

# Burn Management

## Don't Get Burned by Suboptimal Burn Training



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## Disclosures

► None



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## Objectives

- ▶ Define burn
- ▶ Discuss prehospital care
- ▶ Discuss hospital care
- ▶ Review multi-patient case
- ▶ Burn MCI plan
- ▶ +/- Frostbite



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## Case Introduction

- ▶ Per Local News:
  - ▶ A bonfire in Pulaski after the homecoming football game [last year] left dozens injured. The Shawano County Sheriff's Office [indicated] between 30 and 40 people were injured after the bonfire exploded. Five of the young victims [required treatment] at the burn center[s].
  - ▶ Estimated 50-60 people surrounded a fire that ignited a combination of gas and diesel in a 55 gallon drum that was 25% filled. (WBAY ABC ch2)
  - ▶ All patients were transported by private auto(No usage of 911 or prehospital resources).
- ▶ What challenges were encountered with this incident?
- ▶ What is the best way to care for these patients?

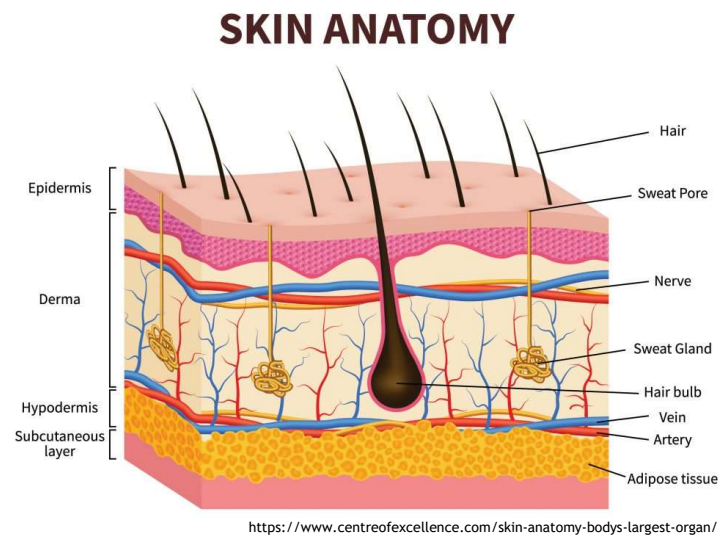


<https://www.nbc26.com/news/local-news/gofundme-pages-raising-funds-for-pulaski-area-bonfire-burn-victims>

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## Functions of Skin

- ▶ Sensation (temp./movement/touch/pressure/etc)
- ▶ Protection from injury
- ▶ Temperature regulation
- ▶ Containment of body fluids
- ▶ Cosmetic / Appearance



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## Types of Burns

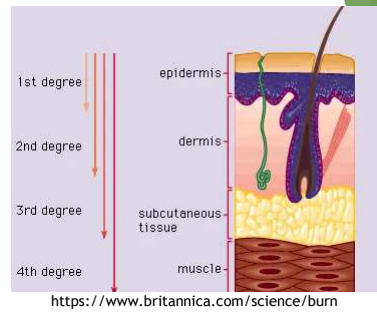
- ▶ Heat transfer
- ▶ Electrical
- ▶ Chemical
- ▶ Radiation
  
- ▶ Frostbite

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## 1<sup>st</sup> degree

- ▶ Epidermis / outer layer involved
- ▶ Appears red (like typical sunburn)
- ▶ Painful
- ▶ Heals in a few days

Note: Not included in TBSA calculation



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## 2<sup>nd</sup> degree

- ▶ Involves entire epidermis and some dermis
- ▶ Can appear red, blistered, wet and/or weepy
- ▶ AKA - partial thickness (can be further separated into deep or superficial)
- ▶ Usually will heal with only good wound care

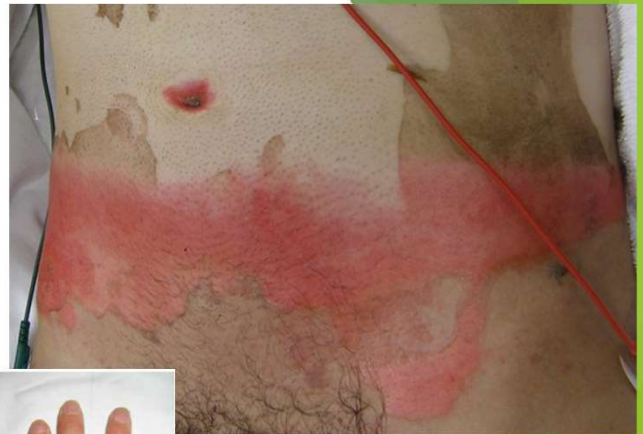


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## 3<sup>rd</sup> Degree

- Involves entire epidermis and dermis
- Appears white or charred
- Nerves also burned → decreased pain
- Coagulated vessels → no capillary refill
- Requires grafting and specialized wound care



[https://www.researchgate.net/figure/A-48-year-old-male-had-crushing-injury-of-hand-resulting-third-degree-burn-involving\\_fig1\\_272410241](https://www.researchgate.net/figure/A-48-year-old-male-had-crushing-injury-of-hand-resulting-third-degree-burn-involving_fig1_272410241)

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## 4<sup>th</sup> Degree

- Involves fat, fascia, muscle or bone
- Requires significant wound care/skin grafting
- Limbs may require amputation



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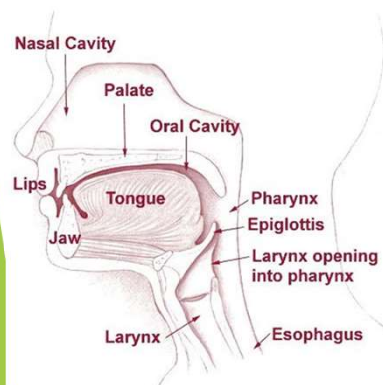
## Prehospital Care

- ▶ Scene safety
- ▶ Initial Assessment → ABCDE
- ▶ DON'T GET DISTRACTED

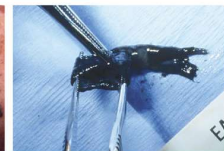
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## Airway

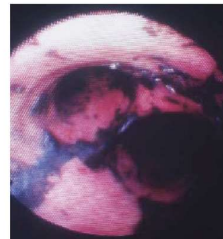
- ▶ Inhalation Injury and/or aspiration of superheated gases, steam, hot liquids or products of incomplete combustion
- ▶ Common cause of fire-related prehospital death
- ▶ Present in 2 - 14% of burn center admissions
- ▶ Edema may develop → must anticipate worsening



**Initial Physical Findings:** Direct thermal injury is generally confined to the face and upper airway. Physical findings include facial burns, burned nasal hairs, and soot in the nares and mouth.



**Bronchial Cast:** Accrued endobronchial debris and exudate can cause obstruction of distal airways contributing to ventilation-perfusion mismatching and secondary infection.



**Bronchoscopic View:** Aerosolized chemicals and incomplete products of combustion can deposit throughout the subglottic airway and lungs. Severity of injury depends on both the agents and particle sizes inhaled; smaller particles travel more distally. Bronchoscopic findings include mucosal irritation, pallor, ulceration, and carbonaceous debris.



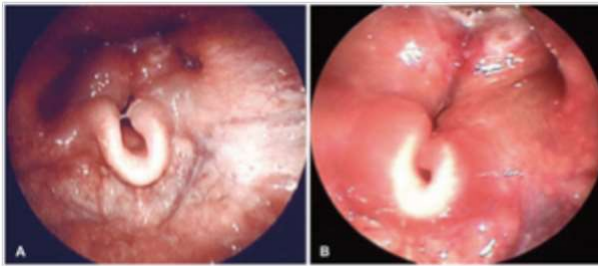
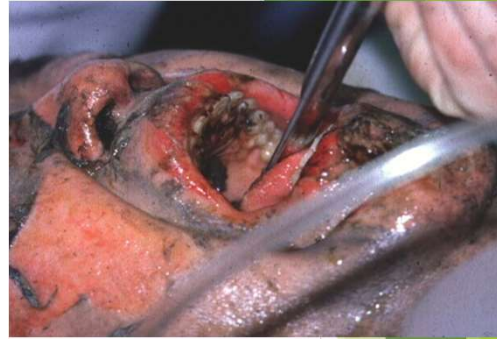
**Facial Burn:** Anoxia, carbon monoxide effects, cyanide effects, local and systemic inflammation, airway obstruction, and infection contribute to morbidity and mortality in patients with inhalation injury. The effects are more marked in those with large cutaneous burns.

<https://www.nejm.org/doi/10.1056/NEJMra1601128>

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## Intubation

- ▶ Consider early if airway swelling/involvement
- ▶ Use most experienced provider
- ▶ Secure tube well
- ▶ Always use video
- ▶ Consider using smaller ETT
- ▶ Consider Bougie for initial pass



<https://www.rcemlearning.org/modules/major-trauma-burns/lessons/airway/>

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## Breathing

- ▶ Provide Oxygen as needed
- ▶ Assess rate and depth of respir
- ▶ Assess for circumferential chest burns (may cause restriction).
  - ▶ Note: usu fatal
- ▶ Consider CO poisoning or CN (Why and how are these treated?)
  - ▶ Note: CN kit will discolor urine + discolor skin → challenge with skin assessment

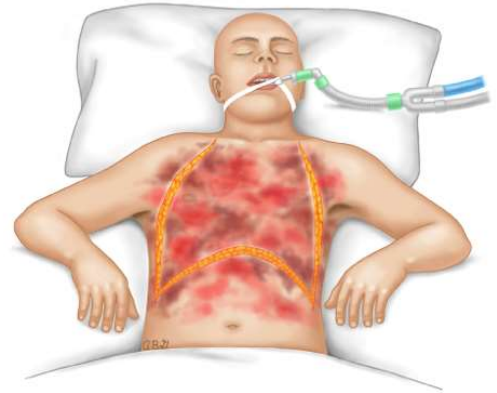


<https://legacy.medictests.com/quick-dirty-guide-burn-classification/>

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## Breathing Cont. - Escharotomy

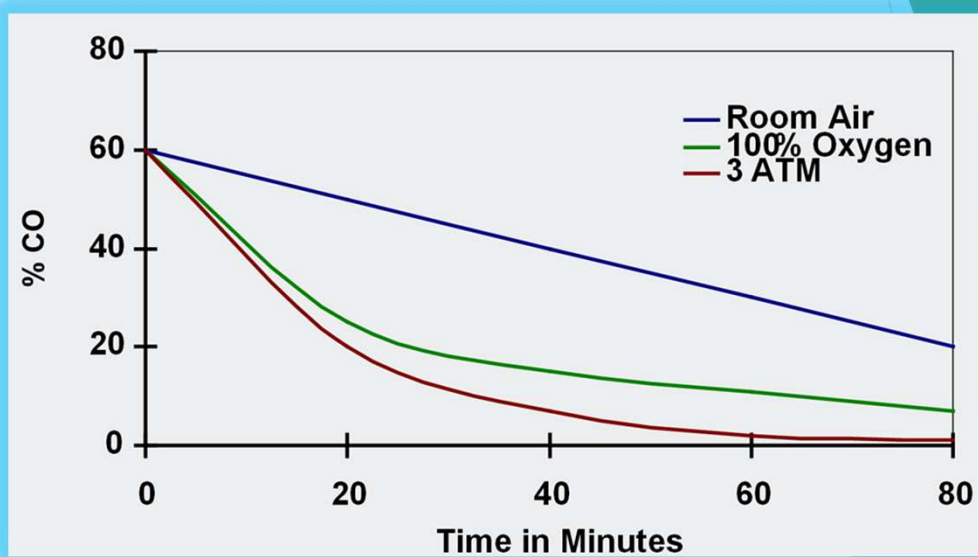
- Sterile (if possible) → cut to subcut. fat / ~1 cm → Should have release in tissue pressure
- Incise from as high as the clavicle to the costal margin in the anterior axillary line ( avoid breasts)
- Should see improved lung compliance
- Place Silvadene +/- sterile dressing



<https://handbook.bcehs.ca/clinical-practice-guidelines/pr-clinical-procedure-guide/pr39-escharotomy/>

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## Breathing Cont. - CO



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## Circulation

- ▶ Assess Vitals → Note normal HR in burn pt is <120
- ▶ Assess skin of unburned extremity
- ▶ Assess circulation of burned extremities
- ▶ IV or IO access → *Don't be reluctant to use IO (initially)*
- ▶ Consider type, amount, and rate of resuscitation

### Prehospital Fluid Resusc. Rate

<6 yo → 125 mL/hr  
 6 - 14 yo → 250 mL/hr  
 >14 → 500 mL/hr




Note: No Bolus unless hypotension.

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## Disability

- ▶ Neuro assessment
  - ▶ Level of consciousness
  - ▶ Moving extremities
  - ▶ Pupil response
  - ▶ Speech
  - ▶ GCS
- ▶ Glucose

### Glasgow Coma Scale

EYE OPENING		VERBAL RESPONSE		MOTOR RESPONSE	
					
Spontaneous	> 4	Orientated	> 5	Obey commands	> 6
To sound	> 3	Confused	> 4	Localising	> 5
To pressure	> 2	Words	> 3	Normal flexion	> 4
None	> 1	Sounds	> 2	Abnormal flexion	> 3
		None	> 1	Extension	> 2
				None	> 1
GLASGOW COMA SCALE SCORE					
Mild 13-15		Moderate 9-12		Severe 3-8	

MEDIC TESTS #1 EMT & PARAMEDIC EXAM PREP

<https://medictests.com/units/glasgow-coma-score>

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## Exposure

- ▶ Consider Trauma (explosion, falling debris, etc.)
- ▶ Expose pt and assess TBSA%



<https://ew.com/article/2014/09/23/denzel-washington-the-equalizer-quiz/>

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## Closest Most Appropriate Facility

- ▶ Best facility may not be the closest
  - ▶ Considerations:
    1. Protocols
    2. Time out of service
    3. Patient stability
    4. Facility burn treatment capabilities

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## Hospital Care

- ▶ Reassess (ABCDE)
- ▶ Reassess burn severity (burns can evolve)
- ▶ Pain control
- ▶ Begin or continue fluid resuscitation (Start time for 1<sup>st</sup> 8 hours of Resusc. is at time of burn)

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## Prognostication - TBSA

- ▶ Rule of nines
- ▶ Palm (use patient's palm)
- ▶ Lund Browder
- ▶ Note: does not include superficial burns

<https://www.emnote.org/emnotes/burn-size-estimation>

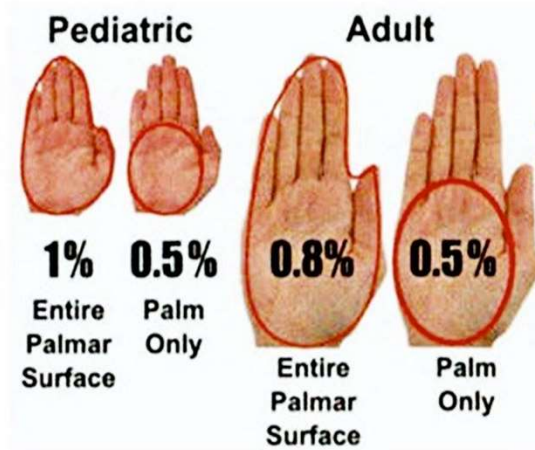
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## Easy / Rapid Assessment

### Rule of Palms

Use PATIENT's hand &  
ENTIRE palmar surface

Good for TBSA < 15%



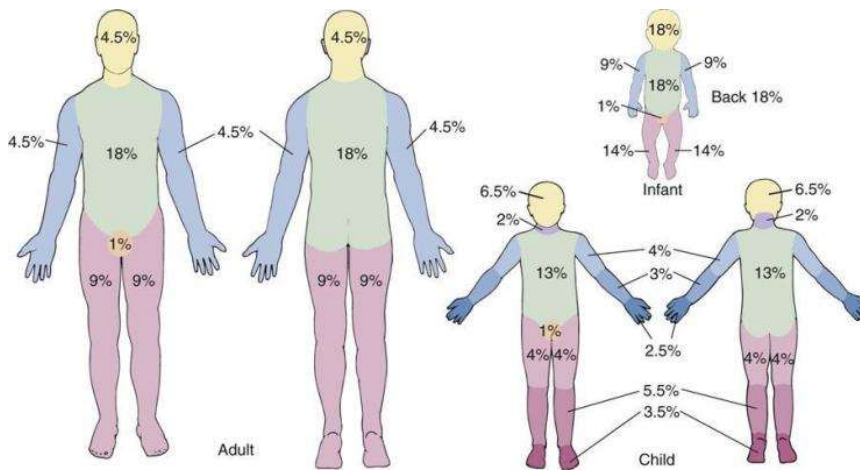
Note: do not use your hand.

<https://www.emnote.org/emnotes/burn-size-estimation>

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## Fairly Easy to use and Fairly Accurate

### Rule of Nines

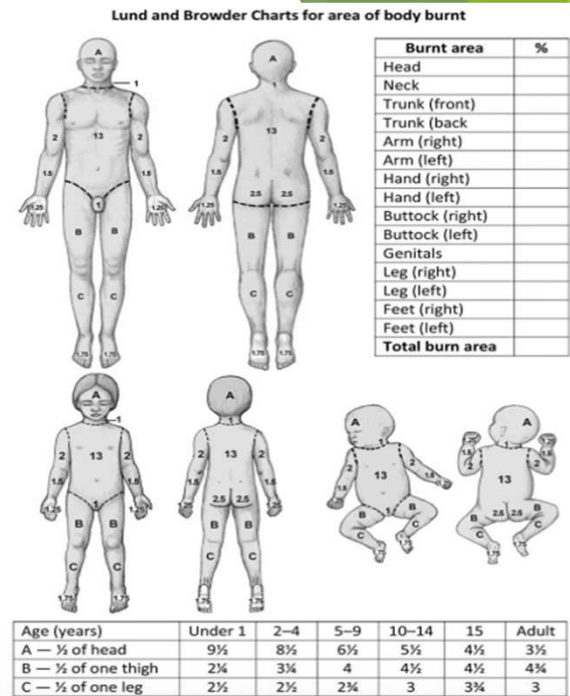


<https://rushemergencymedicine.org/2019/03/21/burns-in-a-rush/>

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## Most Accurate + Complex



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## Revised Baux Score - Mortality Prediction

Use cautiously in peds but approaches 90% specificity if advanced age.

### Predicting Survival

- **Osler T, et al. J Trauma. Mar 2010**
  - Revised the Baux score to include inhalation injury
  - Tested with data on 39,888 patients from National Burn Registry
  - Inhalation injury = additional 17% mortality
- **Modified Baux Score =**
  - Age + %TBSA + 17\*(Inhalation Injury)
  - Inhalation Injury: 1 = Yes 0 = No

Peds - if optimal care any burn <100% may be survivable

Roberts, G; Lloyd, M; Parker, M; Martin, R; Philp, B; Shelley, O; Dziewulski, P (Jan 2012). "The Baux score is dead. Long live the Baux score: a 27-year retrospective cohort study of mortality at a regional burns service". J Trauma Acute Care Surg. 72 (1): 251-6. doi:10.1097/TA.0b013e31824052bb. PMID 22310134. S2CID 19475079.

Data for Advanced age - effective in predicting outcome in 87% of presenting patients aged 60 and above.

Wibbenmeyer, L; Amelon, MJ; Morgan, LJ; Robinson, BK; Chang, PX; Lewis, r, 2nd; Kealey, GP (2001). "Predicting survival in an elderly burn patient population". Burns. 27 (6): 583-90. doi:10.1016/S0305-4179(01)00009-2. PMID 11525852.

	R-baux	Death (%)
1	10-20	0
2	20-30	0
3	30-40	0
4	40-50	0
5	50-60	2.90
6	60-70	16.67
7	70-80	47.83
8	80-90	82.35
9	90-100	76.92
10	100-110	100
11	110-120	100
12	120-130	100
<b>Total mortality</b>		<b>10.6</b>

<https://www.semanticscholar.org/paper/Prediction-of-Mortality-in-Pediatric-Burn-Injuries-Karimi-Motevalian/3feee89d3ccb694ebb1f37fbc68e6edb53d0195b/figure/5>

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## Fluid Resuscitation → Parkland Formula

$$4\text{mL} \times \text{Body Weight (kg)} \times \text{TBSA (\%)} = \text{Total Fluid Volume in First 24 Hours}$$

1/2 of the volume  
given in first 8 hours

1/2 of the volume given  
over the next 16 hours

- *Partial thickness and full thickness*
- Involving *> 20% TBSA in Adults; > 10% TBSA in Children or Elderly*
- Smaller burns but with oral or inhalation injury (Can't tolerate PO fluids)
- Closely monitor fluid status in those with CHF, CKD, etc.

**Note: No Bolus unless hypotension.**

<https://www.ezmedlearning.com/blog/parkland-formula-for-burns-examples-calculator>

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## LR vs NS → prefer LR

- LR best duplicates composition of fluid losses
- Many meds not compatible

Solution	Osmolality	Usage and Limitations
NS - 0.9% NaCl	<b>Isotonic</b> (308mOsm/L)	replaces NaCl deficit and restores/expands extracellular fluid volume; <b>the only solution that may be administered with blood products</b> —does not provide free water that causes hemolysis of red blood cells
1/2 NS - 0.45%NaCl	<b>Hypotonic</b> (154 mOsm/L)	assists with renal function; provides free water, Na and Cl; replaces normal hypotonic daily fluid losses- assists with daily body fluid needs, but not with electrolyte replacement or provision of calories.
D5 1/2 NS - 5% Dextrose & 0.45NaCl	<b>Hypertonic</b> (406 mOsm/L)	to promote renal function and excretion; basically the same as .45NS except provides 170 calories per liter
D5NS - 5% Dextrose & 0.9NaCl	<b>Hypertonic</b> (559 mOsm/L)	to treat fluid volume deficit; for daily maintenance of body fluids and nutrition; basically the same as NS, except provides 170 calories per liter
D5W - 5% Dextrose in water	<b>Isotonic</b> (252 mOsm/L)	provides free water (hypotonic) to the extracellular and intracellular spaces, as the dextrose is quickly metabolized; promotes renal elimination of solutes; treats hyponatremia; does not provide electrolytes; one liter is 170 calories
Lactated Ringer's Solution	<b>Isotonic</b> (273 mOsm/L)	closely resemble the electrolyte composition of normal blood serum and plasma; will need additional K; does not provide calories or free water; used to treat losses from lower GI tract and burns.
10% Dextran 40 in 0.9%NS	<b>Isotonic</b> (308 mOsm/L)	plasma expander

<http://www.slideshare.net/dangthanhtuan/fluid-and-electrolytes1>

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## Monitoring Fluid Resusc.

- ▶ Urine Output
  - ▶ Peds
    - ▶ <10 Kg → 2.0 mL/Kg/hr
    - ▶ 10 - 59 Kg → 1.0 mL/Kg/hr
  - ▶ Adult
    - ▶ >60 Kg → 0.5 mL/Kg/hr



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## Urine is Red (myoglobin)

- ▶ Increase fluid rate to 1 - 1.5 mL/kg/hr
  - ▶ Note: CK may not be reliable for deep tissue injury



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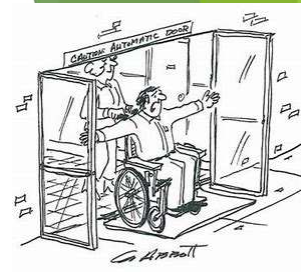
## How to achieve adequate pain control

- ▶ Acute control first
  - ▶ Do what is needed to achieve pain control
- ▶ Add oral method
  - ▶ Must wait appropriate time (45 min - 1 hour)
  - ▶ This is the test to see if wound care can be done with only oral medications
- ▶ Appropriate dose
  - ▶ Enough

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## Burn Care - if Dispo = D/C

- ▶ Provide oral analgesia
- ▶ Use soap/water to clean
- ▶ Provide dressing and simultaneously teach patient and family (q1day dressing changes)
- ▶ May use ointments if going home
  - ▶ Note Silvadene contraindication/caution
    - ▶ for facial burns
    - ▶ Sulfa allergy (*May still be fine*)
    - ▶ Caution in the 3rd trimester of pregnancy.
    - ▶ Avoid contact with eyes / mucus membranes(*external use only*)

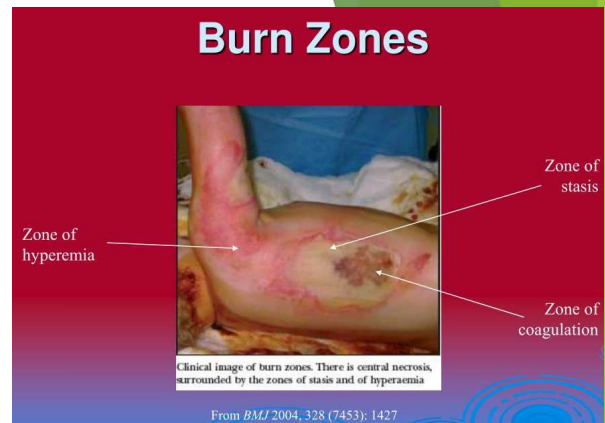


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## Burn Care Cont.

- Teach range of motion (ROM → reduces edema → increases circulation → improves healing)
- Discuss complications ( S/S infection, uncontrolled pain w/ PO meds, etc.)
- Note: Good wound care and ROM → reduced chance of zone of stasis becoming a zone of coagulation



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## Burn Care Examples



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## Burn Care - if Severe → going to burn center

- ▶ Remove gross contamination
  - ▶ If chemical burn → decontamination (should occur prehospital and continue in hospital)
- ▶ Cover in plastic wrap
- ▶ Hold wrap in place with gauze roll

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## Burn Center Referral Criteria

### ABA Burn Referral Criteria

The ABA identifies the following as injuries requiring a Burn Center referral:

- 2nd degree burns > 10% TBSA
- Burns to face, hands, feet, genitalia, perineum, major joints
- 3rd degree burns
- Electrical injury
- Chemical burns
- Inhalation injuries
- Burns accompanied by pre-existing medical conditions
- Burns accompanied by trauma, where burn injury poses greatest risk of morbidity or mortality.
- Burns to children in hospitals without pediatric services.
- Patients with special social, emotional or rehabilitative needs.

\*\*\*Note: If criteria met, does not mean all patients need to be inpatient.

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## Case Discussion - How would care have been changed had EMS / Prehospital services been utilized:

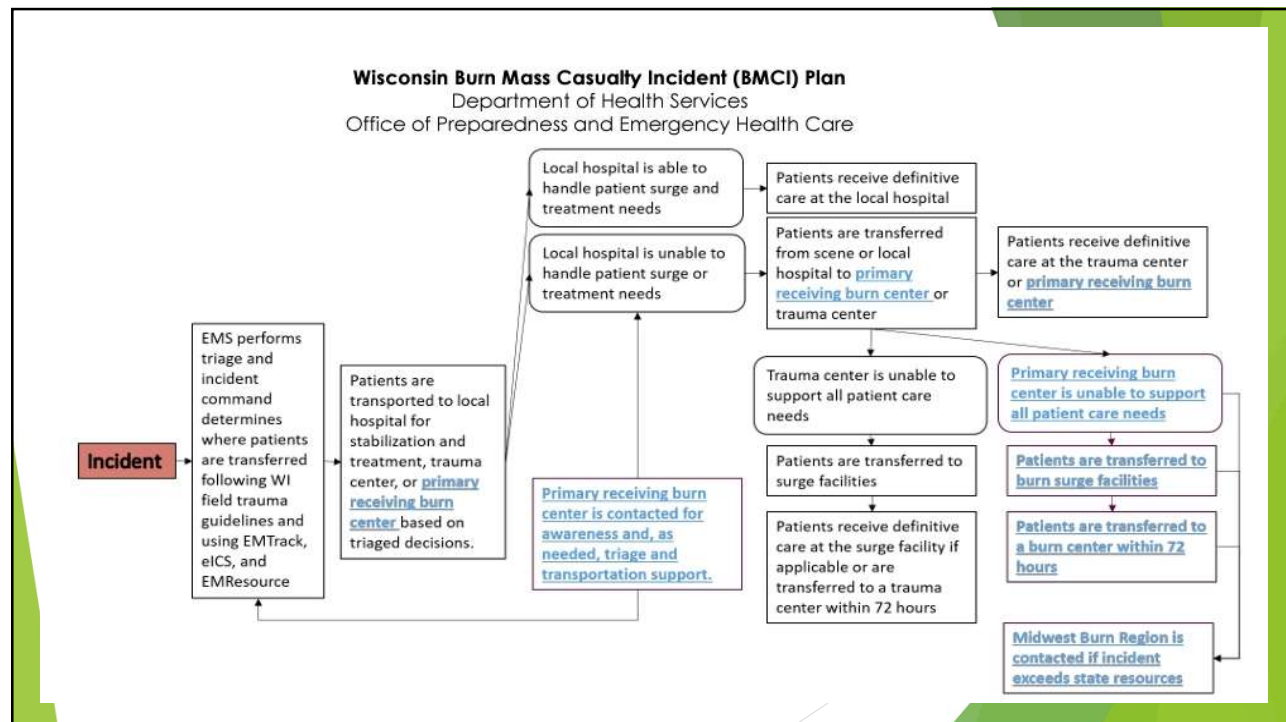
1. Initial assessment by trained prehospital providers (ABCDEs)
  - a) What if there were severe airway edema enroute by private vehicle?
  - b) What if there had been trauma as well (very possible in explosions)?
2. MCI / Triage system could have better matched resources with patients
  - a) What if all patients presented to the same facility?
  - b) What if patients presented to a facility incapable of providing care?
3. Fire Department Resources if continued fire
  - a) What if there was an associated structure fire?
4. Alert hospitals / coordinating downstream medical resources
  - a) What if resources could have been mobilized if adequate time to prepare (hospital staffing etc)?

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## Initial Management of Burn MCI

- ▶ 1st agency establishes incident command(IC) → may request the activation of EOC → primary receiving burn center(PRBC) is called (UW or St Mary's) → Activation of the State BMCI Plan by burn surgeon → EMResource alert is sent to all potential receiving hospitals
- ▶ EMS follows State Trauma Field Triage Guidelines
- ▶ IC / dispatch determine transportation(HEMS or Ground) needs of patients based on acuity and hospital bed capacities(EMResource)
- ▶ Note: Patients may go to PRBC or local facility or Burn Surge Facility(Level 1 or 2 trauma w/ ABLIS trained staff) based on resources/needs

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## Frostbite

- ▶ Why does this matter?
  - ▶ We are at risk because of where we live
  - ▶ Treatment has changed drastically
  - ▶ Early diagnosis and treatment saves digits and even /
    - ▶ Early intervention can offer up to 80% increased salvage of digits and limbs.



[www.aaos.org/aaosnow/2019/mar/cover/cover01titten tissue](http://www.aaos.org/aaosnow/2019/mar/cover/cover01titten%20tissue)

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## Who gets frostbite

- ▶ Can occur when <40 degrees F
- ▶ Average population
  - ▶ Male gender
  - ▶ Age 20-50
  - ▶ Many have some type of incapacitation that does not allow appropriate decision making
  - ▶ Housing insecurity
- ▶ Unique populations
  - ▶ Extreme athletes
  - ▶ Those with memory issues
- ▶ Rare in Children



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## How do we grade the injury

- ▶ Similar to burns
  - ▶ 1st degree - superficial or frostnip
  - ▶ 2nd degree - partial thickness, just blisters - mild frostbite
  - ▶ 3rd degree - full thickness, blisters and dead looking tissue - moderate frostbite
  - ▶ 4th degree - deep structures also involved, ice cold extremity

- ▶ **\*\* There are many different grading system in the literature \*\***

Frostbite			
First degree	Second degree	Third degree	Fourth degree
			
• Epidermis	• Epidermis • Dermis	• Hypodermis	• Skin, muscles, tendons, and bones
Erythema and edema	Hard edema and clear blisters	Hemorrhagic bullae, pale gray extremity	Insensate, black/gray
Minimal pain with rewarming	Mild to moderate pain with rewarming	Severe pain with rewarming	Painless during rewarming

<https://www.bing.com/images/>

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## Frostnip = 1st degree

- ▶ Superficial
- ▶ Tissue pink or red
- ▶ Very tender
- ▶ No blisters
- ▶ No treatment other than rewarming and protection from further injury
- ▶ Patient education



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## Mild frostbite = 2nd degree

- ▶ Involves the superficial dermis / Partial thickness
- ▶ Clear fluid filled blisters develop
- ▶ Very tender



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## Moderate frostbite = 3rd degree

- ▶ Involves deeper dermis / Full Thickness
- ▶ Discolored, blood filled blisters
- ▶ Tender, but can have decreased sensation



<http://blog.alpineinstitute.com/2008/01/frostbite-symptoms-and-treatment.html>

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## Severe frostbite = 4th degree

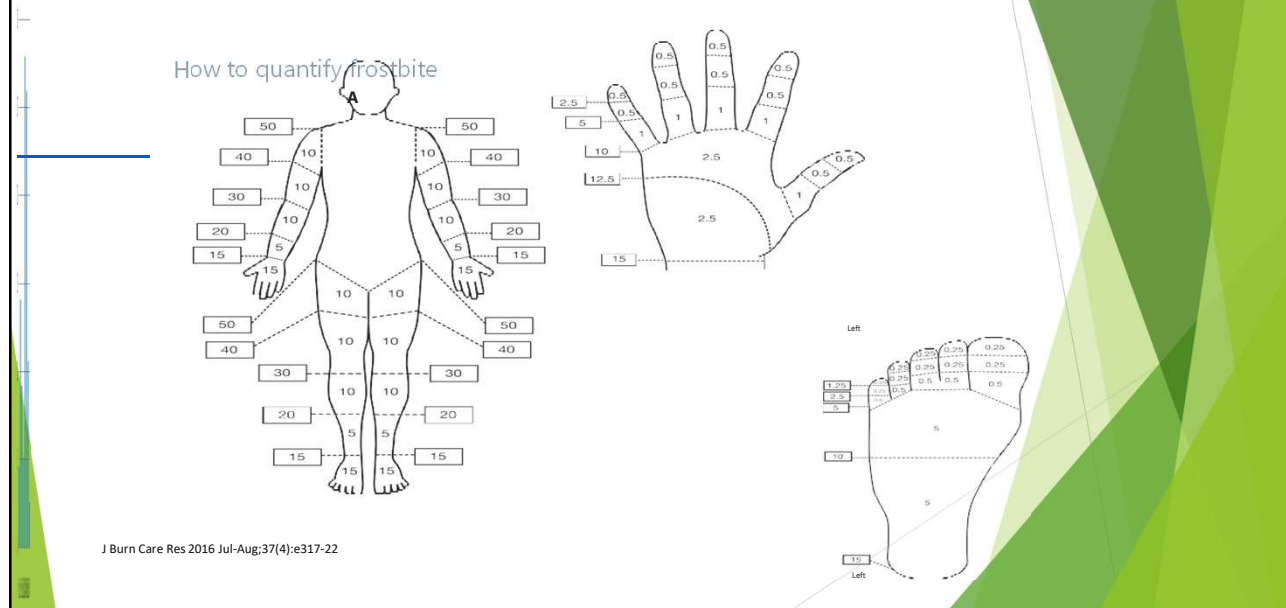
- ▶ Involves deeper tissues below the skin
- ▶ May initially be insensate
- ▶ Severe pain will occur with rewarming
- ▶ Bloody and/or clear blisters may develop during the rewarming process



<https://www.bing.com/aclick?ld=e8Hj6kZpkAW>

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## How to quantify frostbite



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## Treatment of Frostbite - Prehospital

- ▶ Avoid rubbing
- ▶ Don't use frostbitten extremities
- ▶ Don't thaw if there is risk of refreezing
- ▶ Don't pack in ice or snow to keep cold
- ▶ Thaw with warm water
- ▶ Do not apply any creams or salves
- ▶ Seek medical attention

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## Treatment of Frostbite - In Hospital

- ▶ ABCs
- ▶ Look for other trauma
- ▶ Vital signs with core temperature
- ▶ Remove all clothing, gloves, and shoes
- ▶ Use external warming devices
- ▶ Very focused vascular exam



<https://www.modernhealthcare.com/article/20151128/MA-GAZINE/311289988/better-funding-means-trauma-center-shortage-may-become-a-glut>

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## Rapid Rewarming

- ▶ Immerse in water 40 - 42 degrees C (this is the temperature of a warm shower)
- ▶ Keep water warm by exchanging every 5 - 10 minutes
- ▶ This will be quite painful
- ▶ Dry skin to avoid evaporative heat loss

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## Preparation for Transfer

- ▶ 800 mg Ibuprofen
- ▶ Narcotic pain management
- ▶ Transfer to a burn center
- ▶ Rapid rewarming and lytic agents have been shown to greatly improve salvage

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## Burn Center Treatment

- ▶ Systemic lytic agents considered for any patient with
  - ▶ Severe frostbite with decreased perfusion after rewarming
  - ▶ <48 hours since completion of rewarming
- ▶ Contraindications
  - ▶ Repeated freeze/thaw cycles
  - ▶ >48 hours
  - ▶ Bleeding
  - ▶ Recent surgery
  - ▶ Pregnancy
  - ▶ Coagulopathy



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## How we give lytic agent

- ▶ We use intravenous alteplase
  - ▶ 0.15mg/kg bolus
  - ▶ Run 0.15 mg/kg/hr for six hours
  - ▶ Close monitoring during that time
- ▶ Therapeutic anticoagulation for one week
- ▶ Baby aspirin for one month
- ▶ High dose ibuprofen
- ▶ Escalating doses of gabapentin

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## Wound care

- ▶ Debride all blisters and wash wounds with soap and water
- ▶ Apply antimicrobial ointment and apply non-stick gauze to open wounds
- ▶ Cover with cotton gauze to absorb potential drainage
- ▶ Lightly apply compression wrap



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## Now Wait

- ▶ Frostbite in January, operate in July
- ▶ May offer sooner if clear lines of demarcation
- ▶ Definitely if signs of infection

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## Summary

- ▶ Always perform ABCs, assess for other trauma and resuscitate as needed
- ▶ Early diagnosis and treatment saves digits and limbs
- ▶ Rapid rewarming followed by thrombolytic therapy is the most effective treatment
- ▶ Always must consider thrombolytics

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## References and Resources

Some slides, pictures, and information obtained from:

Lee D. Faucher, MD FACS, Professor of Surgery & Pediatrics, Director, UW Health Burn Center

References:

Pictures not from above: all have references listed near pictures

<https://ameriburn.org/education/advanced-burn-life-support-abls/>

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