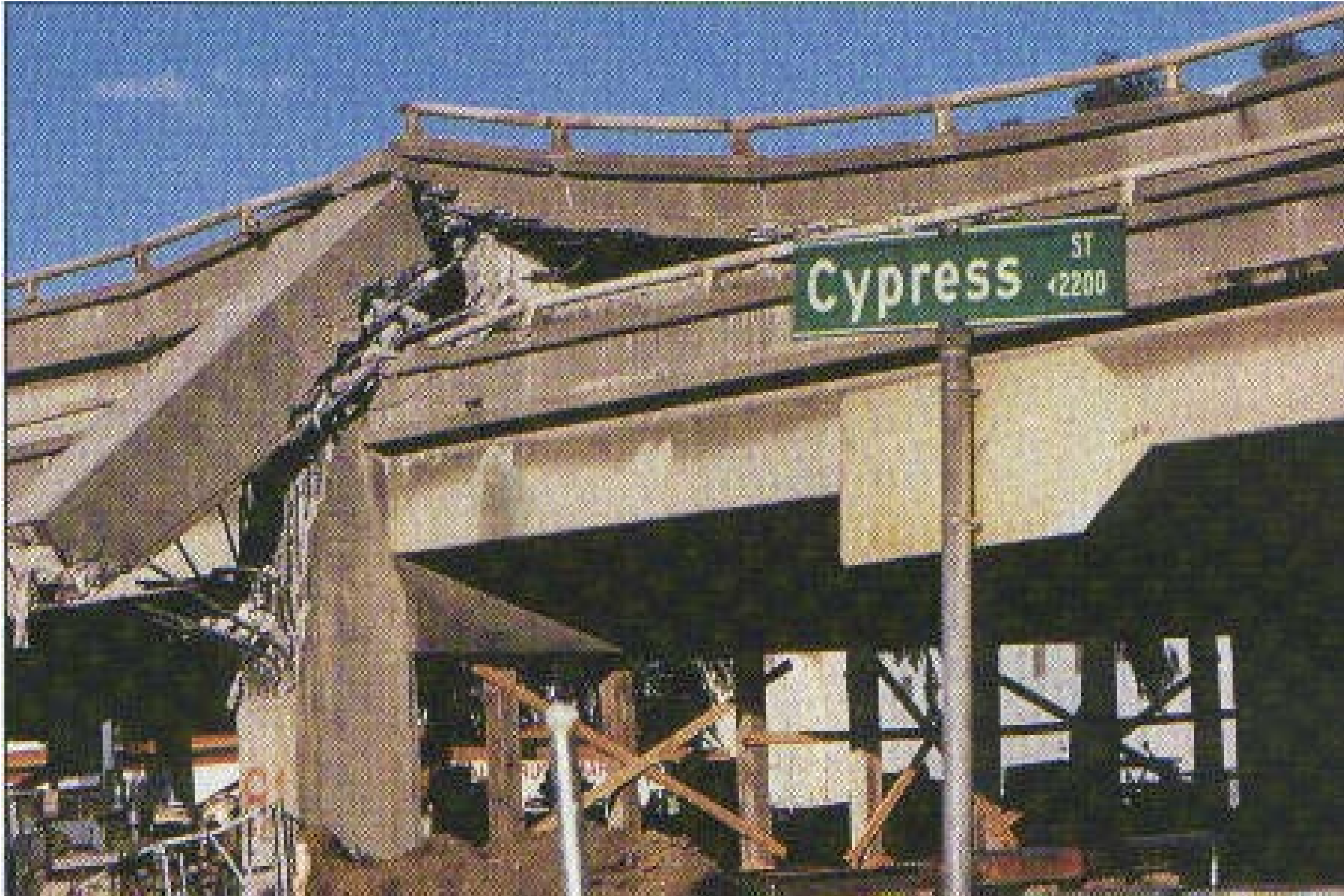
Crush Syndrome

Joe Holley, MD FACEP
EMS Medical Director
Memphis Fire Department
Shelby County Fire Department
TNTF1 FEMA US&R

Crush Syndrome

- The systemic manifestations caused by release of toxic products of crushed muscle tissue which occurs when a victim has sustained a prolonged compressive force on a muscle mass.


Cypress
ST
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Northridge Earthquake


Mobil
TOMS

Crush Syndrome

- It is a disease process that develops within the body at a cellular level
- Symptoms are not immediate
- When symptoms exist, the disease is far advanced and the patient can die suddenly even with aggressive treatment.

- Crush injury and compartment syndrome are different processes with a common pathophysiology
- Crush injury occurs in 2 phases
  - Mechanical cell disruption
  - Ischemia
- Crush syndrome associated with increased external pressure to a body part or region
- Compartment syndrome results from increased pressure within a muscle compartment

Crush Syndrome

- Deterioration of the untreated patient is the rule, not the exception.
- Armenian Earthquake

"--they heard someone in the rubble and lifted the panel that was crushing them--the person died."

Medical Provider


Big crush

Crush Syndrome

- Crush syndrome is common in immobile victims trapped within collapsed structures
- The great irony
  - Patients survive for days despite being trapped
  - Patients may die suddenly within minutes to hours after successful extrication

Crush Syndrome

- Early recognition is imperative!
  - Post-extrication medical deterioration and death occur from potentially treatable mechanisms
  - Science suggests that patients survive if they are treated early and aggressively “in the rubble”
  - Survival is also associated with aggressive hospital care and early dialysis

Crush Syndrome

- Why crush syndrome occurs
  - Muscle is vulnerable to sustained pressure
  - Compression may be caused by debris ***or*** the patient's own weight on a hard surface
  - Time-pressure relationship
    - Time
      - Can develop in 1 hour if the compression is severe
    - Pressure
      - Amount, distribution and anatomical structures involved

Crush Syndrome

- What parts of the body are susceptible?
  - Lower extremities (most common)
  - Buttocks
  - Upper extremities and thorax

Crush Syndrome

- Why do patients die?
  - High serum potassium levels
    - Ventricular fibrillation
  - Metabolic acidosis
  - Hypovolemic shock (blood & plasma loss)
  - Renal Failure

Crush Syndrome

- Pathophysiology
  - Tissue is compressed
  - Blood flow is decreased
  - Cells die
  - Toxins release
    - Hyperkalemia
    - Hypocalcaemia
    - Acidosis (local and systemic)
    - DIC (thromboplastin release)
    - Renal failure:
      - Myoglobinuria

Crush Syndrome

- Crush syndrome effects are not seen until release of the compressive force (extrication)
- Blood flow is restored and toxins are released into the central circulation
- The trapped patient who appeared “stable” suddenly deteriorates

Crush Syndrome

- If left untreated...
  - Cardiac arrhythmia
    - High serum potassium levels
  - Kidney failure
    - Myoglobin and uric acid (from crushed muscle)

Clinical Findings

- Pre-release of entrapment
  - Painless crushed extremity (hypesthesia/anesthesia)
  - Distal pulses may or may not be present

Post-release of entrapment

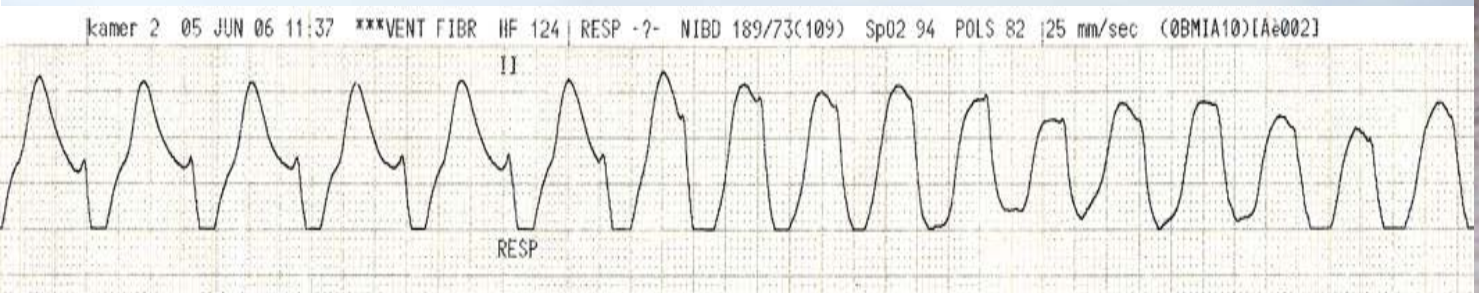
- Agitation
- Continued hypesthesia/anesthesia
- Severe pain in crushed extremity
- Muscle function decreased/absent
- Progressive swelling of injured area
- Systemic problems

Patient Assessment

Hyperkalemia and Hypocalcemia

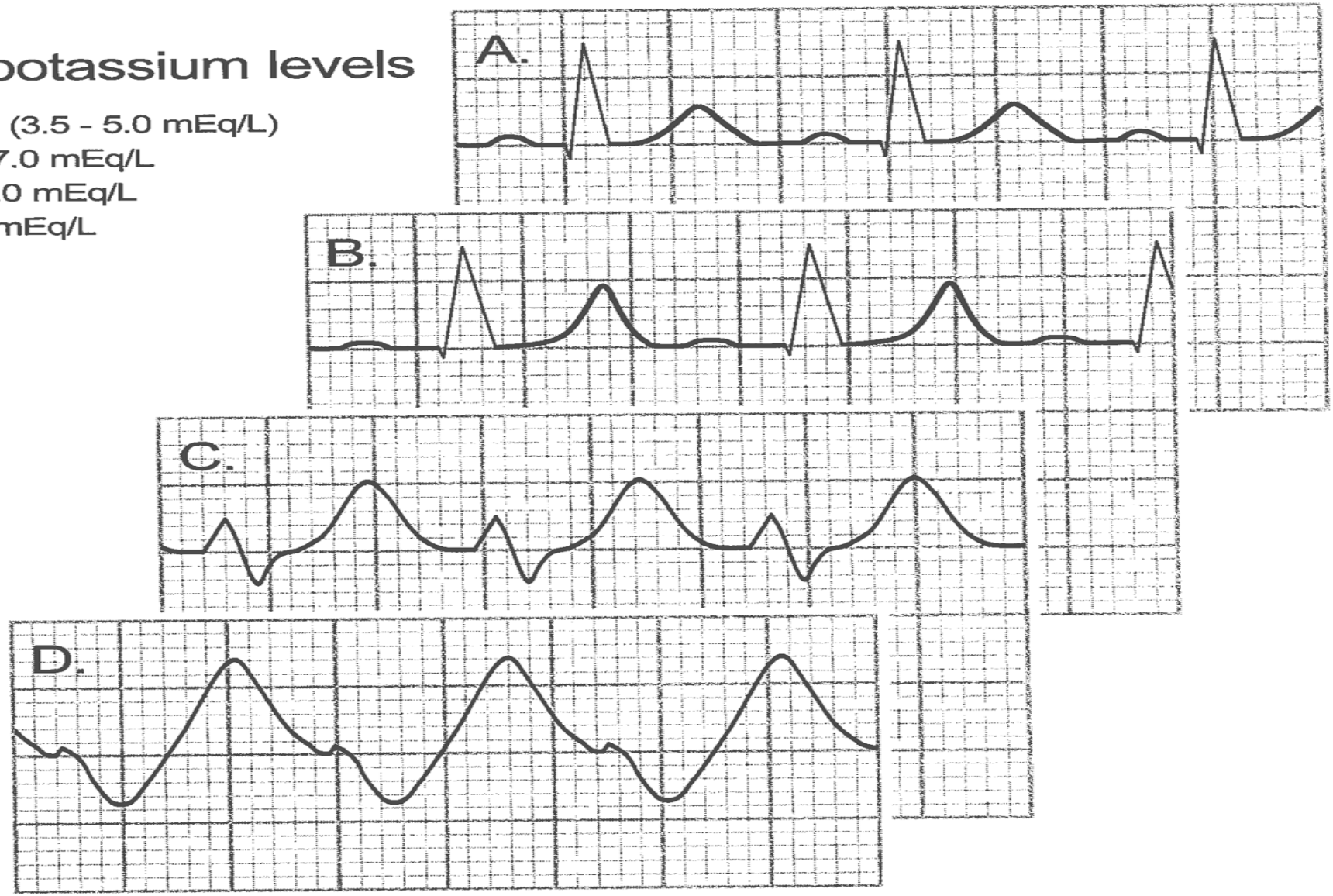
Rhabdomyolysis

Pulmonary Injury

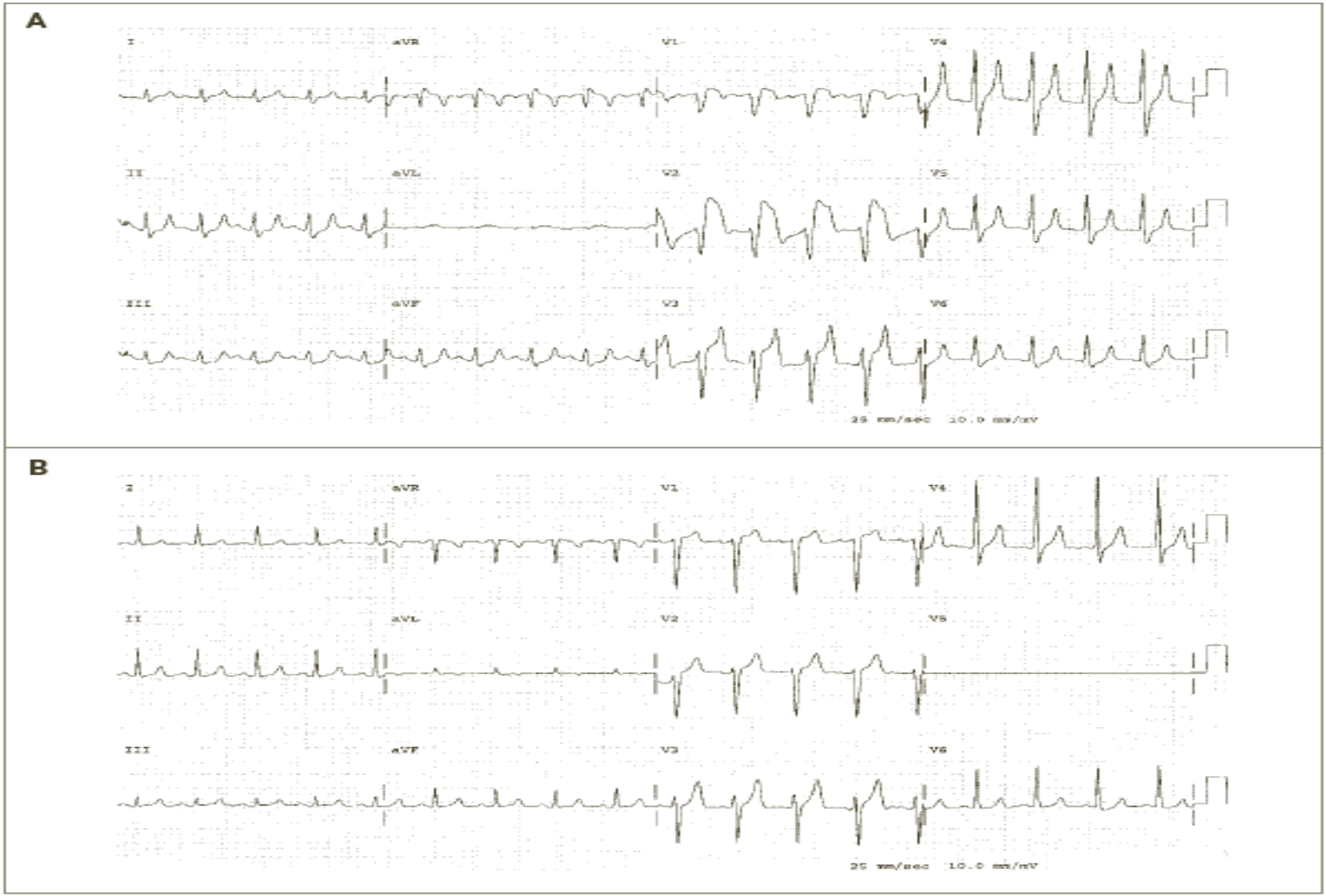


Serum potassium levels

A. normal (3.5 - 5.0 mEq/L)
B. about 7.0 mEq/L
C. 8.0 - 9.0 mEq/L
D. >10.0 mEq/L



Changes in the ECG in lead II caused by hyperkalemia


A
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
25 mm/sec 10.0 mm/mV
B
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
25 mm/sec 10.0 mm/mV


200
100

Rhabdo

Myoglobin

Solubility in urine: 50 mg myoglobin/ml urine

Urine pH	% Precipitated
8.5 to 7.5	0%
6.5	4%
5.5	23%
5.0	46%
<5.0	73%

Crush Syndrome

- Treatment in the Field
  - ***Do not release the victim until treatment has been initiated***

Crush Syndrome

- Treatment
  - IV of Normal Saline Solution
  - Sodium Bicarbonate
  - Dextrose
  - Insulin
  - Continuous nebulized Albuterol
  - Pain control and sedation
  - Other patient specific medications

Sample Protocol

- **Infuse 0.9% Normal Saline or D5W ½ Normal Saline as directed.**
- **When possible, obtain urine and test for the presence of hemoglobin / myoglobin. If necessary, insert a foley catheter.**
- **Administer IV fluids to correct volume deficit:**
  - **Administer 1L 0.9% NS bolus.**
  - **Administer sodium bicarbonate 44mEq (1 amp), IV or Saline Lock bolus.**
  - **Mix sodium bicarbonate 88mEq in 1L D5W and administer at a rate of 1L per hour.**

Additional Protocols

- **If the patient is showing early signs of renal failure/insufficiency including "hematuria"/myoglobinuria and has documented urine output:**
  - **Administer Mannitol 0.5-1 g/kg (maximum dose 12.5g) in 250 cc of D5W ½ Normal Saline to be infused at a rate of 125 cc per hour *or***
  - **Lasix 1-2 mg/kg, IV or Saline Lock bolus.**
    - **NOTE: ANURIC PATIENTS SHOULD NOT BE GIVEN MANNITOL**
- **For extended operations, foley insertion may be required to monitor urinary output and for BBP precautions. Maintain urinary output of 3cc/kg per hour and a pH ≥7.65**
- **Obtain serum glucose level with the i-STAT or glucometer.**

Questions?

joeholleymd@gmail.com