Prehospital Trauma and the Golden Hour

..... All Bleeding Stops, But When........

Dave Duncan MD

CAL FIRE
CALSTAR
Objectives

- Brief Review of Trauma Demographics
- Cover Prioritization in Prehospital Trauma Management
  Focus = hemorrhage

1. Safety
2. Time (The Right Care at the Right Time)
3. Massive Hemorrhage
4. Airway
5. Breathing
6. Circulation
--- A 50/50 disease ---

Annual Trauma Deaths:
- World: 4,000,000
- US: 200,000
- California: 15,000

Ranking as cause of death
- #1 for age group 1-46 (causes 50% of the deaths for those under 50!)
- #3 as leading cause of death overall, across all age groups

Traumatic injury accounts for nearly half of all deaths for Americans under 46
But What About Life Years Lost ???

- “Life Years” are how we attach value to life!
- Average age for traumatic death = 36
  (about 40 “life years” lost)

Trauma is responsible for the most “Life Years” Lost
(more than Heart Disease and Cancer combined)
So How Do We Make A Difference???

The Golden Hour in Trauma: Dogma or Medical Folklore?
Frederick B. Rogers, MD, MS, FACS Medical Director, Trauma Program, LGH

HISTORICAL BACKGROUND

The term “golden hour” is widely attributed to R. Adams Cowley, founder of Baltimore’s famous Shock Trauma Institute. In a 1975 article, he stated:

“The first hour after injury will largely determine a critically-injured person’s chances for survival.”
What About the timing of a Trauma Death??

Trauma Deaths have a “Trimodal” distribution

Epidemiology

Trimodal Distribution of Trauma Deaths

- Golden Hour = 80% of trauma deaths in first hour after injury
- Rapid trauma care has greatest level of impact in these patients
Trauma Demographics

Of the 30% that die an “early death”

MOST OF THESE OCCUR IN THE FIRST HOUR!
Trauma Deaths ---- 50/50’s:
50% die on scene
50% are transported then die

Bleeding 45%
50% of these die in the first 2 hours

CNS injury 41%
Organ failure 10%
Other 4%
The *Golden Hour* is where we have drawn a PERFECT arbitrary line.

**THE EARLIER THE MINUTE, THE MORE LIKELY THE INTERVENTION WILL SAVE A LIFE**

Each Minute From Injury ------ deaths taper off
ZERO Preventable Deaths Program

A NATIONAL TRAUMA CARE SYSTEM

Integrating Military and Civilian Trauma Care Systems to Achieve Zero Preventable Deaths After Injury

The National Academies of
SCIENCES • ENGINEERING • MEDICINE
ZERO Preventable Deaths

Study Sponsors

- American College of Emergency Physicians
- American College of Surgeons
- National Association of Emergency Medical Technicians
- National Association of EMS Physicians
- Trauma Center Association of America
- U.S. Department of Defense’s U.S. Army Medical Research Command
- U.S. Department of Homeland Security’s Office of Health Affairs
- U.S. Department of Transportation’s National Highway Traffic Safety Administration
Evidence Based Medicine (EBM)
(Levels of Evidence for Clinical Application)

Level of evidence

1. Systematic reviews and meta-analyses
2. RCTs with definitive results*
3. RCTs with non-definitive results**
4. Cohort studies
5. Case-control studies
6. Cross-sectional surveys
7. Case reports
Evidence Based Medicine

What Really Happens!

- Systematic review and meta-analyses
- RCTs with definitive results*
- RCTs with non-definitive results**
- Cohort studies
- Case-control studies
- Cross-sectional surveys
- Case reports
But not everything lends itself to a prospective study!

Parachute use to prevent death and major trauma related to gravitational challenge: systematic review of randomised controlled trials

Gordon C S Smith, Jill P Pell

Abstract

Objectives To determine whether parachutes are effective in preventing major trauma related to gravitational challenge.

Design Systematic review of randomised controlled trials.

Data sources: Medline, Web of Science, Embase, and the Cochrane Library databases; appropriate internet sites and citation lists.

Study selection: Studies showing the effects of using a parachute during free fall.

Main outcome measure Death or major trauma, defined as an injury severity score > 15.

Results We were unable to identify any randomised controlled trials of parachute intervention.

Conclusions As with many interventions intended to prevent ill health, the effectiveness of parachutes has not been subjected to rigorous evaluation by using randomised controlled trials. Advocates of evidence based medicine have criticised the adoption of interventions evaluated by using only observational data. We think that everyone might benefit if the most radical protagonists of evidence based medicine organised and participated in a double blind, randomised, placebo controlled, crossover trial of the parachute.

Parachutes reduce the risk of injury after gravitational challenge, but their effectiveness has not been proved with randomised controlled trials.
The “Golden Hour”

The Golden Hour is hard to prove prospectively

- TCCC – Tactical Combat Casualty Care:
  “the Correct Intervention at the Correct Time”

Timely Interventions for those with preventable deaths!
The DoD Joint Trauma System evaluated compliance with this new ≤60-minute mandate and described patient injury, treatment, and transport time relative to morbidity and mortality outcomes. With the premise that battlefield casualties would benefit from reduced time between injury and care, and a firm belief that one hour was a matter of “A morale obligation to the troops,”…

…on June 15, 2009, Sec Def Robert M. Gates directed a ≤60-minute standard, from call to treatment facility arrival, for prehospital helicopter transport of U.S. military casualties with critical injury…cutting in half the previous goal of two hours, and aligning with the “Golden Hour” concept.

OBJECTIVES: To compare morbidity and mortality for casualties before vs after the mandate (2009) and for those who underwent prehospital helicopter transport in < 60 minutes, vs > 60 minutes.


RESULTS:

There was a decrease in median transport time from 90 min to 43 min; P < .001

For the total casualty population, the percentage killed in action went from: 16.0% to 9.9% - after golden hour mandate; P < .001

Missions achieving helicopter transport in < 60 minutes was 25% before vs 75% after mandate; P < .001.

When adjusted for injury severity score, the percentage killed in action was lower for those critically injured who received a blood transfusion 6.8% after mandate [40 of 589] vs 51.0% before mandate [249 of 488]; P < .001.)
Paramedic vs private transportation of trauma patients. Effect on outcome.

BACKGROUND:
Prehospital emergency medical services (EMS) play a major role in any trauma system. However, there is very little information regarding the role of prehospital emergency care in trauma. To investigate this issue, we compared the outcome of severely injured patients transported by paramedics (EMS group) with the outcome of those transported by friends, relatives, bystanders, or police (non-EMS group).

DESIGN:
We compared 4856 EMS patients with 926 non-EMS patients. General linear model analysis was performed to test the hypothesis that hospital mortality is the same in EMS and non-EMS cases, controlling for confounding factors.

SETTING: Large, urban, academic level I trauma center.

RESULTS:
The two groups were similar with regard to mechanism of injury and the need for surgery or intensive care unit admission. The crude mortality rate was 9.3% in the EMS group and 4.0% in the non-EMS group (relative risk, 2.32; P < .001). After adjustment for ISS, the relative risk was 1.60 (P = .002). Subgroup analysis showed that among patients with ISS greater than 15, those in the EMS group had a mortality rate twice that of those in the non-EMS group (28.8% vs 14.1%).

The adjusted mortality among patients with ISS greater than 15 was 28.2% for the EMS group and 17.9% for the non-EMS group (P < .001).

(Mortality for EMS transport was twice that of homie transport)

CONCLUSIONS:
Patients with severe trauma transported by private means in this setting have better survival than those transported via the EMS system. Large prospective studies are needed to identify the factors responsible for this difference ---- What??????
Increased mortality associated with EMS transport of gunshot wound victims when compared to private vehicle transport.

BACKGROUND:
Recent studies suggest that mode of transport affects survival in penetrating trauma patients. We hypothesised that there is wide variation in transport mode for patients with gunshot wounds (GSW) and there may be a mortality difference for GSW patients transported by emergency medical services (EMS) vs. private vehicle (PV).

STUDY DESIGN:
We studied adult (≥16 years) GSW patients in the National Trauma Data Bank (2007-2010). Level 1 and 2 trauma centres (TC) receiving ≥50 GSW patients per year were included. Proportions of patients arriving by each transport mode for each TC were examined. In-hospital mortality was compared between the two groups, PV and EMS, using multivariable regression analyses. Models were adjusted for patient demographics and injury severity.

RESULTS:
74,187 GSW patients were treated at 182 TCs. The majority (76%) were transported by EMS while 12.6% were transported by PV.

Unadjusted mortality was significantly different between PV and EMS (2.1% vs. 9.7%, p<0.001).

After adjustment for ISS and demographics: EMS transported patients had a greater than twofold odds of dying when compared to PV (OR=2.0, 95% CI 1.73-2.35).
SAFETY & TIME --- Safety First!

Tactical Combat Casualty Care (TCCC)

- The goals of (TCCC) are:
  1) Save preventable deaths
  2) Prevent additional casualties

- There are three categories of casualties on the battlefield:
  1. Those who will live regardless
  2. Those who will die regardless
  3. Those who will die from preventable deaths unless........

This is the group MEDICS can help the most.
- 60% Hemorrhage
- 33% Tension Pneumothorax
- 6% Airway Obstruction
Massive Hemorrhage

Patients can exsanguinate in a few minutes! (Really)

- Prioritize Methods of Hemorrhage Control
- Direct Pressure
- Pressure Dressing
- Wound Packing
- Hemostatic Agents
- Combat Application Tourniquet (CAT)
- TXA??
- Junctional Tourniquets?
- Reboa??
Massive Hemorrhage
(an NAEMSP evidence based algorithm)

Prehospital External Hemorrhage Control Protocol

Apply direct pressure/pressure dressing to injury

Direct pressure effective (hemorrhage controlled)

Direct pressure ineffective or impractical (hemorrhage not controlled)

Wound amenable to tourniquet placement (e.g. extremity injury)

Apply a tourniquet*

Wound not amenable to tourniquet placement (e.g. junctional injury)

Apply a topical hemostatic agent with direct pressure#

https://www.facs.org/~media/files/quality%20programs/trauma/education/acscot%20evidencebased%20prehospital%20guidelines%20for%20external%20hemorrhage%20control.ashx
Hemorrhage Control

Hemostatic Agent (EMSA approved products)

EMS Authority Approved Hemostatic Dressings
After an extensive review of the literature and advice from the Emergency Medical Services Medical Directors Association of California Scope of Practice Committee, the following hemostatic dressings are approved by the EMS Authority for use in the prehospital setting:

1. Quick Clot®, Z-Medica®
   a. Quick Clot®, Combat Gauze® LE
   b. Quick Clot®, EMS Rolled Gauze, 4x4 Dressing, TraumaPad®

2. Celox®
   a. Celox® Gauze, Z-Fold Hemostatic Gauze
   b. Celox® Rapid, Hemostatic Z-Fold Gauze

Note:
- The above products are “packaged” in various forms (ie Z-fold, rolled gauze, trauma pads, 4”x4” pads) and are authorized provided they are comprised of the approved product.
- Hemostatic Celox Granules, or granules delivered in an applicator, are not authorized.
Massive Hemorrhage Control
(pressure dressing, trauma dressing, Israeli Bandage)
Impact of Tourniquet Use
Kragh - Annals of Surgery 2009

- Ibn Sina Hospital, Baghdad, 2006
- Tourniquets saved lives on the battlefield.
- Survival was better when tourniquets were applied BEFORE casualties went into shock.
- 31 lives were saved in this study by applying tourniquets in the prehospital setting rather than in the ED
- An estimated 1000-2000 lives have been saved in the Afghanistan/Iraq wars to date by tourniquets. (Data provided to Army Surgeon General)
6. Circulation

- Different tissues have different life spans with ischemia: (keep the brain alive)
  - Brain: 6 minutes
  - Heart: 30 – 60 minutes
  - Gut: 1 - 2 hours
  - Skeleton: 6 hours

- No more high volume crystalloid resuscitation
  (except maybe with TBI - more to come)

- Blood Product Resuscitation: “1:1:1” (or 2:1:1)
  (Thanks to the DOD – whole blood is the ticket)
  - 1-2 PRBC
  - 1 FFP
  - 1 PLT
6. Circulation

- **Permissive hypotension** (or low volume fluid resuscitation) was first studied in 1994,

**The New England Journal of Medicine**

"Injection of a fluid that will increase blood pressure has dangers in itself. ... If the pressure is raised before the surgeon is ready to check any bleeding that might take place, blood that is sorely needed may be lost."
— Walter Cannon, 1918
**Results.** Among the 289 patients who received delayed fluid resuscitation, 203 (70 percent) survived and were discharged from the hospital, as compared with 193 of the 309 patients (62 percent) who received immediate fluid resuscitation ($P = 0.04$). The mean estimated intraoperative blood loss was similar in the two groups. Among the 238 patients in the delayed-resuscitation group who survived to the postoperative period, 55 (23 percent) had one or more complications (adult respiratory distress syndrome, sepsis syndrome, acute renal failure, coagulopathy, wound infection, and pneumonia), as compared with 69 of the 227 patients (30 percent) in the immediate-resuscitation group ($P = 0.08$). The duration of hospitalization was shorter in the delayed-resuscitation group.
6. Circulation (Permissive hypotension)


Liberal versus restricted fluid resuscitation strategies in trauma patients: a systematic review and meta-analysis of randomized controlled trials and observational studies

OBJECTIVE:
Hemorrhage is responsible for most deaths that occur during the first few hours after trauma. Animal models of trauma have shown that restricting fluid administration can reduce the risk of death; however, studies in patients are difficult to conduct due to logistical and ethical problems. To maximize the value of the existing evidence, we performed a meta-analysis to compare liberal versus restricted fluid resuscitation strategies in trauma patients.

STUDY SELECTION:
We selected randomized controlled trials and observational studies that compared different fluid administration strategies in trauma patients. There were no restrictions for language, population, or publication year.

DATA SYNTHESIS:
The quantitative synthesis indicated that liberal fluid resuscitation strategies might be associated with higher mortality than restricted fluid strategies, both in randomized controlled trials (risk ratio, 1.25; 95% CI, 1.01-1.55; three trials; I(2), 0) and observational studies (odds ratio, 1.14; 95% CI, 1.01-1.28; seven studies; I(2), 21.4%). When adjusted odds ratios were pooled for observational studies, odds for mortality with liberal fluid resuscitation strategies increased 26.3%

CONCLUSIONS:
Current evidence indicates that initial liberal fluid resuscitation strategies may be associated with higher mortality in injured patients. However, available studies are subject to a high risk of selection bias and clinical heterogeneity.
The survival of the patient with significant TBI is directly proportional to their SBP:

- Up to about 120
- 10% increased mortality for each 10 pt drop in SBP!

Spaite, et al
6. Circulation

- How about medications to help maintain blood volume in trauma ????
274 Hospitals

20,211 Patients

40 Countries
CRASH-2 Results: bleeding

- Deaths Due to Bleeding
- Deaths Due to All Other Causes
## CRASH-2 Results

“the results weren’t that impressive”

<table>
<thead>
<tr>
<th>Cause of Death</th>
<th>TXA</th>
<th>Placebo</th>
<th>Risk of Death</th>
<th>P-Value</th>
</tr>
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<tbody>
<tr>
<td>Death</td>
<td></td>
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<tr>
<td>Death</td>
<td>10,060</td>
<td>10,067</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bleeding</td>
<td>489</td>
<td>574</td>
<td>0.85 (0.76–0.96)</td>
<td>0.0077</td>
</tr>
<tr>
<td>Thrombosis</td>
<td>33</td>
<td>48</td>
<td>0.69 (0.44–1.07)</td>
<td>0.096</td>
</tr>
<tr>
<td>Organ failure</td>
<td>209</td>
<td>233</td>
<td>0.90 (0.75–1.08)</td>
<td>0.25</td>
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<tr>
<td>Head injury</td>
<td>603</td>
<td>621</td>
<td>0.97 (0.87–1.08)</td>
<td>0.60</td>
</tr>
<tr>
<td>Other</td>
<td>129</td>
<td>137</td>
<td>0.94 (0.74–1.20)</td>
<td>0.63</td>
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<tr>
<td>Any death</td>
<td>1463</td>
<td>1613</td>
<td>0.91 (0.85–0.97)</td>
<td>0.0035</td>
</tr>
</tbody>
</table>
CRASH-2 Results: bleeders

- \( \leq 1 \text{ hour} \)
  - RR (99% CI): 0.68 (0.54–0.86), \( p = 0.0001 \)

- >1 to \( \leq 3 \) hours
  - RR (99% CI): 0.79 (0.60–1.04), \( p = 0.033 \)

- >3 hours
  - RR (99% CI): 1.44 (1.04–1.99), \( p = 0.004 \)

- All Bleeding Patients
  - RR (99% CI): 0.85 (0.76–0.96), \( p = 0.0077 \)
“CRASH was done in 3rd World Countries”
Reduces mortality everywhere - particularly well in modern countries

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<tr>
<td>Asia</td>
<td>114</td>
</tr>
<tr>
<td>Latin America</td>
<td>56</td>
</tr>
<tr>
<td>Africa</td>
<td>52</td>
</tr>
<tr>
<td>EU, Australia, Canada</td>
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<td>World</td>
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</table>

*** Note: High Income Countries mortality risk reduction = 37% (3/4 of participants were moderate or high income countries)
RESULTS:

The TXA group had lower unadjusted mortality than the non-TXA group (17.4% vs. 23.9%, respectively; $P = .03$) despite being more severely injured (mean ISS = 25.2 vs. 22.5, respectively; $P < .001$).

This benefit was greatest in the massive transfusion group (TXA group mortality = 14.4% vs 28.1% in non-TXA group; $P=.004$).
TXA in Pediatric Trauma – Combat Setting

J Trauma Acute Care Surg. 2014 Dec;77(6):852-8;
Tranexamic acid administration to pediatric trauma patients in a combat setting: the pediatric trauma and tranexamic acid study (PED-TRAX)

SUMMARY:

- 766 patients < 18 yrs admitted to NATO hospital: 2008-2012
- Average age = 11
- 76% required surgery / 35% required Transfusion = SICK!!
- 66 (9%) received TXA
- TXA group had > ISS, Hypotension, Acidosis, Coagulopathy
- TXA group had markedly and significantly reduced mortality: Odds Ratio = 0.3 (P < .03)
- (30% mortality reduction)
Case 1 --- GSW to RUQ

- **3 yr old female** grabbed dad’s handgun from a cabinet ---- attempted to hand it to him ---- **shooting herself in the RUQ**
- Transported by ground to SRMC in extremis where she underwent DCS. Then deemed stable for transport to UCD --- about 1 hour post-op.
- Injuries: Liver, Diaphragm, R. Pneumo/Hemothorax, Shock
- CALSTAR arrived, completed logistics and lifted in 15 minutes
- VSS, blood and IV’s running.
- After lift child began to pour blood out of incision (8 min. flight)
- Delivered to UCD Trauma Bay in 15 minutes --- coded upon arrival.
Case #2 ----- MVA/Polytrauma

- 4/17/14
- 8 year old female
- 29.5kg
- Restrained front passenger in a “Razor” off road vehicle
- Helmeted / Belted
- Initial GCS 7
- Unresponsive with minimal respiratory effort ---- Dad gave rescue breaths
Initial Assessment

- **Head**
  - 2” lac above left eye
  - Blood in mouth and nose

- **Neck**
  - Trachea midline, no JVD

- **Chest**
  - 6” full thickness lac Right shoulder toward right nipple
  - Right clavicle crepitus

- **Neuro - GCS** 7 → 5
Initial Assessment

- **ABD**
  - Soft
  - Pelvis stable

- **Extremities**
  - Open right tib/fib fracture with 5” full thickness lac
  - Multiple exposed bone segments
  - No distal pulse
  - Significant bleeding controlled
**Treatment En Route**

- NRB 15lpm
- Spinal immobilization
- PIV- 18g Left AC, 20g right AC
- 100ml NS
- Repositioning right leg = positive pulses
- Transport to local hospital for airway management and stabilization
On Arrival Sierra Vista

- Decorticate posturing / GCS 4
- Intubated
  - Lidocaine 30mg
  - Etomidate 9mg
  - Succs 45mg
- Propofol gtt 20mcg/kg/min
- 1320: pH 7.21, \textit{PCO}_2 51.3
  \textit{PO}_2 324, Bicarb 20.7/-7
  H/H: 9.9/29
- 1325: 500ml LR bolus
- 1330: TXA 1gram/ 10mins
- 1 unit PRBC
Diagnosis and Findings

- Subarachnoid Hemorrhage, Subdural Hemorrhage, and diffuse axonal brain injury
- Closed fracture clavicle
- Open Comminuted Tib/ Fib fx with tissue loss
- Lung contusion
- Pneumothorax
- Hemothorax
- Small Liver Laceration
- C7, T6-8 spinal fx
Blood Products

- CRMC
  - 2 unit PRBC’s (3 total)
  - 1 unit FFP and 60ml Cryoprecipitate
The early minutes save preventable deaths

“the Correct Intervention at the Correct Time”

- ABOVE ALL DO NO HARM – Unnecessary procedures and lengthy scene times do harm
- Remember we can only save those that have preventable deaths....
- The right time for the intervention is different for every injury that is about to kill you: Consider this MCA vs Tree case:
  1) Facial Crush with Airway compromise and
  2) Expanding anterior neck hematoma:
    15 Minutes for RSI
  3) Tension Pneumothorax:
    20 Minutes for needle thoracostomy
  4) TBI with Hypoxemia and Hypotension:
    Correction ASAP to minimize secondary brain injury
  5) Grade 4 spleen and liver injury
    1 hour for TXA, Transfusion and to the OR
Questions ???

Contact:
Dave Duncan  daveduncanmd@gmail.com
PREHOSPITAL BURN CARE
OBJECTIVES

To gain an overview of the nature of burns, understand admit criteria for burn centers, and learn what to do with a burned patient before and during transport to a burn center.
What is a burn?
A burn is any injury to skin or tissues beneath it caused by:

- Heat — thermal, flash, electricity
- Cold — frostbite, bad decisions
- Radiation — chemo tx
- Chemicals — acid/bases, cleaners
- Friction — road rash
Who gets burned?

- The very young
- The very old
- The very unlucky
- The very careless

Most common ages: 2-4 and 17-25
Triage Info – cool to know – but always call a burn center!

<table>
<thead>
<tr>
<th>Age, in years</th>
<th>Percent TBSA burn size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-9  10-19  20-29  30-39  40-49  50-59  60-69  70-79  80-89  ≥ 90</td>
</tr>
<tr>
<td>0-1.9</td>
<td>Outpatient</td>
</tr>
<tr>
<td>2-4</td>
<td></td>
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<tr>
<td>5-19</td>
<td></td>
</tr>
<tr>
<td>20-29</td>
<td></td>
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<tr>
<td>30-39</td>
<td></td>
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<tr>
<td>40-49</td>
<td></td>
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<tr>
<td>50-59</td>
<td></td>
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<tr>
<td>60-69</td>
<td></td>
</tr>
<tr>
<td>≥ 70</td>
<td></td>
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</tbody>
</table>

*Note: TBSA refers to Total Burn Surface Area.*
Because burns are injury to skin, to understand a burn’s progression, you need to know skin.
Skin has three layers: the epidermis, dermis, and hypodermis (subcutaneous tissue).
Your dermis is the regenerative layer where skin cells grow.

It is not a renewable resource!

So the extent of any burn injury is really in relation to the injury to the dermis.

And our ability to help a person heal is in relation to if they have enough dermis left post-injury to heal locally, or to go around via grafts.
With that in mind, let’s look at types of burns you’ll see.

And discuss how to grade them in type and size.
SUPERFICIAL BURN

1st Degree

- Affects epidermis 1st layer of skin
- Pink to red
- Mild to moderately painful
- Heals 7-10 days, no scar
- No blistering
- Dry in appearance
- Does not count in TBSA
- These are your sunburns, your flash burns (from too standing near an explosion, like lighter fluid on a BBQ, but not getting fluid on you)

Dermis is OK!
First degree people are going to be cranky because it all hurts – just remember the last time you had a really bad sunburn! – but they’ll be all right.

Remember, superficial damage does not count towards TBSA – total burned surface area – which is how we’ll calculate fluid requirements shortly.
PARTIAL THICKNESS (2\textsuperscript{ND})

- Entire epidermis and upper layers of dermis
- Blisters present
- Wet appearing
- Blanching or slow to blanch
- Pink or cherry red
- Sensation present or diminished
- Healing times 10-21 days, severity of scarring varies
These are examples of partial thickness burns.

The epidermis is injured enough to have blistered, and the damage continues to the tissue underneath.

We will press on the skin repeatedly in different areas to see if it blanches – tissues that blanch still have adequate blood supply, whereas ones that don’t are deeper…
DEEP PARTIAL (2\textsuperscript{ND})

- Entire epidermis, most of dermis
- Red to white
- Sensation diminished to absent
- Blanching sluggish or absent
- Surgery, skin grafting
- Can convert
- Dry
That whiter area in the center there is deeper – chances are, when pressed on, it won’t blanch, which means it no longer has good perfusion and the tissue will most likely die (or is already dead.)

Remind me to discuss conversion in a moment!
THIRD DEGREE

- All layers destroyed/deep, extends to subcutaneous layer
- White, charred, black, eschar
- Non-blanching
- Fixed Hemoglobin
- Dry leathery
- Insensate
- Requires Surgery
Basically, total epidermal and dermis destruction:

Will require excision and grafting – and possible escharotomies and fasciotomies to maintain blood flow.
Don’t lose what you’ve got!

Check for FREQUENTLY distal pulses, warmth, capillary refill.

Loss or diminished pulses or delayed cap refill may indicate:

- Shock
- Inadequate resuscitation
- COMPARTMENT SYNDROME due to circumferential burns

This is a surgical emergency requiring prompt intervention!
FOURTH DEGREE

• Full thickness that extents to muscle and/or bone. Frequently due to electrical injuries.
• Amputation likely.
It’s important to remember that most burns are irregularly shaped – in all dimensions.

Certain areas can be deeper than others.

And areas that seem fine originally may convert and become worse as tissue dies.

Some burns take a few days to ‘declare’ their injuries fully.
ZONES OF BURNS

It’s all about perfusion:

No perfusion: tissue will die and require excision.

Compromised perfusion: may convert or recover

Increased perfusion: will most likely heal
How to calculate TBSA or total burned surface area:

- Lund and Browder chart
- Rule of 9s
- 1% palm rule – patient’s palm, not your own
- Remember not to count superficial injury!
Rule of 9

Front 18%

Back 18%

18% 18%

9%

9%

Surface area covered by patient’s hand with fingers closed = 1%
ABA Burn Center Transfer Criteria:

- Partial thickness burns of greater than 10% total body surface area.

- Burns that involve the face, hands, feet, genitalia, perineum or major joints.

- Third-degree burns in any age group.

- Electrical burns, including lightning injury.

- Chemical burns.
ABA Burn Center Transfer Criteria Cont:

- Inhalation injury
- Burn injury in patients with preexisting medical disorders that could complicate management, prolong recovery, or affect mortality.
- Burned children in hospitals without qualified personnel or equipment for the care of children.
- Burn injury in patients who will require special social, emotional or rehabilitative intervention.
Prehospital/Burn Center Care:

Stop the burning process! Then:

- Airway
- Breathing
- Circulation
Initial Management:

Stop the burning process!
100% NRB mask
Take off clothes & jewelry – wounds & edema
Examine body, head to toe, front to back

Then traditional trauma management:
C-spine?
Hemo/pneumothorax?
Fractures, abd damage?
Labs! Etc.

Don’t lose your cool! Burns scare people – but they won’t kill you as fast as an undiscovered/untreated trauma will.
Inhalation and Intubation
A significant amount of all fire deaths are related to the inhalation of toxic products of combustion – and can occur without a skin burn.
Events that lead to inhalation:

- Enclosed space – closets, cars
- Loss of consciousness in fire

Physical Signs of Inhalation Injury:

- Soot on face, tongue, teeth – soot in oropharynx
- Singed scalp, nasal, or facial hair
- Change in voice quality
Signs to Intubate:

- Signs of airway obstruction: hoarseness, stridor, accessory respiratory muscle use, sternal retraction
- Extent of the burn (TBSA burn > 40-50%)
- Extensive and deep facial burns
- Burns inside the mouth
- Significant edema or risk for edema
- Difficulty swallowing
• Signs of respiratory compromise: inability to clear secretions, respiratory fatigue, poor oxygenation or ventilation

• Decreased level of consciousness where airway protective reflexes are impaired

• Anticipated patient transfer of large burn with airway issue without qualified personnel to intubate en route
Inhalation S/S may be absent on admission -- but obstruction or closure may happen up to 24 hrs post-injury! External and internal edema have a parallel time course!
Perform frequent checks for increased WOB, stridor, wheezing.

Remember that intubations that can be done easily and safely earlier on may become impossible later.
CO & HCN considerations:

Carbon Monoxide has a higher affinity for hemoglobin. Pt can appear cherry red, but not always. Give 100% O2 via NRB.

HCN can be off-gased from burning plastics. If 100% O2 does not improve pt status consider antidote.
Fluid Resuscitation
Burn shock is hypovolemic shock!

Burns can cause hemodynamic changes:

- Generalized capillary leak
- Decreased plasma volume
- Decreased cardiac output
- Decreased end-organ perfusion
- Metabolic Acidosis
- Multisystem Organ Failure
- Death
Goals of Perfusion:

Maintain tissue perfusion and organ function

Lactated Ringer is best – mimics intravascular solute content.

How to perfuse?

Any which way you can!
IV, Central, IO
It is OK to put IVs thru burned skin if you have no other option.
Prehospital Fluid Starting Points – before calculating TBSA

- 5 years old and younger: 125 ml LR per hour
- 6 – 13 years old: 250 ml LR per hour
- 14 years and older: 500 ml LR per hour
But once you have the pt’s weight in kg and their % of 2\textsuperscript{nd} and 3\textsuperscript{rd} degree burns….

It’s Parkland time!
The Parkland Formula:

2mls X pts weight in kg X % of burned TBSA

- give half in the first 8 hrs
- the rest over the next 16
The Parkland Formula:

Ex: 70kg pt with a 50% TBSA burn….  

2mls x 70 x 50 = 7000 mls total

7000 / 2 = 3500, then / 8 hr = 437 mls/hr

3500 / 16 = 218 mls/hr for the 16 after that.
The Parkland Formula con’t:

For pedi pts (under 30 kg) – use 3 mls – and D5 maint.

For electrical injury – use 4 mls (help the kidneys flush!)
Keep in mind that Parkland Formula is only a starting point – fluid should be titrated according to UO (30-50 ml/hr).
Other Pre-Burn Center Pearls:

Only cool small wounds – major burns need to get to a burn center ASAP, and the delay to cool them may cause more harm.

Once the patient is naked, cover with clean dry dressings and transport. Don’t wash them or dress them otherwise, the center will handle that.

Don’t over-sedate – we need to assess neuro status too!
Test time!

Who needs to go to the burn center?
A patient with a burn walks in....

How big – how deep?
Located where?
Caused by?
& if you’re sure a burn center isn’t required...
• Premedicate patient
• Heat room & saline (if possible)
• Cleanse the wound gently – J&J baby soap
• Pop any blisters over 2cm
• Dress with either xeroform and bacitracin
• Or SSD for deeper areas
• Then wrap with gauze & instruct pt how to do drsgs

Whenever you are in doubt though – CALL!
Any questions?
If you’re interested in learning more about in-hospital burn care or going into more depth on the topic of burns, Santa Clara Valley Medical Center offers ABLS classes twice a year!