How to Avoid a Meltdown: a warm-up on burns and initial management in pediatric patients (and adults)

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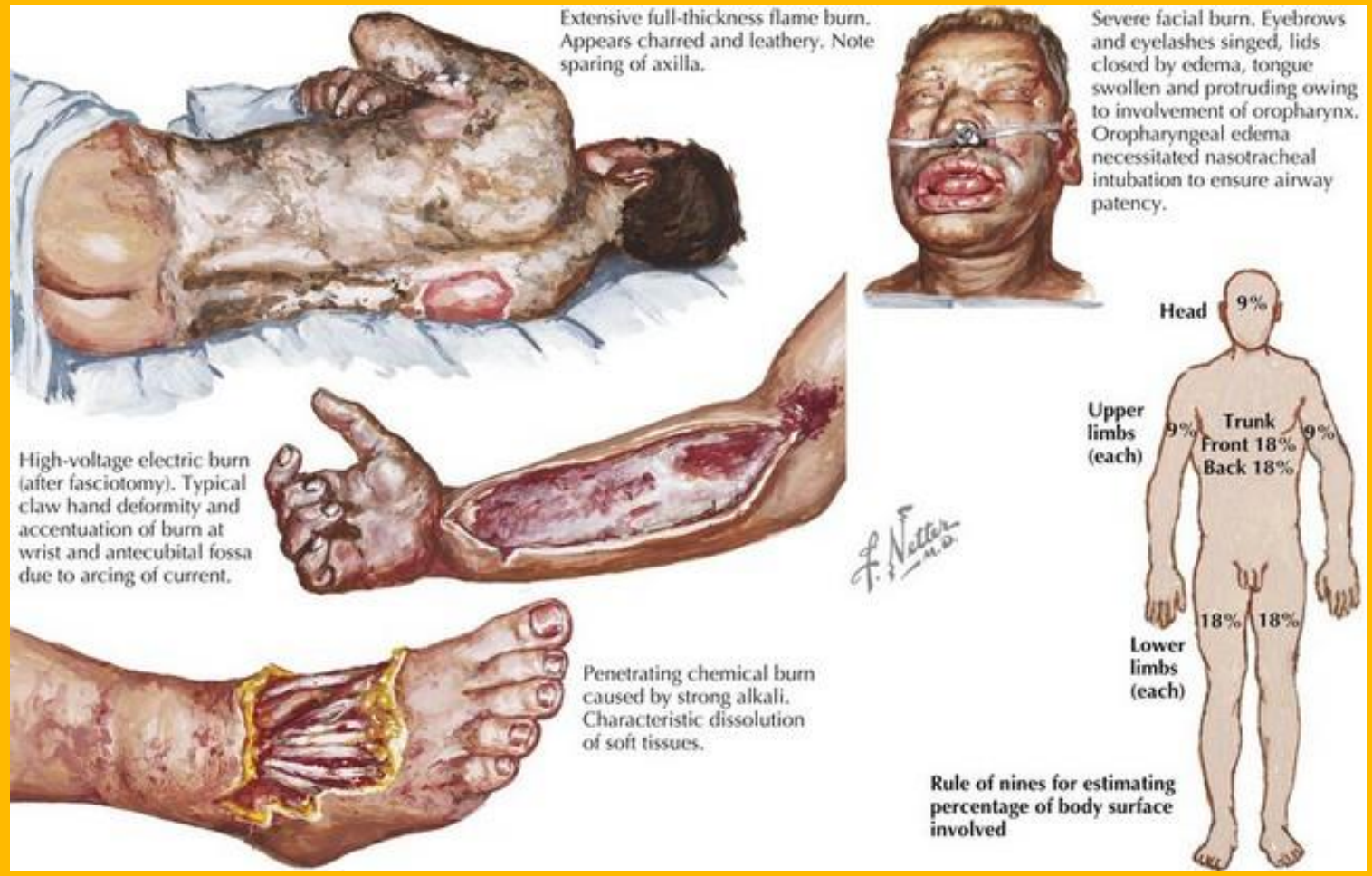
Anyone. Anytime. Anywhere.

The injuries can be caused by cold, heat, radiation, chemical or electric sources, but most burn injuries are caused by heat from hot liquids, solids or fire.

Severe burn injuries also produce a profound hypermetabolic stress response



Demographics

40,000 annual hospital admissions, 1/3 are pediatric patients

House fires are the leading cause

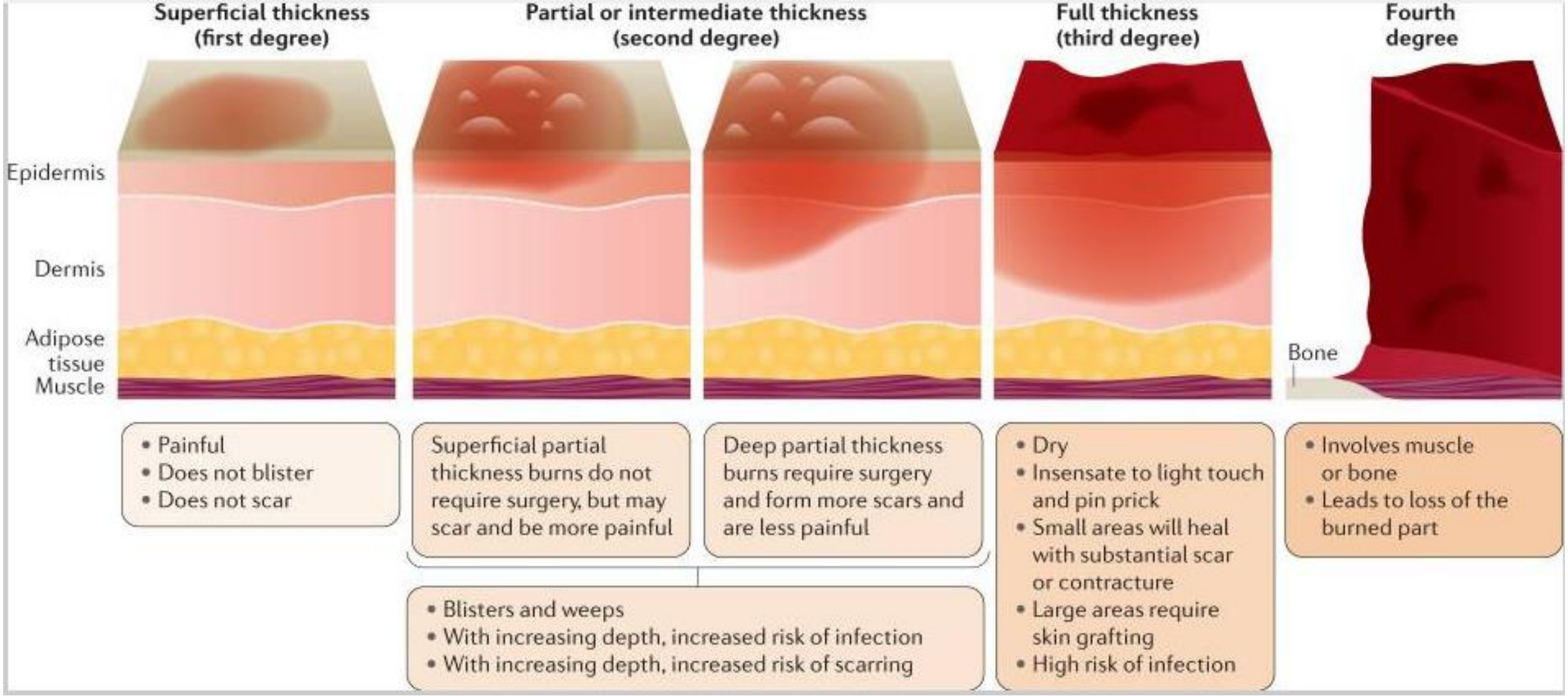
- Children under 5 are at a higher risk

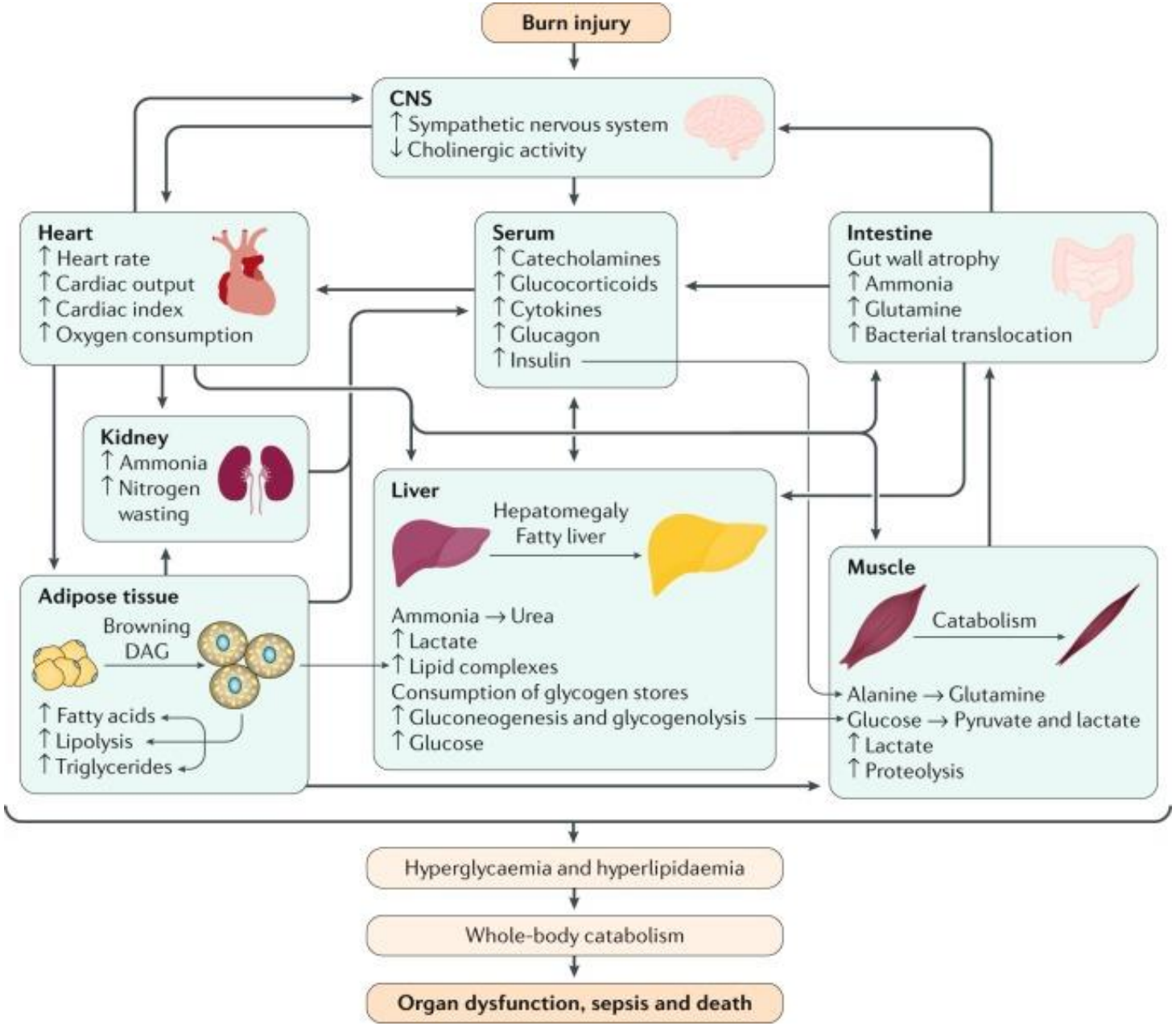
Scald Burns are the most common mechanism of injury among pediatric patients

- 71% of all burn injuries nationwide

Flame burns are the dominant cause of burns in adolescents and are associated with increased severity and need for hospitalization compared to other burns.

Case 1


Superficial thickness (first degree)
Partial or intermediate thickness (second degree)
Full thickness (third degree)
Fourth degree
Epidermis
Dermis
Adipose tissue
Muscle
Bone
• Painful
• Does not blister
• Does not scar
Superficial partial thickness burns do not require surgery, but may scar and be more painful
Deep partial thickness burns require surgery and form more scars and are less painful
• Blisters and weeps
• With increasing depth, increased risk of infection
• With increasing depth, increased risk of scarring
• Dry
• Insensate to light touch and pin prick
• Small areas will heal with substantial scar or contracture
• Large areas require skin grafting
• High risk of infection
• Involves muscle or bone
• Leads to loss of the burned part

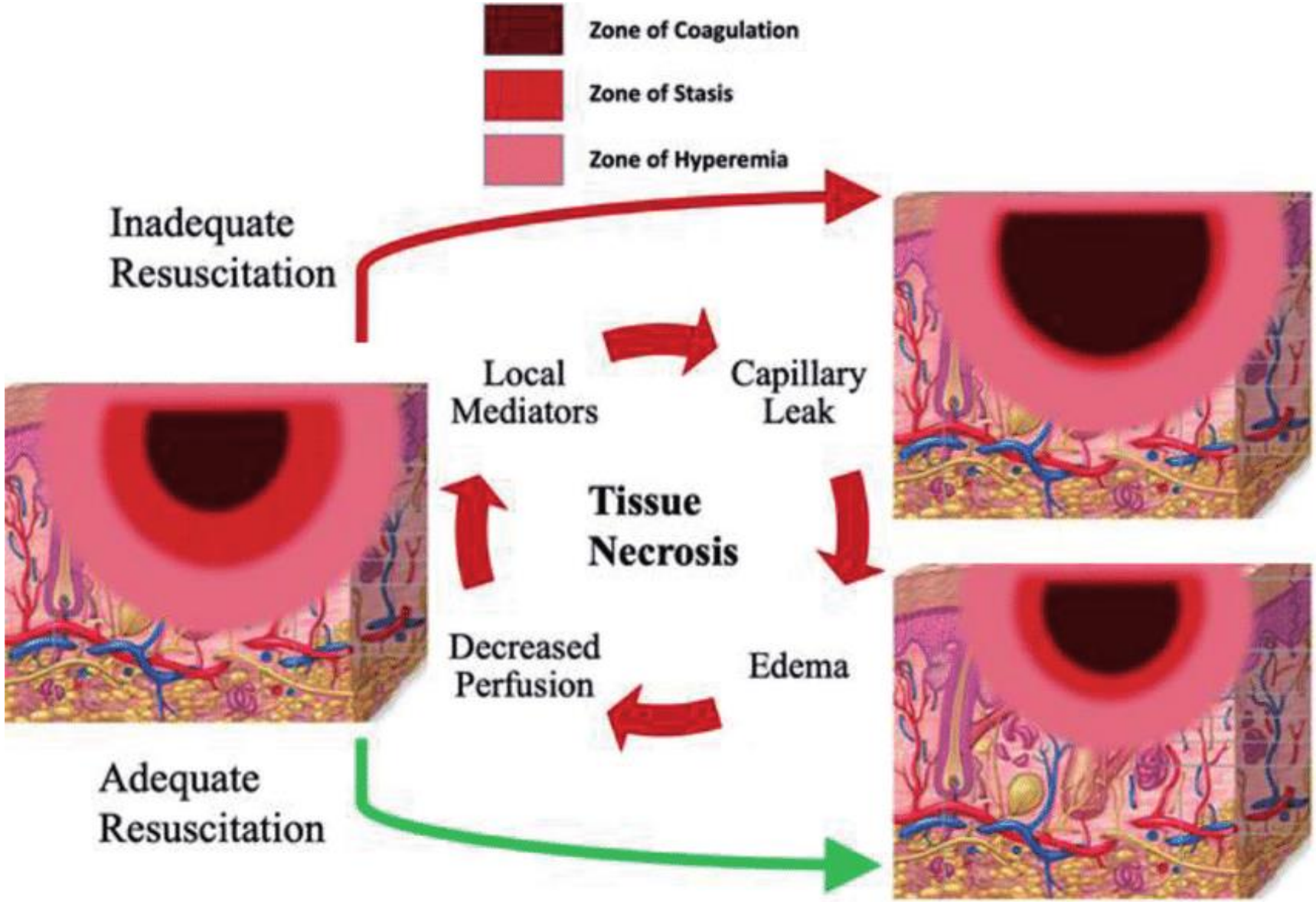

Burn injury
CNS
↑ Sympathetic nervous system
↓ Cholinergic activity
Heart
↑ Heart rate
↑ Cardiac output
↑ Cardiac index
↑ Oxygen consumption
Serum
↑ Catecholamines
↑ Glucocorticoids
↑ Cytokines
↑ Glucagon
↑ Insulin
Intestine
Gut wall atrophy
↑ Ammonia
↑ Glutamine
↑ Bacterial translocation
Kidney
↑ Ammonia
↑ Nitrogen wasting
Liver
Hepatomegaly
Fatty liver
Ammonia → Urea
↑ Lactate
↑ Lipid complexes
Consumption of glycogen stores
↑ Gluconeogenesis and glycogenolysis
↑ Glucose
Muscle
Catabolism
Alanine → Glutamine
Glucose → Pyruvate and lactate
↑ Lactate
↑ Proteolysis
Adipose tissue
Browning
DAG
↑ Fatty acids
↑ Lipolysis
↑ Triglycerides
Hyperglycaemia and hyperlipidaemia
Whole-body catabolism
Organ dysfunction, sepsis and death

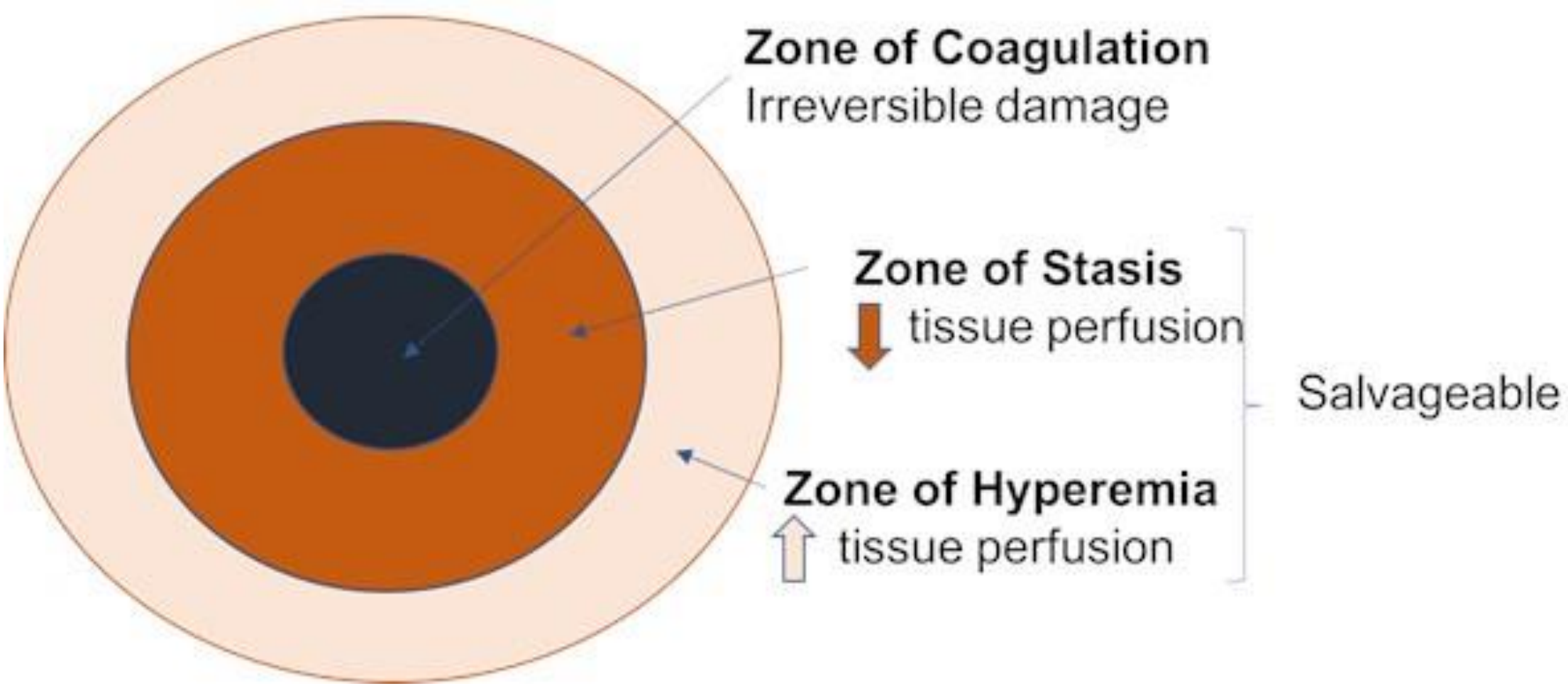
Severe burns, regardless of cause, result in the development of an extremely dysregulated inflammatory host response.

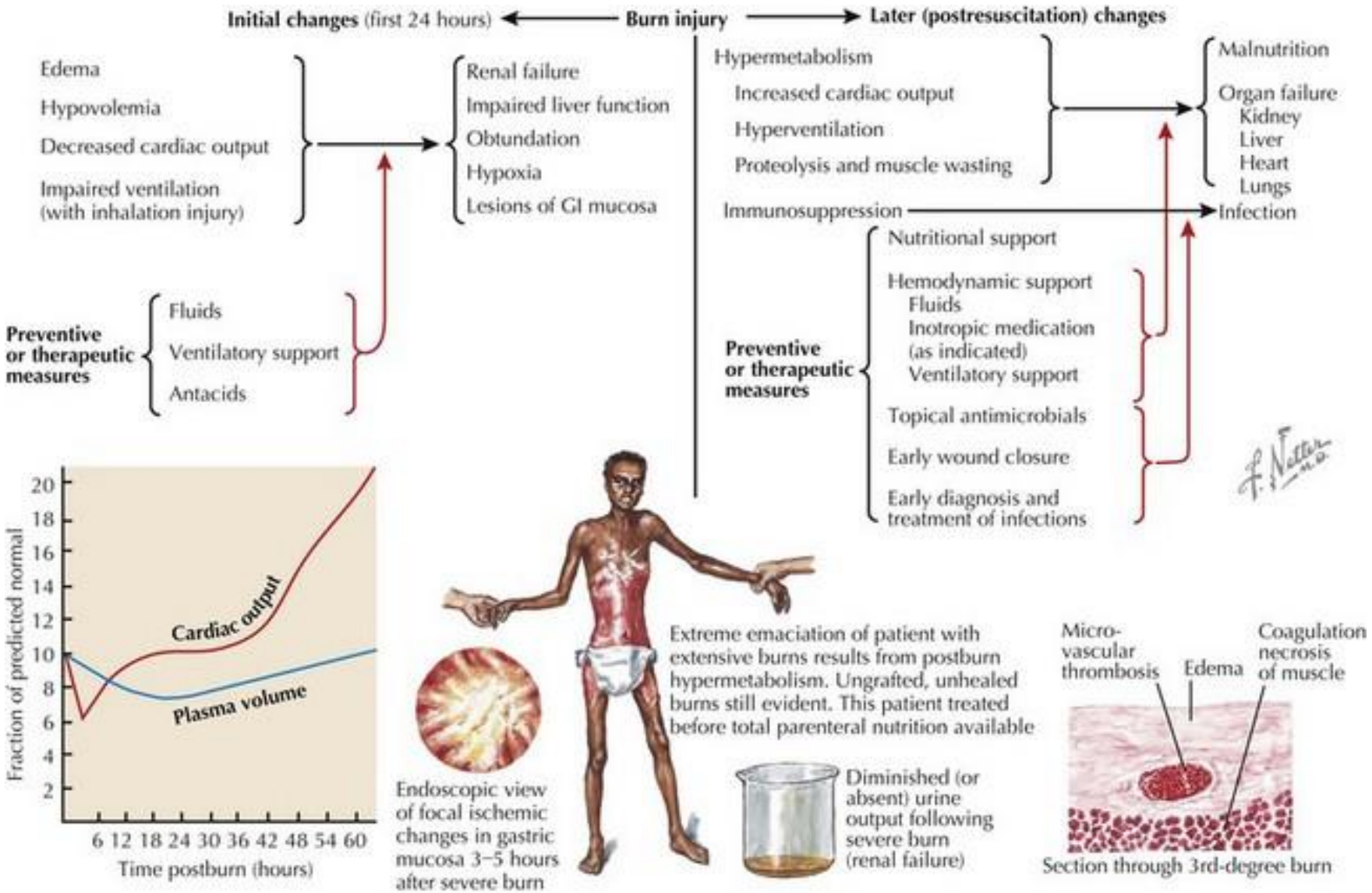
- Elevated cytokines, chemokines and acute phase proteins
- Hypermetabolic state

Factors to consider:

- Burn severity (percent TBSA, depth)
- Cause
- Inhalation injury
- Exposure to toxins
- Trauma
- Patient age, medical history, drug use, delays in care


Zone of Coagulation
Zone of Stasis
Zone of Hyperemia
Inadequate Resuscitation
Local Mediators
Capillary Leak
Tissue Necrosis
Edema
Decreased Perfusion
Adequate Resuscitation


Zone of Coagulation
Irreversible damage
Zone of Stasis
tissue perfusion
Zone of Hyperemia
tissue perfusion
Salvageable


Initial changes (first 24 hours)
Burn injury
Later (postresuscitation) changes
Edema
Hypovolemia
Decreased cardiac output
Impaired ventilation (with inhalation injury)
Renal failure
Impaired liver function
Obtundation
Hypoxia
Lesions of GI mucosa
Hypermetabolism
Increased cardiac output
Hyperventilation
Proteolysis and muscle wasting
Malnutrition
Organ failure
Kidney
Liver
Heart
Lungs
Immunosuppression
Infection
Preventive or therapeutic measures
Fluids
Ventilatory support
Antacids
Nutritional support
Hemodynamic support
Fluids
Inotropic medication (as indicated)
Ventilatory support
Topical antimicrobials
Early wound closure
Early diagnosis and treatment of infections
Fraction of predicted normal
Cardiac output
Plasma volume
Time postburn (hours)
Endoscopic view of focal ischemic changes in gastric mucosa 3–5 hours after severe burn
Extreme emaciation of patient with extensive burns results from postburn hypermetabolism. Ungrafted, unhealed burns still evident. This patient treated before total parenteral nutrition available
Diminished (or absent) urine output following severe burn (renal failure)
Micro-vascular thrombosis
Edema
Coagulation necrosis of muscle
Section through 3rd-degree burn

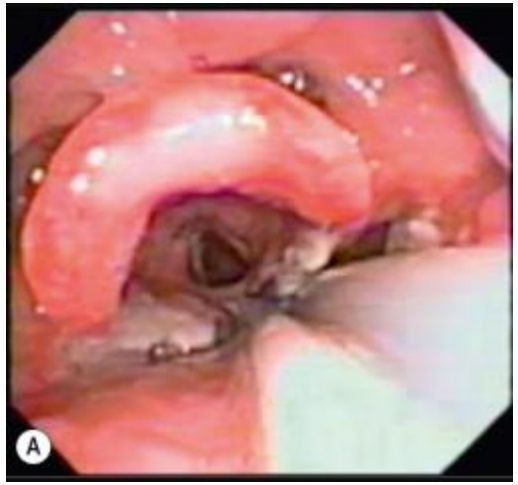
Other Injuries

Inhalation Injury

- Respiratory tract or lung tissue
- Increases risk of pulmonary complications including VAP, fluid requirements and mortality
- Clinical signs: stridor, hoarseness, carbonaceous sputum, dyspnea
- Evaluate posterior pharynx for evidence of thermal injury

Associated with Trauma

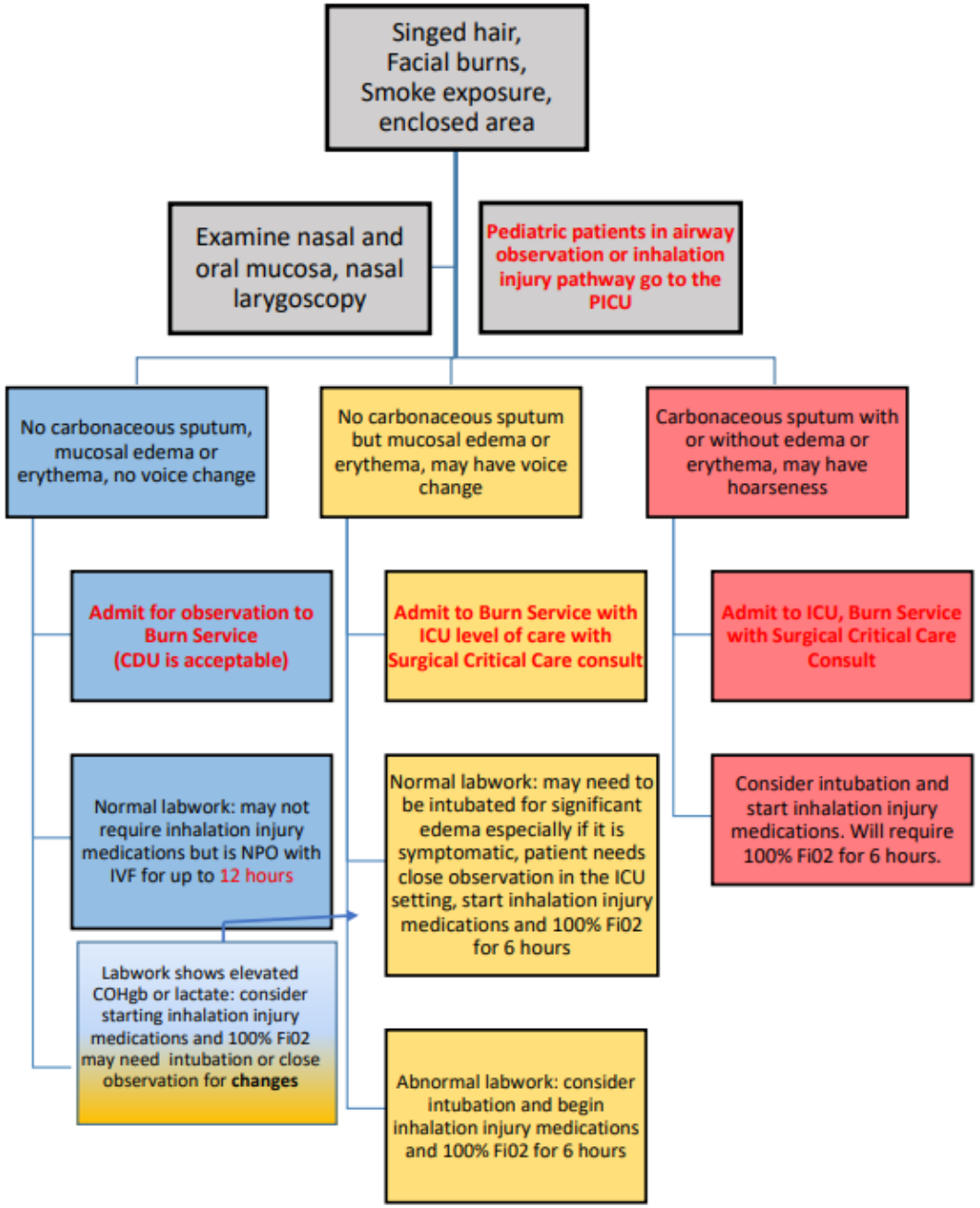
- TBI, abdominal or thoracic cavity, fractures, complex soft tissue injuries (crush vs degloving injuries)
- Have worse outcomes than those without traumatic injuries



Multiorgan System Failure

- Brain atrophy, acute renal failure, liver failure, gut atrophy
- Primary cause of >70% of all burn related deaths

Figure 1: Upper Airway Thermal and Lower Airway Inhalation Injury Algorithm



Cyanide Toxicity

Dosing—ADULT (≥16 years old and ≥40kg)

CYANOKIT (Hydroxocobalamin) 5000mg/200mL infuse over 15 minutes (~15mL/min)

Dosing—PEDIATRIC (<16 years old)

Dosages on chart calculated to provide 70mg/kg using CYANOKIT (Hydroxocobalamin) 5000mg diluted with 200mL having a Final CONCENTRATION of 25mg/mL

5kg	8kg	10kg	12kg	15kg	20kg	25kg	30kg	35kg	40kg	45kg	50kg
14mL= 350mg	22mL= 550mg	28mL= 700mg	34mL= 850mg	42mL= 1050mg	56mL= 1400mg	70mL= 1750mg	84mL= 2100mg	98mL= 2450mg	112mL= 2800mg	126mL= 3150mg	140mL= 3500 mg

Life threatening toxicity *

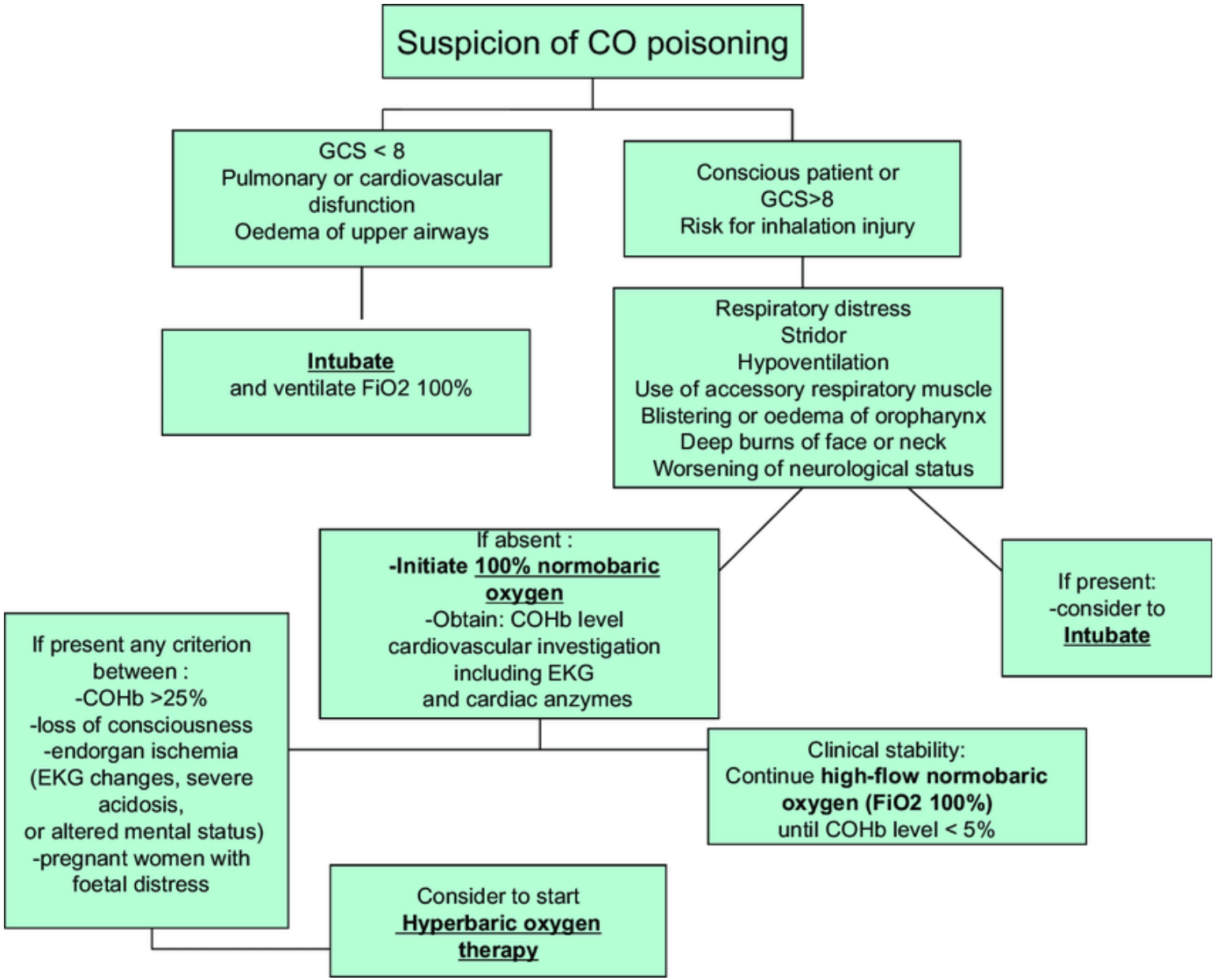
(*can lead to irreversible injury and death w/in minutes)

- Dyspnea/Respiratory Depression/Apnea
- Hypotension w/o clear etiology
- Arrhythmias/cardiac arrest
- Coma and/or seizure
- Lactate ≥10 mmol/L

Carbon Monoxide

Clinical presentation depends on level of exposure.

Tension headache, dizziness, nausea, vomiting, stomachache, confusion, shortness of breath, cognitive impairment



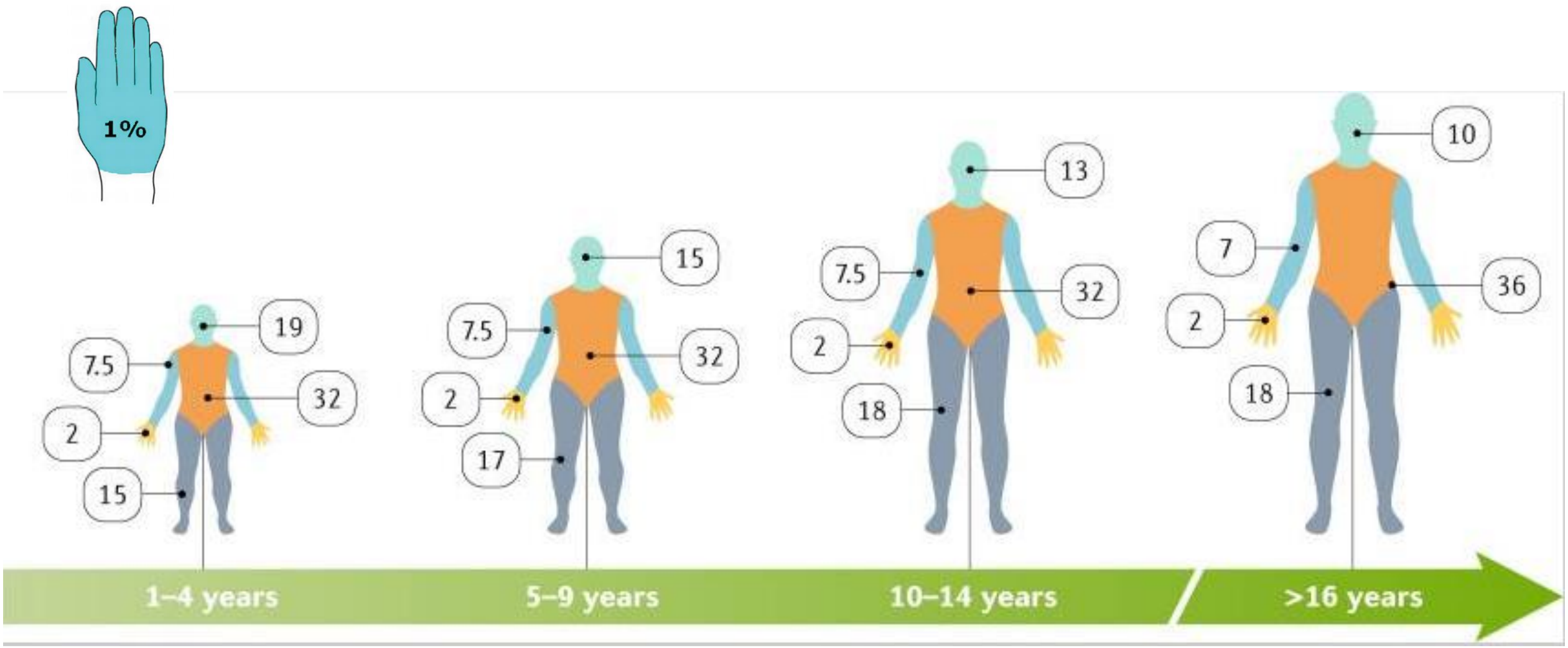
What happens when a fire tells a joke about you?

You get burned.

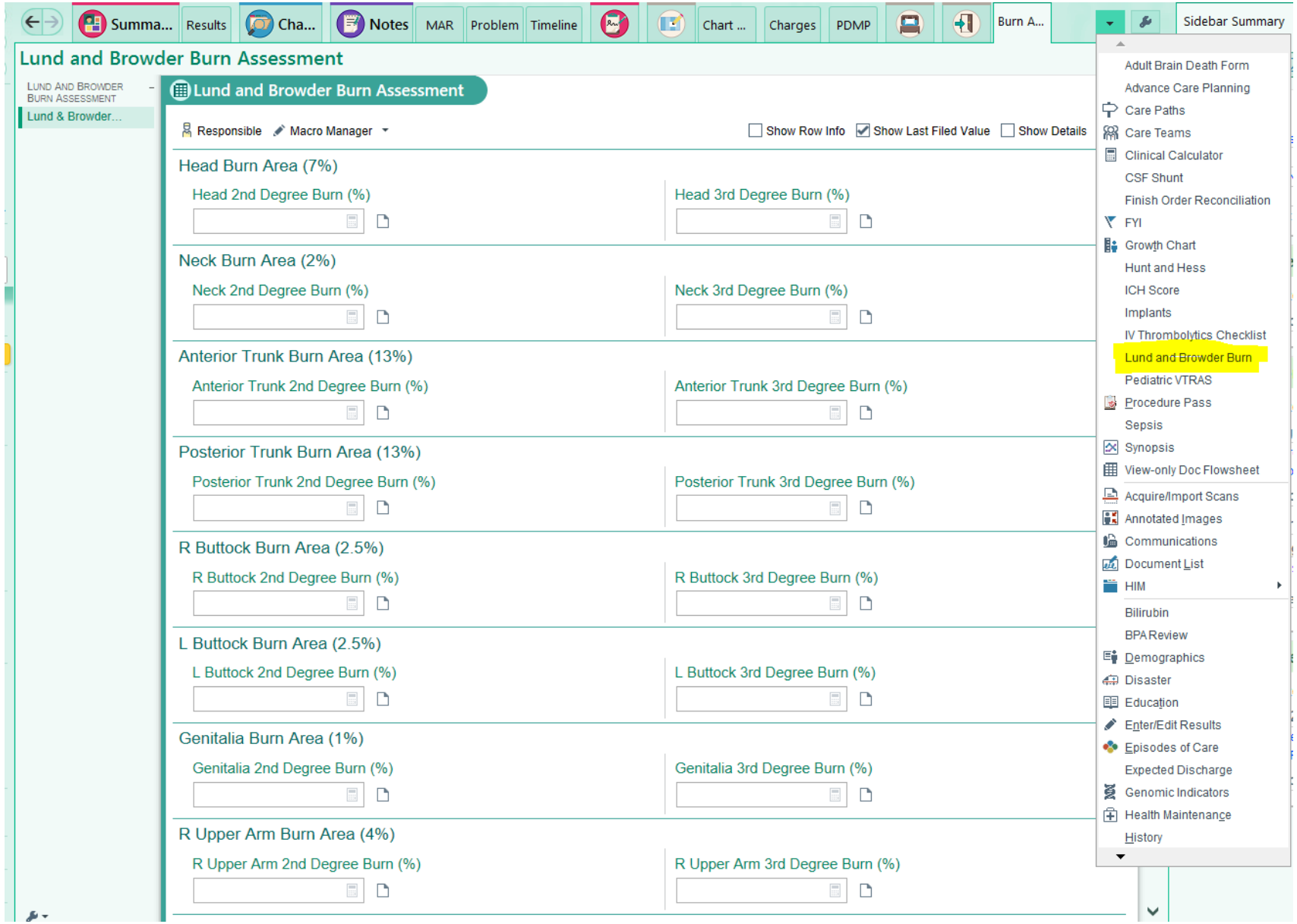
Case 2

30M presenting found outside a 2-story building that is on fire. Patient required endotracheal intubation in the field and presents to the emergency room. His vital signs are BP 113/65 HR 110 T 35.5 C RR 12 SaO2 98%.

You are the only surgeon on call.


1%
19
7.5
32
2
15
15
7.5
32
2
17
13
7.5
32
2
18
10
7
36
2
18
1–4 years
5–9 years
10–14 years
>16 years

VCU Health


Summa...
Results
Cha...
Notes
MAR
Problem
Timeline
Chart ...
Charges
PDMP
Burn A...
Sidebar Summary
Lund and Browder Burn Assessment
LUND AND BROWDER BURN ASSESSMENT
Lund & Browder...
Lund and Browder Burn Assessment
Responsible
Macro Manager
Show Row Info
Show Last Filed Value
Show Details
Head Burn Area (7%)
Head 2nd Degree Burn (%)
Head 3rd Degree Burn (%)
Neck Burn Area (2%)
Neck 2nd Degree Burn (%)
Neck 3rd Degree Burn (%)
Anterior Trunk Burn Area (13%)
Anterior Trunk 2nd Degree Burn (%)
Anterior Trunk 3rd Degree Burn (%)
Posterior Trunk Burn Area (13%)
Posterior Trunk 2nd Degree Burn (%)
Posterior Trunk 3rd Degree Burn (%)
R Buttock Burn Area (2.5%)
R Buttock 2nd Degree Burn (%)
R Buttock 3rd Degree Burn (%)
L Buttock Burn Area (2.5%)
L Buttock 2nd Degree Burn (%)
L Buttock 3rd Degree Burn (%)
Genitalia Burn Area (1%)
Genitalia 2nd Degree Burn (%)
Genitalia 3rd Degree Burn (%)
R Upper Arm Burn Area (4%)
R Upper Arm 2nd Degree Burn (%)
R Upper Arm 3rd Degree Burn (%)
Adult Brain Death Form
Advance Care Planning
Care Paths
Care Teams
Clinical Calculator
CSF Shunt
Finish Order Reconciliation
FYI
Growth Chart
Hunt and Hess
ICH Score
Implants
IV Thrombolytics Checklist
Lund and Browder Burn
Pediatric VTRAS
Procedure Pass
Sepsis
Synopsis
View-only Doc Flowsheet
Acquire/Import Scans
Annotated Images
Communications
Document List
HIM
Bilirubin
BPA Review
Demographics
Disaster
Education
Enter/Edit Results
Episodes of Care
Expected Discharge
Genomic Indicators
Health Maintenance
History

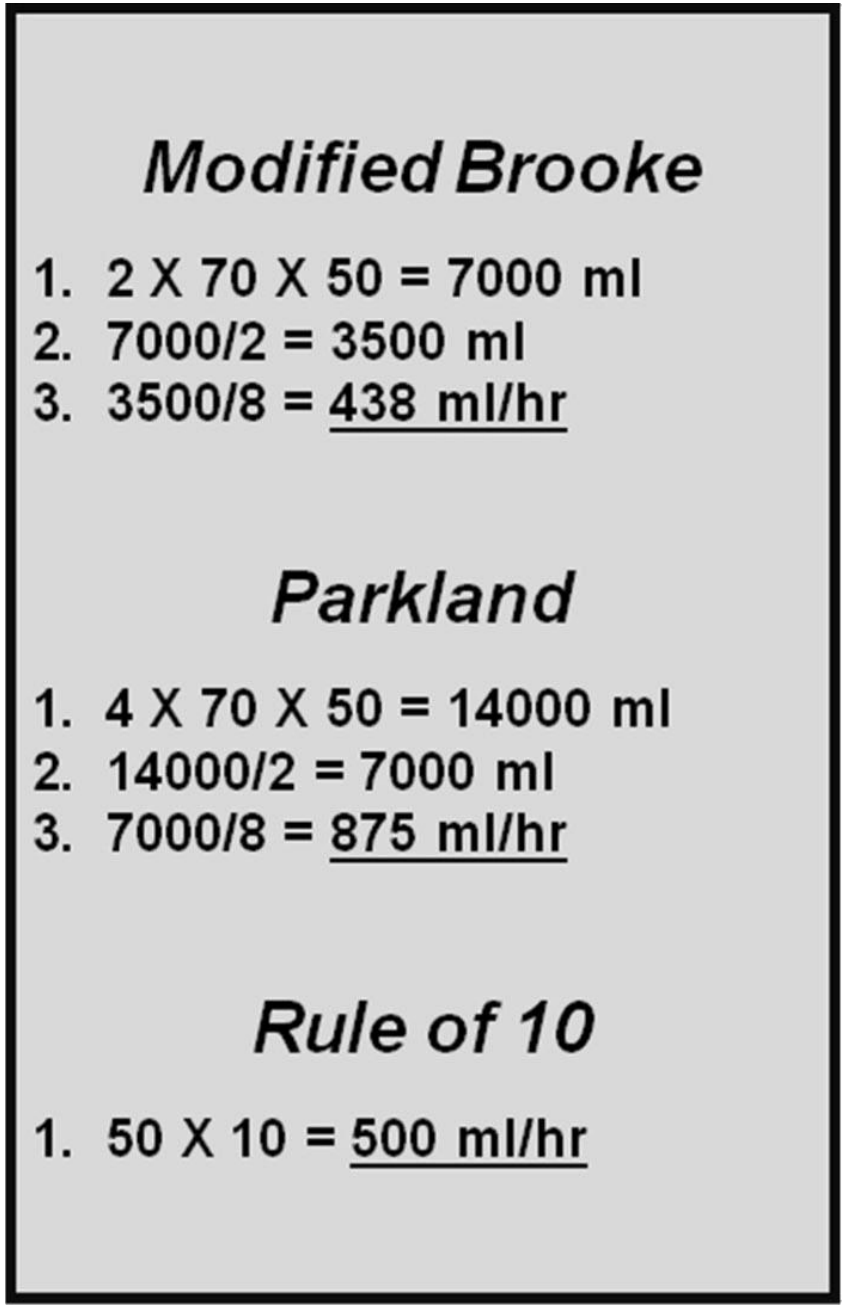
Secondary Survey

Ensure adequate tetanus prophylaxis

>15%: CBC, metabolic panel, INR, ABG

Smoke inhalation: laryngoscopy

Decide if resuscitation is required and calculate how much to give.



Comparison of initial fluid rate calculations for an adult weighing 70 kg with a 50% TBSA burn using the Modified Brooke, Parkland, and rule of 10.

VCU Health

Special Considerations of Age

Pediatric Population

- Newborns have a bigger head to body ratio with correspondingly smaller legs
- Must have mIVF in addition to resuscitative fluids

Elderly Population

- Age > 65 years have the worst outcomes after burn injury
- Frailty

VCU Health

Resuscitation

1st use crystalloids

- Warmed LR
- Most commonly, burn > 20% TBSA will require fluid resuscitation (15% TBSA in patients younger than 15 years old)

Colloids:

- Addition of 5% albumin within 8 hours after burn injury enables the infusion of a lower total volume in the first 24 hours.
- Also consider plasma
  - Preserves microvascular endothelium compared to other resuscitative fluids
  - Should consider TRALI

Evan Haynes Burn Center Policy and Procedures

For patients <15 years old with second or third degree burns totaling greater than or equal to 15% TBSA will receive formal fluid resuscitation.

- 2 mL x % TBSA x weight (Kg)
- If patient is <30 kg, should receive mIVF with D5LR
- ICU level of care
- Must have functioning IV, central access >30% TBSA, enteric access. May consider arterial lines

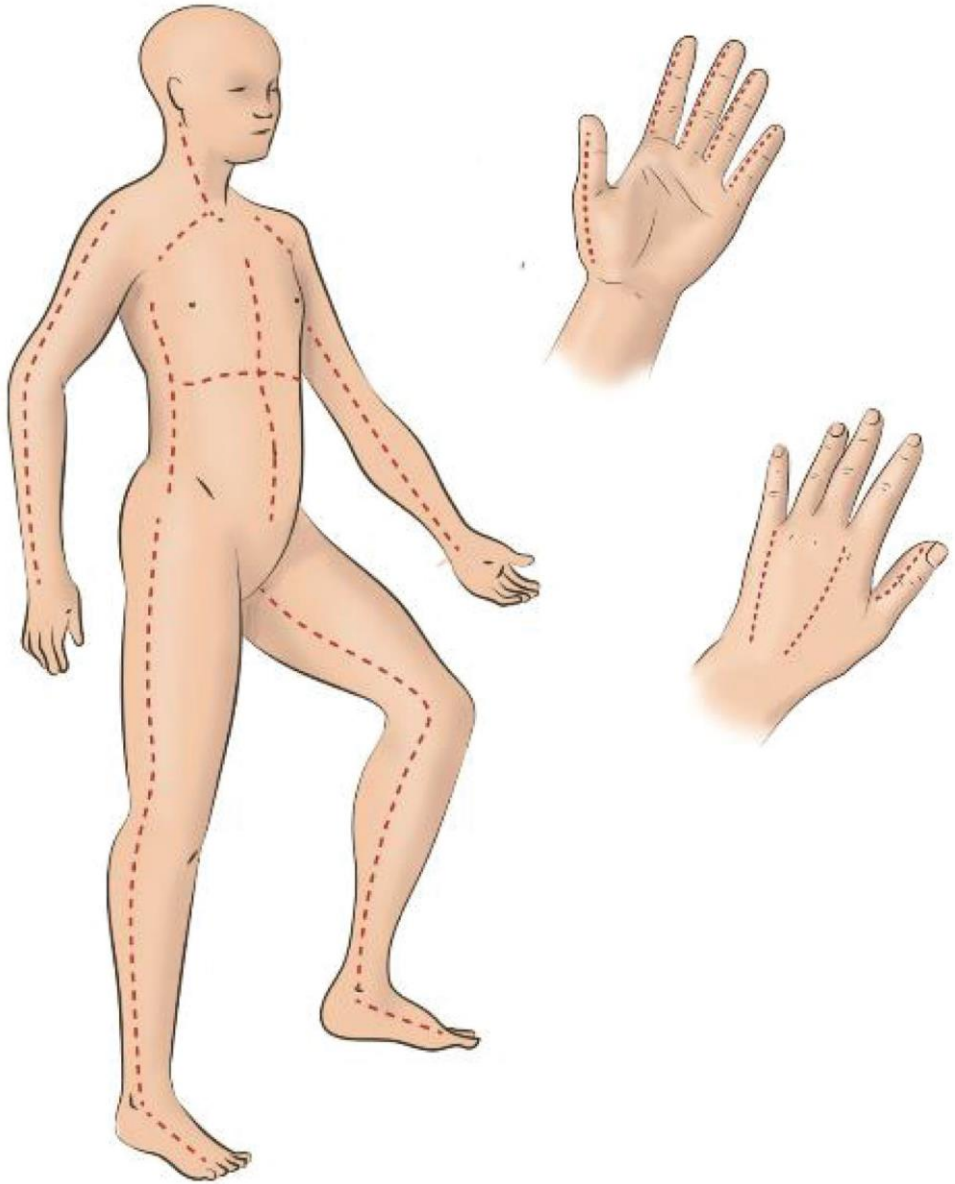
Goal Urine Outputs

- <30 kg: 1 mL/kg/hr
- >30 kg: 0.5 mL/kg/hr
- Myoglobinuria or rhabdo: 2 mL/kg/hr

Case 3

You're called to the bedside by the nurse who reports your patient has severe bilateral foot pain that has worsened over the past three hours.

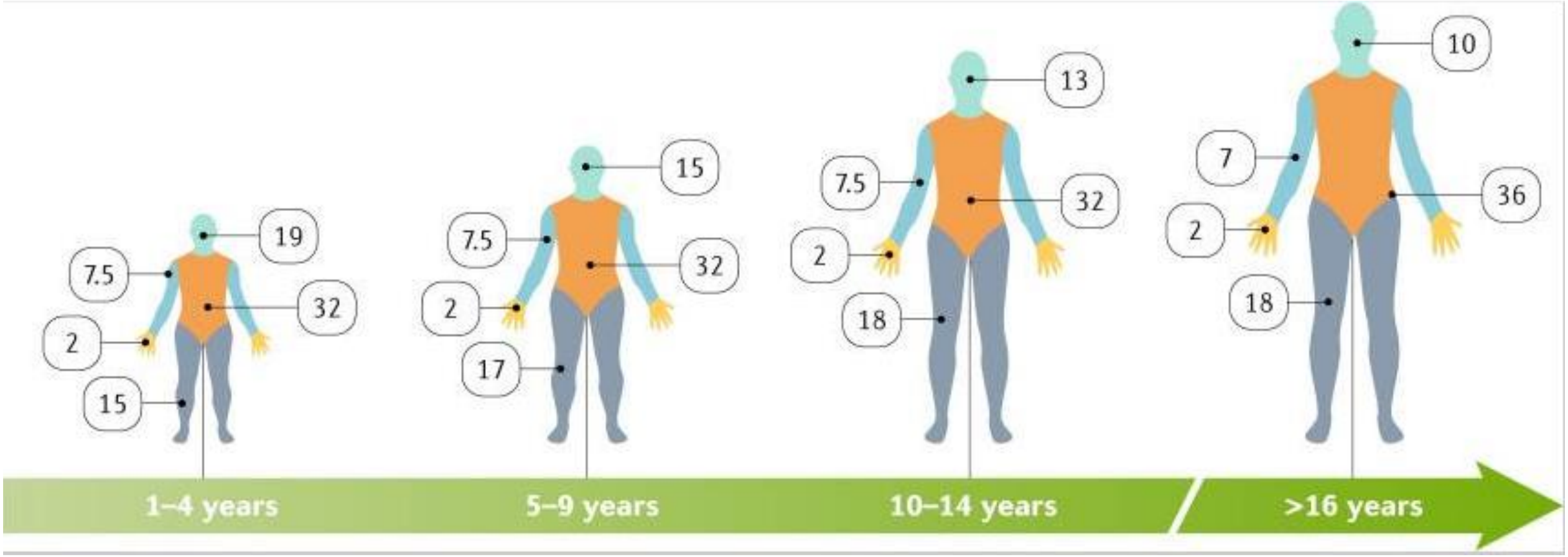
Escharotomy

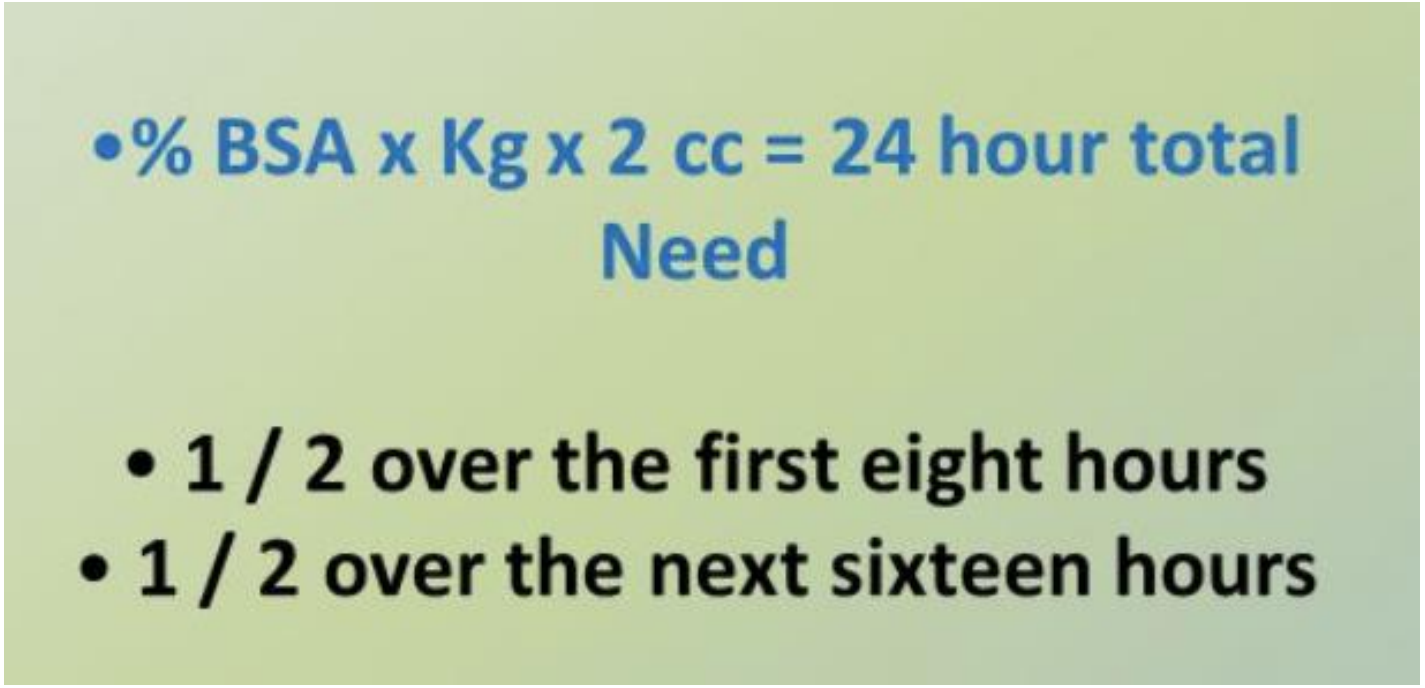


Case 4

You are working in the emergency department (ED) of a community hospital when the ambulance arrives with A.N, an 14-year-old girl who was caught in a house fire. She was sleeping when the fire started and managed to make her way out of the house through thick smoke. The emergency medical system crew initiated humidified oxygen at 15L/min per nonrebreather mask and started a 16-gauge IV with LR. On arrival to the ED, her vital signs are 100/66, 125, 34, Sao, 93%. An additional 16-gauge IV is inserted. She appears anxious and in pain.

As you perform your initial assessment, you note superficial partial-thickness burns on A.N.'s right anterior leg, left anterior and posterior leg, and anterior torso. Using the "rule of nines", calculate the extent of A.N.'s burn injury.





A.N. is undergoing burn fluid resuscitation using the modified Brooke formula.
She was admitted at 0400. She weighs 50 kg. Calculate her fluid requirements, specify the fluids used, specify how much will be given, and indicate what time intervals will be used.

A.N. is undergoing burn fluid resuscitation using the modified Brooke formula.
She was admitted at 0400. She weighs 50 kg.

1. What is the goal urine output for this patient based on the Evans-Haynes Burn Center protocol?

2. What additional orders should you consider for this patient?

A.N. is undergoing burn fluid resuscitation using the modified Brooke formula.
She was admitted at 0400. She weighs 50 kg.

Eighteen hours after the injury, you are notified by the RN that the patient's urine output for the past hour was 15 mL.

1. What do you suspect is occuring and why is it concerning?

2. What adjunct can you consider adding as part of your resuscitation?

References

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