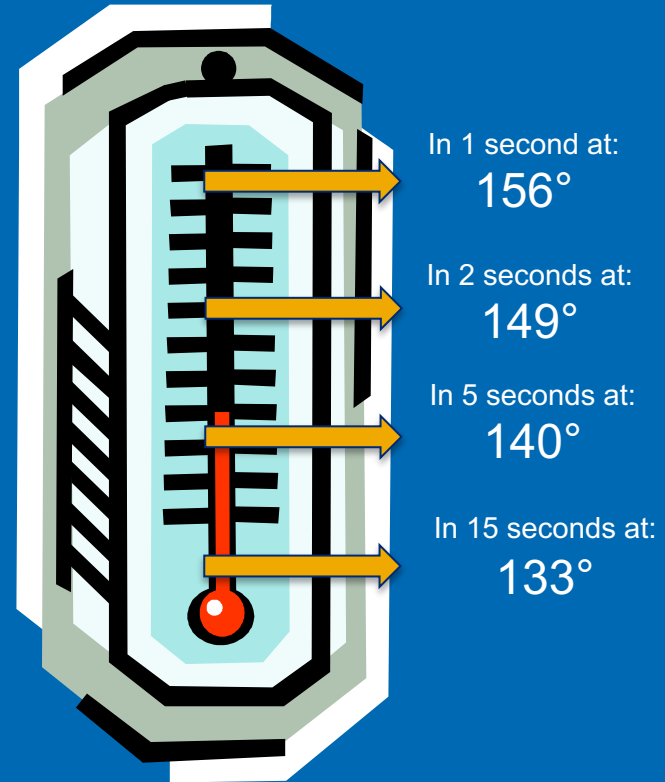
Time of Exposure

the lower the temperature but longer exposure
the deeper the burn



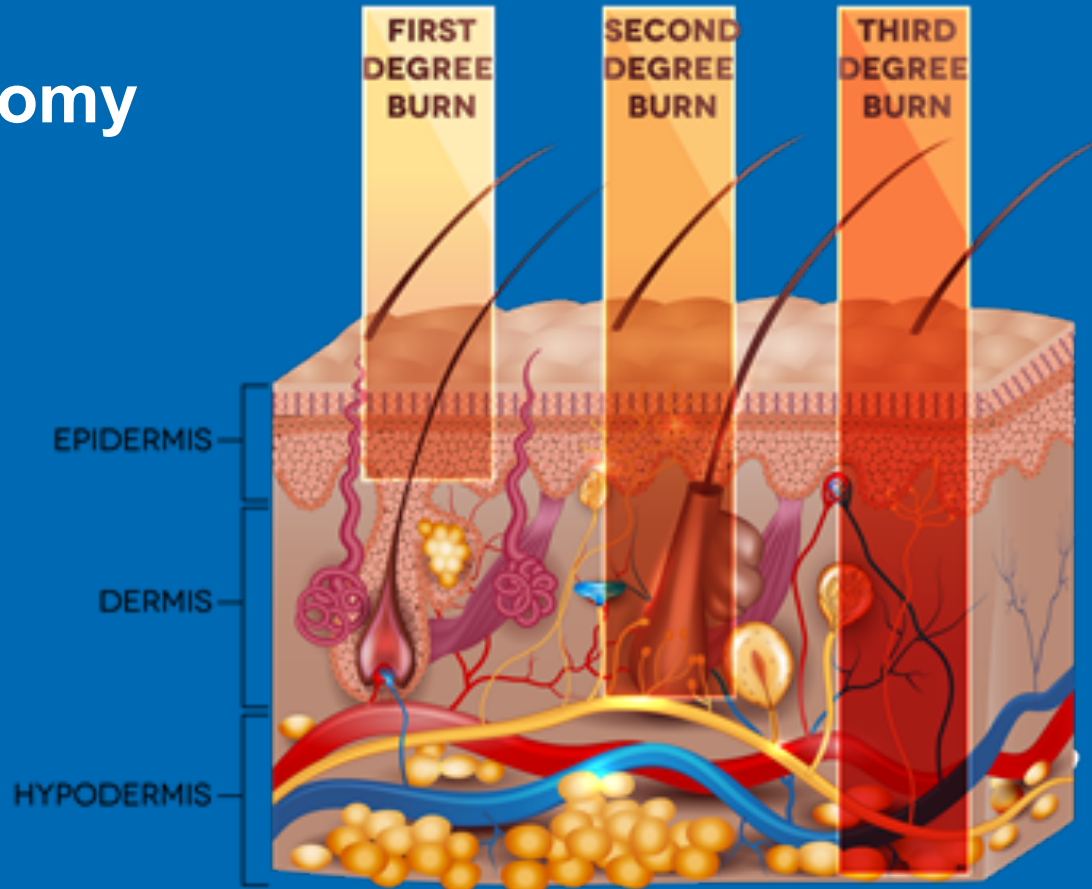
In seconds:

- ❖ Scald burns are the most common injury in children
- ❖ Clothes retain heat
- ❖ Grease and hot oil almost always cause a full thickness injury



A thermal burn injuries requires 1 minute of cooling exposure to reach a level at which no further burning occurs

Skin Anatomy



Superficial (first degree)

- ❖ Do Not count into the Total Burn Surface Area (TBSA)
- ❖ Involves only the outermost layer of the epidermis
- ❖ Appears pink and painful



Superficial Partial Thickness (second degree)

- ❖ Involves the upper 1/3 of the dermis
- ❖ Blisters are common
- ❖ Red, wet, painful and blanching
- ❖ Heals in 7-14 days
- ❖ Minimal to no scarring



Deep Partial Thickness (second degree)

- ❖ Deep dermal involvement
- ❖ Blisters may be present
- ❖ Red to pink, slow or absent, blanching
- ❖ Healing takes around 21 days
- ❖ Prone to scarring
- ❖ Marginal blood supply



Full Thickness (third degree)

- ❖ Loss of all dermal elements
- ❖ Dry, leathery, firm, colors vary
- ❖ No blanching, insensate
- ❖ Edema may be massive



Immediate Care

- ❖ Trauma will always take precedence over burn
 - ❖ Burns do not bleed
- ❖ Stop the burning process
 - ❖ Ice is NOT recommended
 - ❖ Remove clothing and diapers
 - ❖ Remove jewelry
- ❖ Avoid Hypothermia



Airway

❖ Airway Control

- ❖ Chin lift
- ❖ Jaw thrust
- ❖ Insert oral pharyngeal airway
- ❖ Assess need for ET intubation

❖ Maintain in-line cervical immobilization in patients at risk



Breathing & Ventilation

- ❖ Examine
- ❖ Assess rate and depth
- ❖ Administer high flow O₂
- ❖ Monitor chest wall excursion in presence of circumferential torso burns



Inhalation Injury

- ❖ Burn injury occurred in an enclosed space
- ❖ Singed nasal hair
- ❖ Carbonaceous sputum
- ❖ Brassy or sooty cough
- ❖ Hoarseness
- ❖ Stridor



Circulation

- ❖ Monitor Vital Signs
- ❖ Establish IV access
 - ❖ Where?
 - ❖ What size?
 - ❖ How many?
 - ❖ Securement?
- ❖ Assess circulatory status of burned extremities



Disability, Neurologic Deficit

Assess using AVPU

A- Alert

V- Responds to verbal stimuli

P- Responds to painful stimuli

U- Unresponsive

If patient is not alert, consider:

Associated Injuries

CO poisoning

Substance abuse

Hypoxia

Pre-existing medical conditions



Exposure/Environmental Control

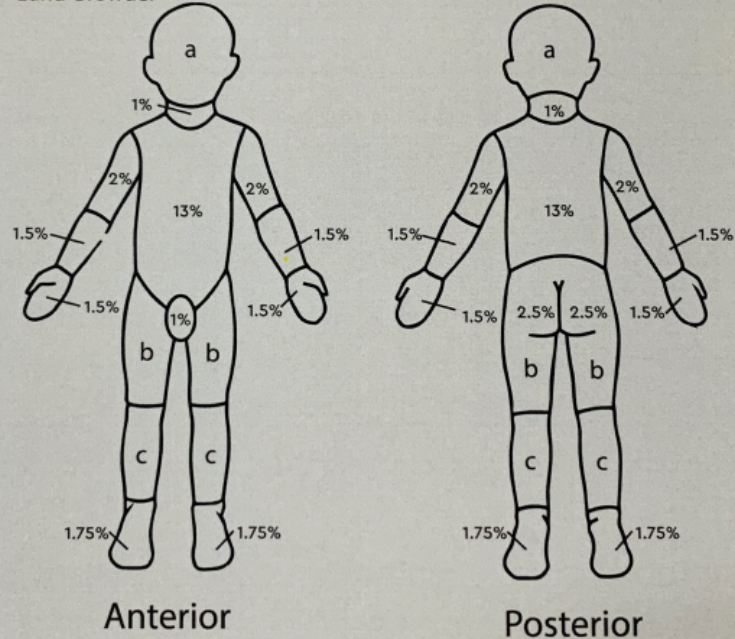
- ❖ Remove all clothing and jewelry
- ❖ Remove contact lenses
- ❖ Maintain patient temperature
 - ❖ Warm room
 - ❖ Keep covered with dry sheets/blankets
 - ❖ Warm IV fluids



Lund Browder

Total Body Surface Area (% TBSA) Affected by Age

Lund-Browder



Body Part

a = 1/2 of head

b = 1/2 of 1 thigh

c = 1/2 of 1 lower leg

AGE

0 yr	1 yr	5 yr	10 yr	15 yr
9.5%	8.5%	6.5%	5.5%	4.5%
2.75%	3.25%	4.0%	4.5%	4.5%
2.5%	2.5%	2.75%	3.0%	3.25%



Practice!









Got Fluid?

Burns greater than 20% TBSA

What fluids should you give and how much?

5 years and younger: LR @ 125mL/hr

2 years and younger use D5LR instead of LR

6-14 years: LR @ 250mL/hr

>14 years: LR @ 500mL/hr



Why LR?

- ❖ Mimics intravascular fluid
- ❖ Treats hypovolemia
- ❖ Replaces intracellular sodium deficits
- ❖ Saline can contribute to ongoing acidosis



Increased Capillary Permeability

Water “leaks” from intravascular space to interstitial space resulting in edema in burn tissue and throughout the body

This permeability increases and large molecules can pass through the capillary pores easily. These large molecules include protein



Chest Escharotomy



Upper Extremity Escharotomy



Non-Accidental Trauma



Non-accidental Trauma (NAT)

- ❖ 25% of patients admitted to CHCO are suspected NAT
- ❖ Mean age of NAT burn wound= 2.5 yrs of age
- ❖ Scald burns are most common inflicted burn- overlooked as accidental at times
- ❖ History, psychosocial risk factor assessment and pattern of injury are critically important



Non-accidental trauma

❖ Assess for:

- ❖ Lines of demarcation
- ❖ Sparing

❖ Ask yourself:

- ❖ Does the pattern of the burn match the story?
- ❖ Can the child developmentally perform the task?
- ❖ Does the scene support the injury?
- ❖ What was the situation surrounding the injury?

❖ Report

❖ Photographs







Clear Lines of Demarcation





Special Considerations



Chemical Burn

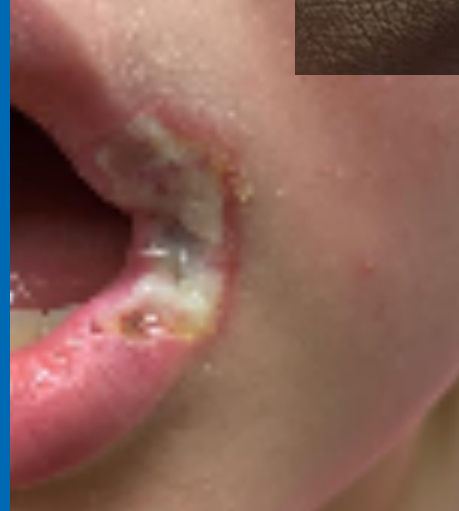
- ❖ Protect yourself
- ❖ Brush off any powder and remove clothing
- ❖ Irrigate with copious amounts of water for at least 20 minutes





Electrical Injury

- ❖ Confirm the scene is safe
- ❖ Findings suggesting electrical injury
 - ❖ Loss of consciousness
 - ❖ Paralysis or mummified extremity
 - ❖ Loss of peripheral pulse
 - ❖ Contact injury
 - ❖ Myoglobinuria
- ❖ Household electrical injury
 - ❖ EKG
 - ❖ Local wound care



What do you do?

- ❖ Keep the patient warm
- ❖ NO WET dressings- dry blankets
- ❖ Pain medication
- ❖ Creams/Ointments are not necessary
- ❖ IV fluid per ABA guidelines



Questions?



Children's Hospital Colorado
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The Safe Transport of Children in Ambulances

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**We have no relevant
financial disclosures**



Objectives

1

Discuss
Ambulance
Transportation
Issues and
Considerations

2

Crash
Dynamics/
Rear-facing

3

Review
Child
Safety
Seats (CSS)
Basics

4

Child Safety
Seats:
Considerations
for Ambulance
use

5

Discuss
Ambulance
-Specific
Child
Restraints



It Ain't Sexy But They Work...

- March 9th in Spanish Fork River, UT
- Mom found dead / 18 mo Lily found dangling from car seat for approx 14 hrs
- Lily recovering well and discharged





Ambulance Crash Characteristics

Approximately 6.2 million people transported via ambulance each year in the U.S.

Approx. 10,000 ambulance crashes result in injury or death annually

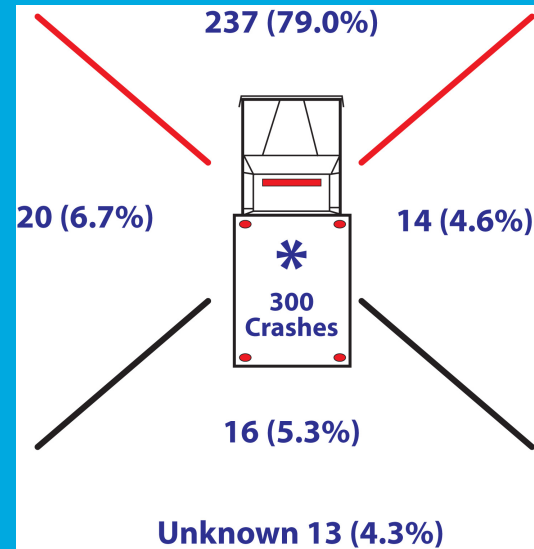
Up to 1,000 ambulance crashes a year involve pediatric patients



Ambulance Crash Characteristics

NIOSH analysis of field crash data

Of 300 fatal crashes, 79% considered frontal impacts



2. NHTSA Fatality Analysis Reporting System (FARS), 1991-2000; Green J. et al, "Reducing Vehicle Crash-Related EMS Worker Injuries Through Improvements in Restraint Systems", World Congress on Safety & Health at Work, 9/05.





Ambulance Crash Characteristics

- Most serious/fatal injuries occur:
 - in rear compartment
 - to unrestrained or improperly restrained occupants
 - at intersections
 - during emergency use
- 82% of fatally injured rear occupants were unrestrained



Ambulance Crash Characteristics



- EMTs and Paramedics have a rate of injury that is three times the national average for all occupations.
- Cause of death
86% transportation related





It's Personal

- 2006 along I-76 in northeast Colorado
- CCT tx pregnant pt w/ RN from NE to CO
- Rear occupant pt (ejected) & RN both pronounced dead on scene
- EMT driver cited

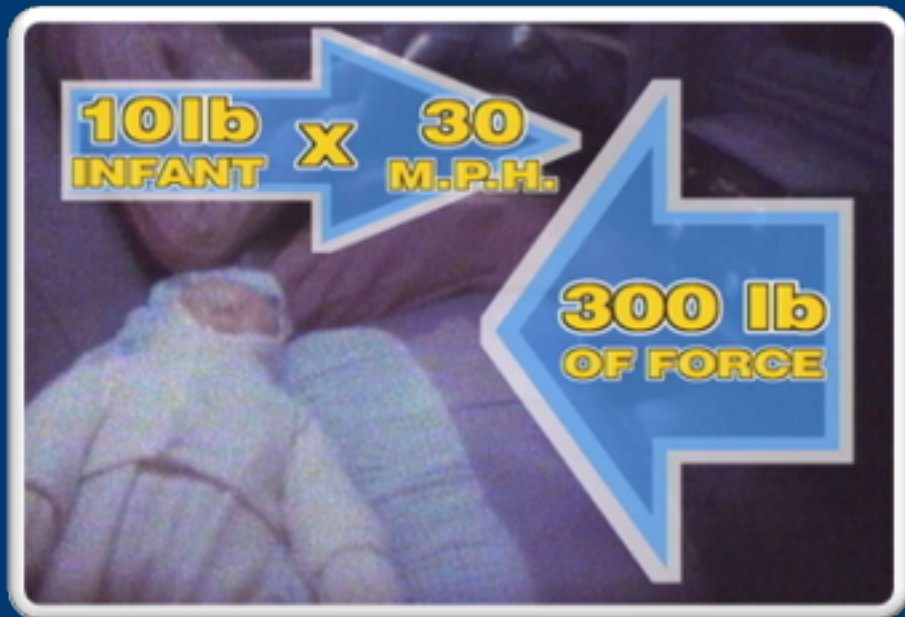


It's An Extension of Clinical Care



Crash Dynamics





Crash Dynamics

Explaining Crash Forces

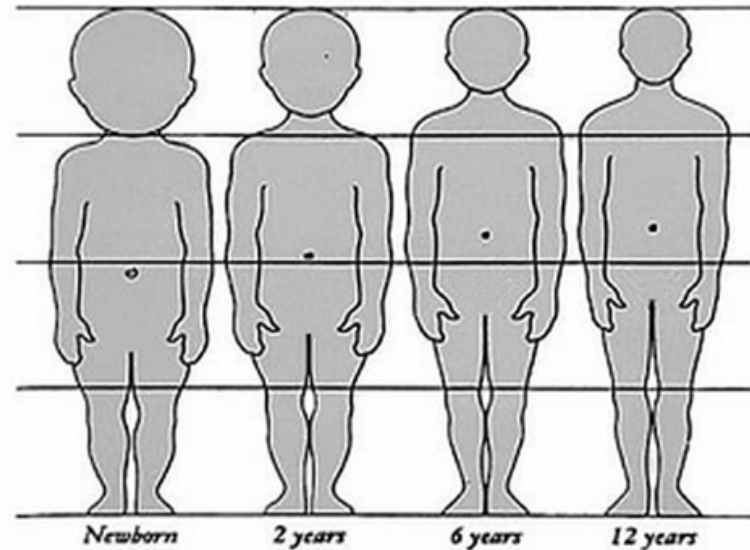
Weight X Speed =
Restraining Force



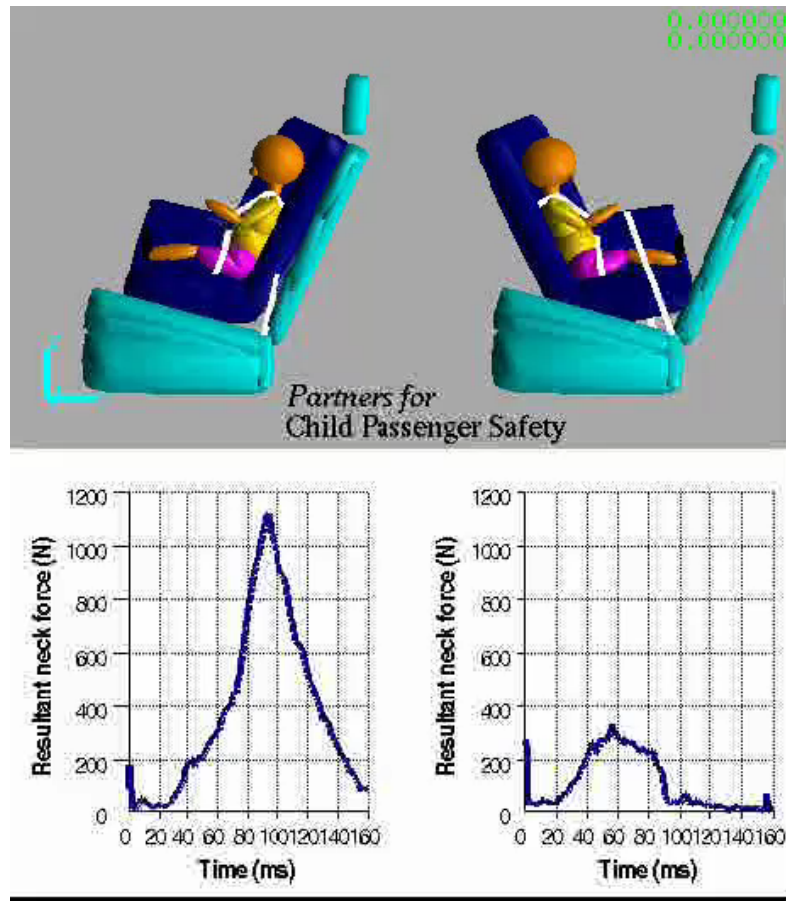
Why Children Should Travel Rear-Facing

- Physical Development
 - Babies have big heads
 - Bones, tendons, and muscles are not fully developed

Child's Body Proportions



Why Children Should Travel Rear-Facing, cont'd



It Was a Beautiful Halloween Sunday Morning



Pop Case Review

- Sunday morning, rural area, high speed MVA in front of church.
- ~9 y/o boy, restrained front passenger SUV
 - Awake, mumbling, moaning, following simple commands, pupils equal and eyes tracking, breathing, skin warm/dry, cap refill < 3 seconds, left open femur fracture
- Sick/Not sick?



Pop Case Review

- Initial Documentation
 - History (~9 year boy, estimated 25kg – how?)
 - **Airway** - Patent
 - **Breathing** - Unlabored and equal breath sounds, 10L oxygen by NRBM
 - **Circulation** - Warm, pink, dry, CR <3 seconds, + bleeding, 18G IV with NS infusing
 - **Disability/Da Brain/Dextrose** - Awake, PERRL, GCS 13, not moving bilateral lower extremities, D-stick 121
 - **Expose** – Open left femur fracture, two small bruises noted on abdomen (upper quadrants); blankets for warmth
 - **VS: HR 60, RR 22, 75/P, 97% spO2**



Pop Case Review

Clinical Features / Neurogenic Shock

- Acute Spinal Cord Injury (mechanism, BLE paralysis)
- Warm, dry skin
- Hypotension
- Bradycardia
- Hypothermia (later)



Pop Case Review

- Arrive in 58 min to Trauma Room 1
- Trauma Team activated prior to arrival
- 500mL infused
- Respiratory effort waning, pale
- HR 40's no distal pulses
- Cardiovascular collapse → CPR, intubation, IV
- Epi, Mannitol,
- Massive Transfusion Protocol started:
 - 40mL/kg NS and 2 units blood via rapid infuser
- FAST Ultrasound = + fluid in abdomen





Pop Case Review

- PICU
- Mid-cervical spinal cord injury with evidence of disruption at C7-T2 and epidural hemorrhage, rib fractures, femur fracture, posterior fusion from C5-T6



Pop Case Review



Pop Case Review



Child Safety Seats



Types of Child Safety Seats



Convertible Child Safety Seat



**Example of convertible seat installed
rear facing with recline feature**



**Example of convertible seat installed forward-
facing**



Harness Fit



- ▶ Harness should fit snugly. Your fingers should slide off the harness when you pinch the webbing at the shoulder.
- ▶ Position harness retainer clip arm-pit level



Research of Convertible Child Restraints on an Ambulance Cot





Background



- Research conducted in 1990 and 2000 by the Automotive Safety Program at Riley Hospital for Children with the University of Michigan Transportation Research Institute (UMTRI)
- Recommendations from 2000 were published by Bull et. al (2001) entitled: "Crash Protection for Children in Ambulances", 45th Annual Proceedings, AAAM, Sept. 2001

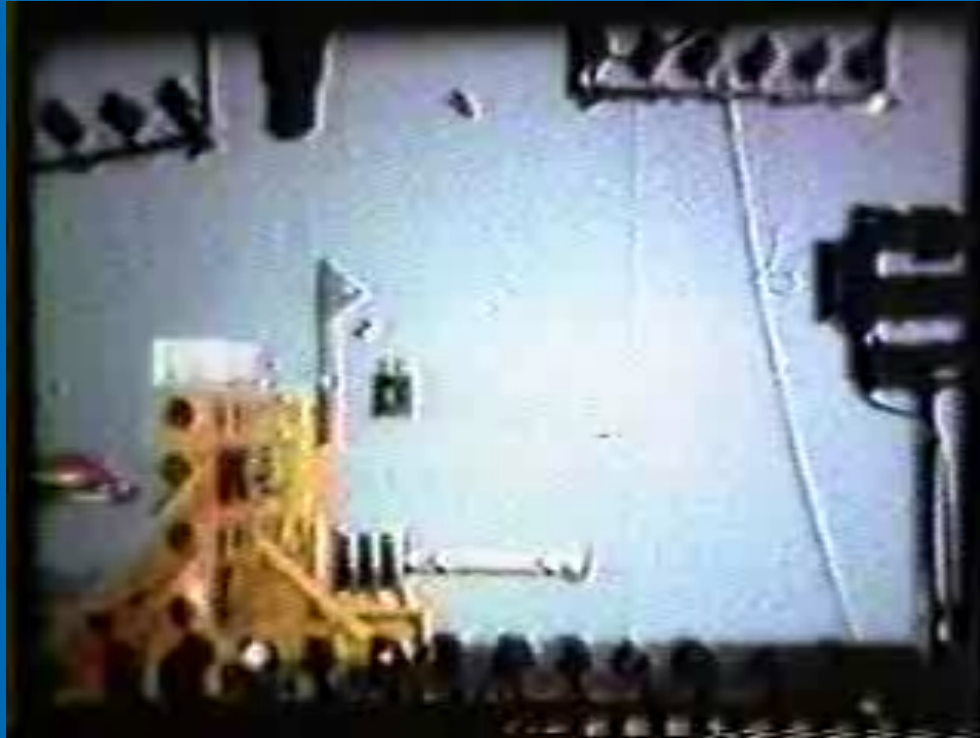


1990 Test: Convertible CSS

- ▶ Test date: January 30, 1990.
- ▶ 3 year old test dummy.
- ▶ Convertible seat facing the rear of the ambulance on Ferno 30 ambulance cot with Ferno 175 ambulance cot fastening system.
- ▶ The convertible seat was reclined with the harness through the middle slots. The convertible CSS was installed using a cot belt through each (rear facing and forward facing) belt path.
- ▶ Frontal impact at 48km/h (30 mph), 20 G with cot backrest fully reclined and side rails up.
- ▶ This test dummy was not instrumented. Failure of the fastener system appeared to be imminent at the conclusion of the test. If safety lanyards had not been used, it is suspected that the fastener system would have failed.



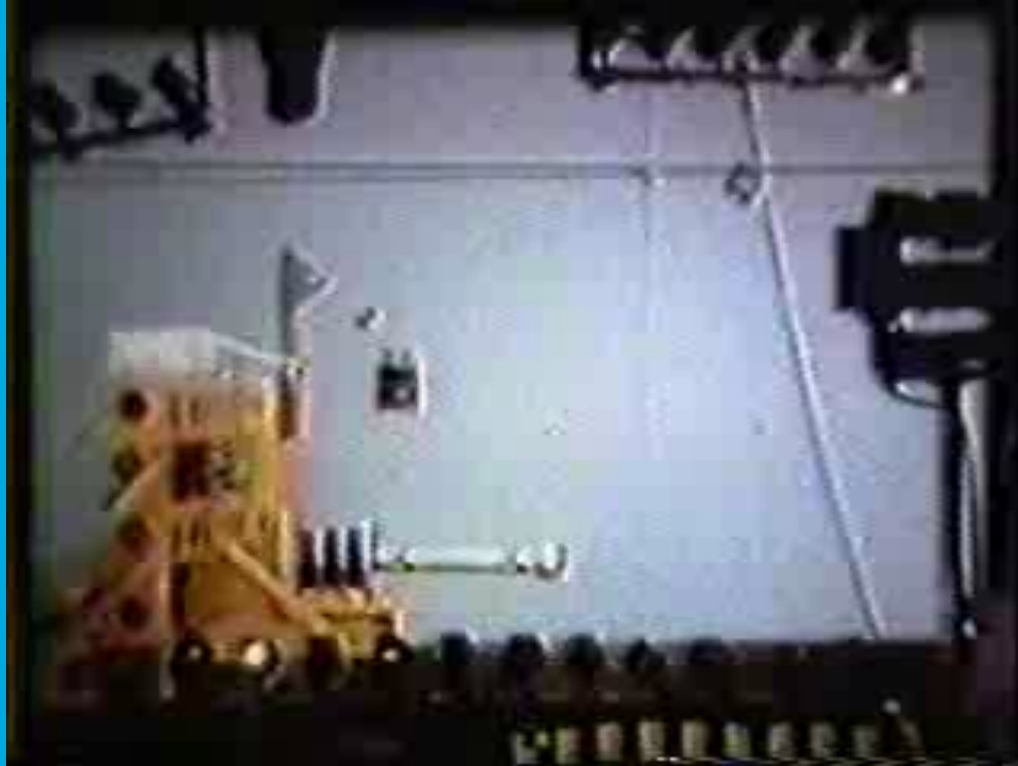
1990 Convertible Test



<https://youtu.be/tX6WxUhxKuk>



1990 Isolette Test (Has Not Been Repeated)

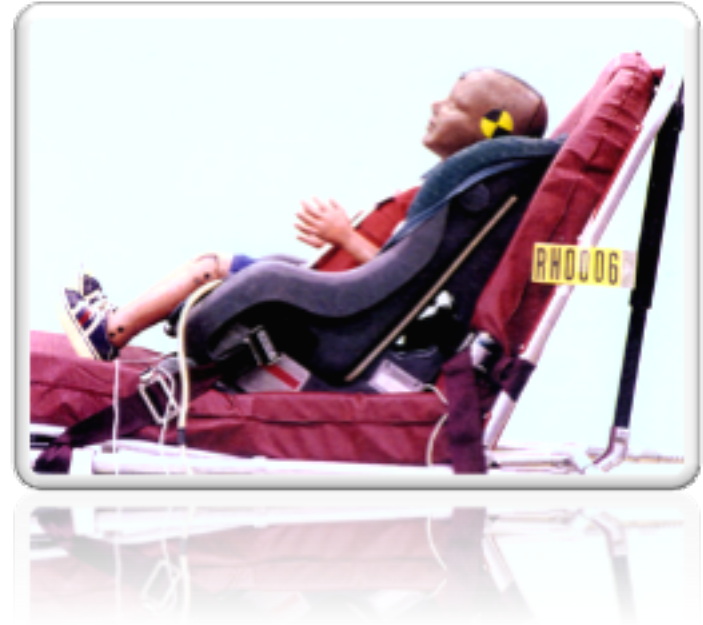


<https://youtu.be/H9mrSYQlhak>



2000 Test Set-Up: Convertible CSS

- ▶ Test date: **July 11, 2000**
- ▶ Convertible CSS meeting FMVSS 213
- ▶ 3 year old, 15 kg test dummy weighted to 18kg
- ▶ CSS facing the rear of the ambulance on Ferno Mobile Transporter 35-AST with sheet metal back on Ferno Stat Trac 185 cot fastening system
- ▶ CSS reclined, harness through middle slots; cot belts through rear-facing and forward-facing belt paths
- ▶ Frontal impact at 48km/h (30 mph), 23 G, simulated ambulance floor on impact sled; cot backrest fully up with side rails down



2000 Convertible CSS Crash Test



<https://youtu.be/ZGp21LJEMRw>

Results: Convertible CSS

- Good restraint performance during impact and rebound
- Chest G resultant was 43G
(compliant with 213 standard)
- Head Injury Criterion was 501
(compliant with 213 standard)
- Head target was well contained



Recommendations: Convertible CSS

For children 5-40 pounds:

- Install with rear-facing & forward-facing belt paths
- Choose seat with 5-point internal harness
- Position seat facing rear of ambulance
- Elevate cot backrest to fully upright position
- Adjust restraint recline mechanism to fit snugly against cot backrest



**Convertible
CSS: Cot
Belt
Through FF
Belt Path**



**Convertible
CSS: Cot
Belt
Through RF
Belt Path**



Convertible Car Seat





Child Safety Seats: Considerations for Ambulance Use

Uninjured children should ride
in a passenger vehicle in a child
restraint appropriate for their
height, weight, and age
whenever possible



These are
safer than...



This



CSS Use in Front Passenger Seat of Ambulance

- Infant-only seat could be installed:
 - rear-facing if no active airbag
- Convertible seat could be installed:
 - rear-facing or forward-facing if no active airbag
- Forward facing or booster is fine
(slide seat all the way back)



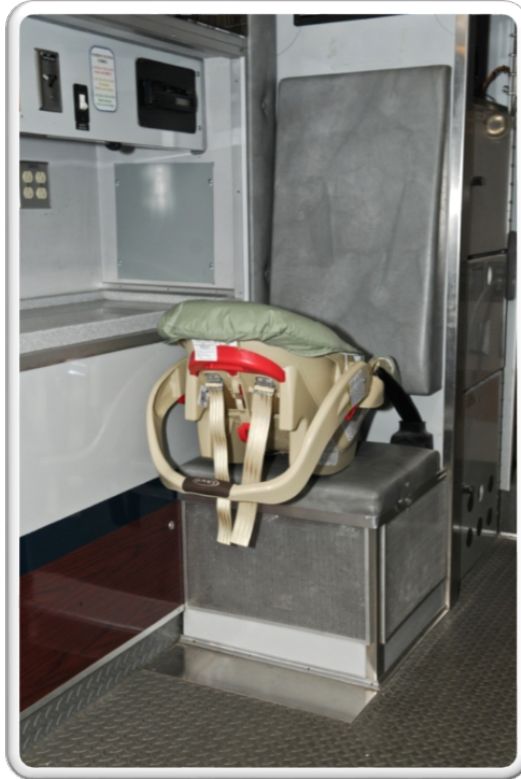
Child Safety Seats: Considerations for Use in Rear-Compartment



NEVER install a
child restraint
side-facing on a
bench seat or
captain's chair



Rear-Facing CSS on Rear-Facing Attendant Seats



CSS Use on Ambulance Cot

CANNOT install:

- Infant-only, forward-facing only, combination, or specialty CSS

These seats have only one belt bath and cannot be adequately secured to the cot

- Belt-Positioning Booster

Requires use of vehicle lap/shoulder belt



CSS Use on Ambulance Cot

CAN Install:

- Convertible CSS
- Two separate belt paths allow for installation on a cot
- Crash test results and specific procedures for use on the ambulance cot for children under 40 pounds are discussed in NHTSA Best Practice Recommendations



Contraindications: Convertible CSS on Cot

Not appropriate if:

- Child acutely ill or unable to maintain thermoregulatory stable
- Child's injuries cannot be treated in a semi-reclined position
- Child may have a spinal cord injury
- Child requires intubation
- Child does not meet or exceeds wt./ht. limits of CSS



Harness Systems

- Adult cot-mounted harness systems may not provide adequate restraint for pediatric patients in the event of a crash
- Design of harness systems that provide adequate occupant protection remains an area of future research and development



Put Your
Parent Hat
On...



The sampling of products is not intended to be all inclusive or imply endorsement or crashworthiness of products



We have no financial disclosures; however, we would love some.



Child Restraints Designed for Ambulance Use

2 Types:

- Cot Mounted Child Restraints
- Integrated Child Restraints Located Inside Ambulance Seats

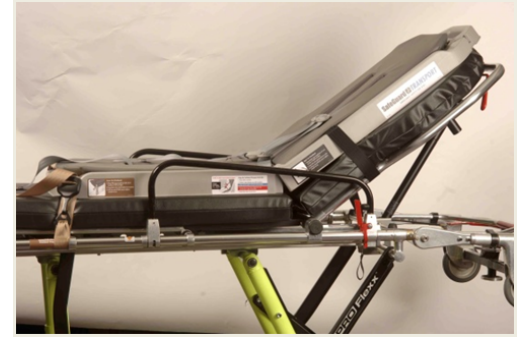


Safe Guard Transport by IMMI

www.IMMI.net.com
1-317-896-9531



- Cot-mounted restraint for patients over 1 year of age from 22 to 100 lbs
- Restraint weighs 22 pounds
- 5-point harness system with one-handed adjustment for harness height and tightness
- Children 22-40 pounds can use with cot back angle at 70 and 45 degrees
- Children 40-100 pounds can use with cot back angle at 70 degrees and completely flat
- Not a Spine Board



The Rescu-Air: Air Filled Child Transport Seat

www.epandr.com

1-800-322-5725



- For children 20-40 pounds and less than 40" tall
- Five-point restraint system with pelvic adjustment
- 2-level adjustable shoulder harness
- Must purchase "cot harness system" separately to use on ambulance cot
- Inflates/deflates with included 12v DC pump in 60 seconds



Ferno

1-877-733-0911

www.ferno.com



Neo-Mate
7-14 lbs.

\$325



Pedi-Mate
10-40 lbs.

\$275



Pedi-Mate Plus
10-100 lbs.

\$350





Neo-Mate



Ped-Mate



Pedi-Mate Plus



**EVS 1880
Hi-Bac Seat
by E.V.S.
Ltd.**



1-800-364-3218
www.evsltd.com



- Designed for uninjured children who must be transported in the ambulance with the patient
- Accommodates children 20-50 pounds
- 5-point harness, folds down from seat back
- Child restraint cannot be used side-facing
- Can be equipped with lap/shoulder belt for staff use

Guardian Safety Seat by Serenity Safety Products

1-800-536-0676
www.SerenitySafetyProducts.com



- 3 in 1 attendant seat with built-in infant only seat, toddler restraint, and 4-point restraint for attendant



THANK YOU

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