PATIENT CARE THEORY 2

UNIT 2, PART 2: Burn Trauma

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Burn Management for Paramedics

- smoke inhalation
- sources of burns
  - Products of combustion
- Pathophysiology
- burns and child abuse patterns
- measuring body surface area (BSA)


LEADING CAUSE OF DEATH
IN A FIRE
SMOKE INHALATION

Smoke Inhalation

- Smoke Inhalation is the most common cause of fire related death
- Carbon monoxide (CO) is the most common chemical of combustion
  - It is an odourless and colourless gas

Smoke Inhalation

- 50% - 80% of fire related deaths occur not because of burns, but because of smoke inhalation
- CO has an affinity for haemoglobin that is 200 times greater than O_2
- Hx...
  - *what was the length of exposure?
  - *enclosed space?
  - * what was burning?
  - * loss of consciousness?

Smoke Inhalation

- watch for the early signs of CO poisoning (COHb)
  - headache, “throbbing in the temples”
  - Dizziness, weakness or “flu-like” symptoms
  - tachypnea, tachycardia
- altered mental status, N/V
- coma, seizures

Carboxyhemoglobin > 15% (SpCO2) is significantly abnormal and requires treatment and > 25% is an indication for hyperbaric therapy

Smoke Inhalation

Treatment

- Hyper-oxygenate with supplemental O_2 for a min of 30 min.
- ventilatory assistance prn
- pulse oximetry will be of limited value – why?
  - Alternatives?

Hyperbaric treatments use high pressure oxygen to displace CO

CO

Screening for CO and MET using a RAD-57cm ™ CO-Oximeter

Rules: 1. Transport any symptomatic patient regardless of readings

2. For any SpCO reading > 5%, always check SpMET%

SpCO% Interpretation (carboxyhemoglobin):

0 – 5%	Normal in non-smokers
5 – 10%	Normal in smokers For non-smokers, assess for s/s, treat with high flow O2 if present
10 – 15%	(In any patient) assess for s/s, treat with high flow O2 if present
> 15%	•High flow O2 X 30 minutes then reassess •If SpCO remains > 10% or s/s present, transport
> 30%, or unconscious, or pregnant	Consider immediate transport to closest hyperbaric treatment facility

CARBON MONOXIDE LEVELS CHART

0 ppm	**Recommended Safe Level**	
6 ppm	WHO 24 Hour Average	
9 ppm	ASHRA 8 Hour Average EPA 8 hour 8 Hour Average NAAQS 8 Hour Average WHO 8 Hour Average	**Physical Symptoms** physical symptoms may include headache, fatique, dizziness and/or nausia.
25 ppm	ACGIH 8 Hour Average	
30 ppm	WHO 1 Hour Average	
35 ppm	NIOSH 8 Hour Average NAAQS 1 Hour Average	Physical symptoms after 6-8 hours.
50 ppm	OSHA 8 hour Average (PEL)	
30-69 ppm	UL 30 Day Alarm	
87 ppm	WHO 15 Minute Average	
70-149 ppm	UL 1-4 Hour Alarm	
200 ppm	NIOSH 15 minute STEL	Physical symptoms after 2-3 hours.
150-399 ppm	UL 10-50 Minute Alarm	Physical symptoms in 1-2 hours. Life threatening 3 hours.
400+ ppm	UL 4 Minute Alarm	Physical symptoms in 45 minutes. Unconscious in 2 hours. Fatal in 2-3 hours.
800 ppm		Physical symptoms in 20 minutes. Fatal within 1 hour.
1,600 ppm		**Physical symptoms in 5-10 minutes**. Fatal within 25-30 minutes.
3,200 ppm		Physical symptoms in 1-2 minutes. Fatal within 10-15 minutes.
6,400 ppm		Fatal within 1-3 minutes.
12,800 ppm		

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SENSOR SPECIALISTS

Hyperbaric Chamber - Why?

- Dalton's law- Increasing pressures increases amount of dissolved O_2
- HBOT (hyperbaric oxygen therapy) increases the atmospheric pressure to 2.5x that of normal
- Helps to displace the CO and increase the amount of O2 dissolved and available to the tissues

BURNS

Anatomy

Skin is the largest organ of the body

- Thermal regulation and prevention of fluid loss
- Hermetic (completely sealed) barrier against infection
- Contains sensory receptors that provide information about environment
- Disruption of the skin from burns may result in:
  - Hypothermia (we must keep patient warm)
  - Infection (we must wear PPE to protect the patient from us)
  - risk of injury

Anatomy - Skin is divided into two layers

- **Epidermis**: outermost layer composed of epithelial cells
  - Very thin layer; protects against bacteria and moisture loss
  - 0.07 to 0.12 mm thin (< 1 mm in most areas)
  - no blood supply
  - outer surface cells die and are sloughed off as newer cells divide at the stratum germinativum (basal layer).
- **Dermis**: middle layer composed of primarily connective tissue & collagen.
  - It contains capillaries that nourish the skin, sweat glands, nerve endings, and hair follicles

Subcutaneous tissue(hypodermis): This is a layer of adipose and loose connective tissue between the skin and underlying organs/muscles/etc

Pathophysiology

- skin nearest heat source suffers most profound changes (Zone of Coagulation)
- Cell membranes rupture and are destroyed
- blood coagulates

lots of water and potassium (main instracellular ion) lost

- structural proteins begin to denature (break down and coagulate) - skin layers rapidly coagulate
- Cytokines and histamine release from the burn causes capillaries to dilate and leak; blood plasma is lost as it seeps into the interstitial space

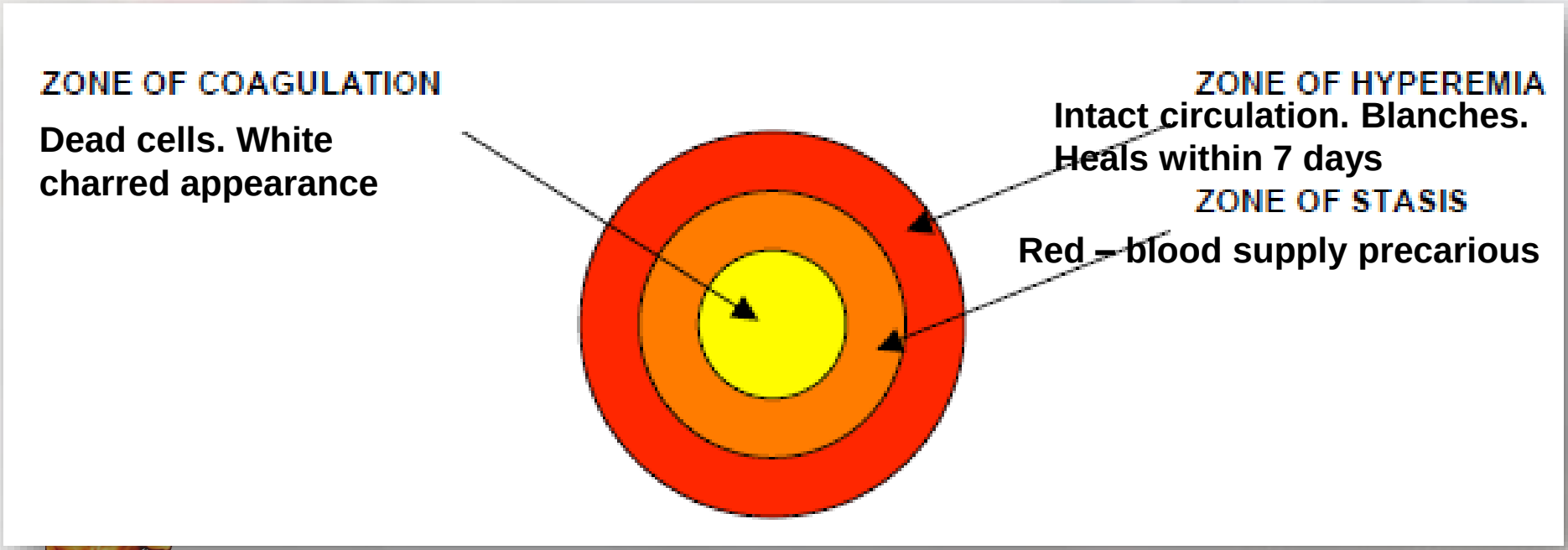
Pathophysiology

- Continued damage to tissue releases leukotrienes, prostaglandins, oxygen free radicals and histamine
- Larger burns (>30%): leads to a systemic increase of capillary permeability
  - results in hypovolemia & poor tissue perfusion.
  - vicious circle begins

inflammatory response causes capillary dilation, causing intravascular fluid to leak, and hypotensionC

Pathophysiology

- thermal burns cause several effects collectively termed "Jackson's Theory of Thermal Wounds“
- There are 3 zones:

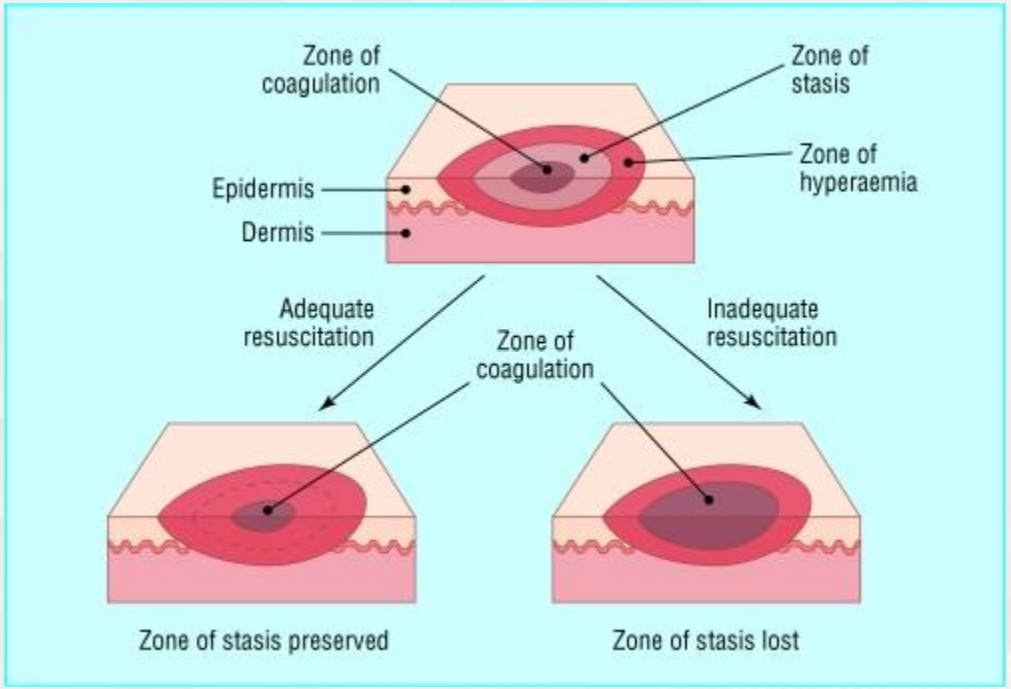


Zone of Coagulation

- Point of maximum damage
  - Irreversible tissue damage

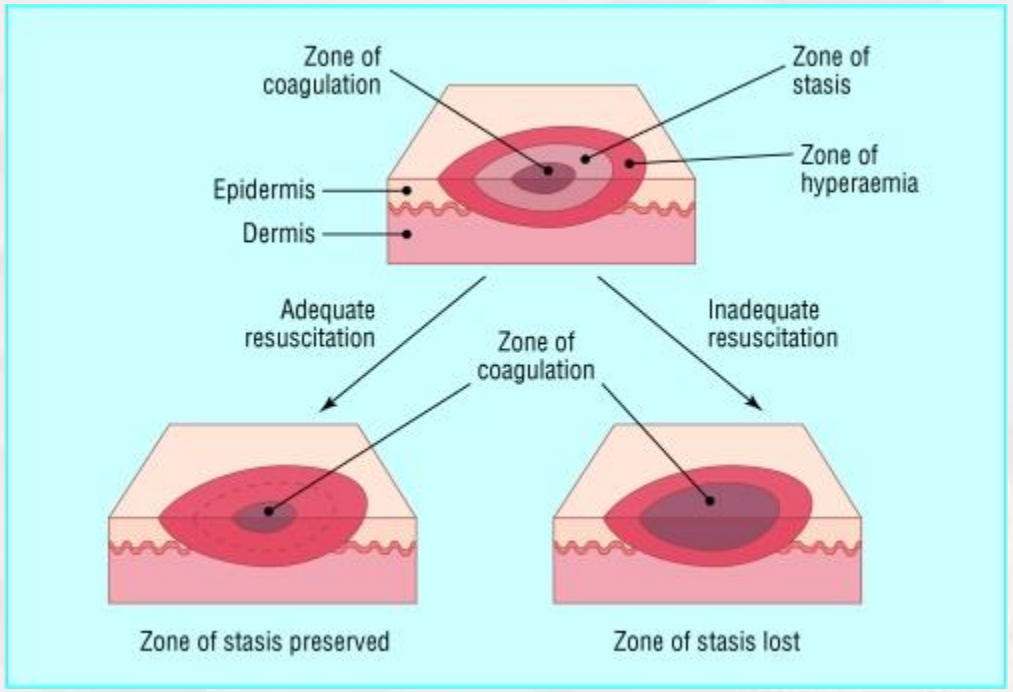
Zone of Stasis

- Surrounds the zone of coagulation
  - Decreased tissue perfusion
  - Potentially salvageable tissue



Zone of Hyperemia

- Outermost zone
  - Better tissue perfusion
  - Will recover unless prolonged hypoperfusion or
  - severe sepsis occurs



Body's Response To Burns

- Emergent Phase (Stage 1)
  - Happens Immediately
  - Pain response
  - Catecholamine release
  - Tachycardia, tachypnea, mild hypertension, mild anxiety
- Fluid Shift Phase (Stage 2)
  - Length 18-24hrs
  - Begins after Stage 1; reaches peak in 6-8 hours
  - Damaged cells initiate inflammatory response
    - Increased blood flow to cells
    - Shift of fluid from intravascular to extravascular space*
      - MASSIVE EDEMA
      - "Leaky Capillaries"

Body's Response To Burns

- **Hypermetabolic Phase (Stage 3)**
  - Last for days to weeks
  - Large increase in the body's need for nutrients as it repairs itself
- **Resolution Phase (Stage 4)**
  - Scar formation
  - General rehabilitation and progression to normal function

Systemic Complications

- Hypothermia
  - Disruption of skin and its ability to thermoregulate
- Hypovolemia
  - Shift in proteins, fluids, and electrolytes to the burned tissue
  - Loss of osmotic pressure
  - General electrolyte imbalance
- Eschar (Es-Kar)
  - Type of dead tissue
  - Hard, leathery product of a deep full thickness burn
  - Dead and denatured skin constricts over the wound → Increased pressure from edema and restricts blood flow

Systemic Complications

- Infection
  - Greatest risk of burn is infection
- Organ Failure
  - Kidneys (failure)
  - Liver (failure)
  - Heart (dysrhythmias)
- Special Factors
  - Age & Health
- Physical Abuse
  - Elderly, Infirm or Young

Burns- Major Sources

- Thermal
  - Flame – up to 50% of adult burns
    - Associated with inhalation and other trauma
  - Scald – Commonly seen in children and elderly
  - Contact – direct touch
  - Flash – arc from high voltage source
  - Electrical
    - Domestic (low voltage AC)
    - Commercial/ high voltage (1000V or more)
  - Friction
  - Radiation

https://pmc.ncbi.nlm.nih.gov/articles/PMC421790/

Burns - Thermal

Flames

- poorly ventilated spaces = reduced oxygen content or increased carbon dioxide/monoxide concentration
- oxygen concentration may drop from the normal 21 per cent to as low as 15 per cent before it causes fatigue
- danger from carbon monoxide poisoning (4000 ppm produces coma and death)

Burns - Thermal

Flames

- Cyanide (e.g. nylon, wool, polyurethane, urea-formaldehyde), hydrogen chloride (plastics), and acrolein are common toxic products of combustion
- Freon gas from burning appliances can lead to latent death
- Polyvinyl Chloride (plastics) when burned produces hydrogen chloride which is more toxic than CO
- ** important to report what was burning as much as possible

Burns - Thermal

Flames

- small concentrations of hydrogen chloride and ammonia cause direct irritation of the respiratory tract and the eyes and can impede a victims ability to escape, causing death
- Inhalation injury mortality is 10-30%. This increases with TBSA burns
  - **Be highly suspicious of inhalation injury if the patient was in an enclosed space for a minute or more**
- more victims are claimed by the products of fire than by burns[1] (chemicals)

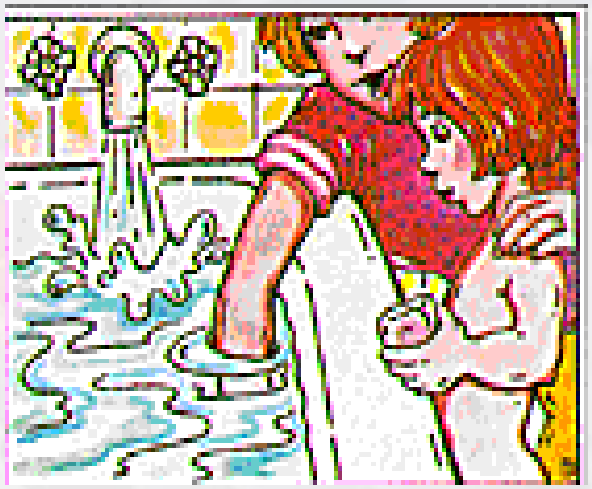
Water Burns

- Bathtub/sink when only turned-on hot water or turned off cold
- Hot water spilled/splashed
- Patient burned/scalded while stepping or being put into bathtub
- hot tap water (misc.)
- climbed into or fell into a bathtub or sink

Water Burns

Water Temperature	Time required for a full thickness burn
68° C (155° F) 64° C (148° F) 60° C (140° F)	1 second 2 seconds 5 seconds
56° C (133° F) 52° C (126° F)	15 seconds 1 minute
51° C (124° F) 48° C (120° F)	3 minutes 5 minutes
37° C (98.6° F) is a safe temperature for a bath	

Water Burns



- Home hot water should NOT exceed 48^{o} C
- FYI: hot tubs are kept at $\leq$ 40^{o} C (104 F)

Inhalation Burns

- thermal burn below the glottis is uncommon
- exposure to steam may produce DEEP airway burns
- chemical burns may produce massive pulmonary edema and difficulty in ventilation

Additional Reading

Burns: Emergency Care
https://ptolemy.library.utoronto.ca/content/burns-emergency-care

eMedicine
http://www.emedicine.com/EMERG/topic72.htm

Burnsurgery.org
http://www.burnsurgery.com/Betaweb/Modules/BurnWound/part_v.htm

About Burn Injuries
http://www.burn-recovery.org/injuries.htm

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2. National Research Council Canada: CBD-144. Toxic Gases and Vapours Produced at Fires. *K. Sumi, Y. Tsuchiya. http://irc.nrc-cnrc.gc.ca/cbd/cbd144e.html*
3. Library of the National Medical Society. http://www.medical-library.org
4. J. Fisher. Acute Burn Management: University of Toronto Department of Surgery. http://surgclerk.med.utoronto.ca/Burn/objectiv.htm
5. *Helman, A. Fish, J. Ivankovic, M. Kovacs, G. Burn and Inhalation Injuries: ED Wound Care, Resuscitation and Airway Management. Emergency Medicine Cases. May, 2019. https://emergencymedicinecases.com/burn-inhalation-injuries/. Accessed [January 10,2020]*

Questions?