



Crush Syndrome Trauma



History

- Entrapped and crushed under heavy load > 30 minutes
- Extremity / body crushed
- Building collapse, trench collapse, industrial accident, pinned under heavy equipment

Signs and Symptoms

- Hypotension
- Hypothermia
- Abnormal ECG findings
- Pain
- Anxiety

Differential

- Entrapment without crush syndrome
- Vascular injury with perfusion deficit
- Compartment syndrome
- Altered mental status

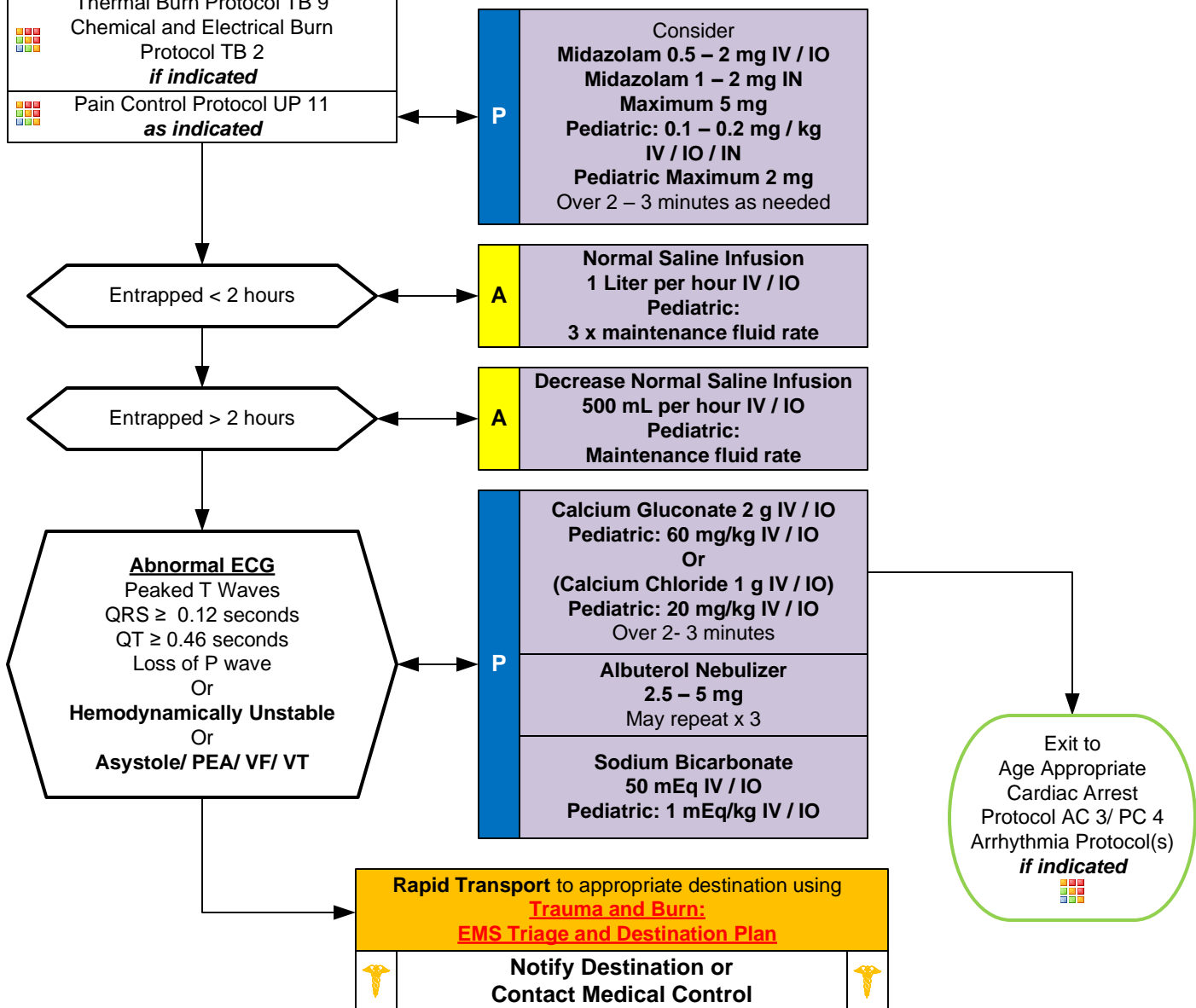
	Age Appropriate Airway Protocol(s) AR 1 - 7 as indicated
B	12 Lead ECG Procedure
	IV or IO Access Protocol UP 6
P	Cardiac Monitor
	Multiple Trauma Protocol TB 6 if indicated
	Thermal Burn Protocol TB 9 Chemical and Electrical Burn Protocol TB 2 if indicated
	Pain Control Protocol UP 11 as indicated

Age Specific Blood Pressure indicating possible shock

Age 0 – 28 days: SBP < 60
Ages ≥ 1 month: SBP < 70
Age 1 – 9: SBP < 70 + (2x Age)

Ages 10 – 64: SBP < 90
Ages ≥ 65: SBP < 100

All ages:
Shock Index HR > SBP





Crush Syndrome Trauma



Crush Syndrome

- Commonly affects the lower extremities (75%), upper extremities (10%) and the trunk (9%).
- Crush injuries often occur in the settings of bombings, structural collapse and natural disasters.
- The systemic manifestations are caused by traumatic rhabdomyolysis (the breakdown of muscle) and release of toxic muscle cell enzymes, proteins and electrolytes into the circulation causing acidosis, hyperkalemia, organ dysfunction, and hypocalcemia.
- Fluid retention in extremities (third spacing) may result in hypotension.
- Metabolic problems may cause cardiac arrhythmias.
- Acute renal failure may also occur.

Intranasal Midazolam Dose:

Mix 5 mg of Midazolam in 1 mL of NS
Dose: **0.2 mg/kg IN** (≥ 26 kg **5 mg**)
Contact Medical Control for repeat dose.

Reperfusion Syndrome

- Sudden release of a crushed anatomical part may result in acute hypotension/ hypervolemia and metabolic problems, which can lead to fatal cardiac arrhythmias and sudden death.

Management of Crush Syndrome

- Crush syndrome should be considered in any patient where entrapped or obvious crush noted for ≥ 4 hours. Where an anatomical part is entrapped / crushed and abnormal neurological exam or vascular exam is noted this may also signal crush syndrome. Numbness, weakness, heaviness or paresthesia (burning, prickly-type pain) or diminished or absent pulses are signs and symptoms of potential crush syndrome.
- Vascular compromise can be remembered by the 5 P's:
Pain, Pallor, Paresthesia, Pain with Passive movement and Pulselessness.

Hydration:

- When crush syndrome is suspected the patient should receive 1 – 2 liters of NS before releasing the crush object when possible. If this is not possible apply a tourniquet to the crushed part if able and maintain until fluids can be delivered. Contact Medical Control before releasing tourniquet.

Cardiac Arrhythmias:

- Calcium Gluconate at **2 g IV / IO** is preferred. Pediatric dose is **60 mg/kg IV / IO**. If not available, give Calcium Chloride **1 g IV / IO** in the adult and **20 mg/kg IV / IO** in the pediatric patient.
- Treat sudden cardiac arrest with Calcium and sodium bicarbonate and if occurs in the setting of crush syndrome.
- Monitor for and treat cardiac arrhythmias.

Midazolam IN 5 mg in 1 mL NS		
Wgt kg	Dose mg	Volume mL
2	0.4	0.08
4	0.8	0.16
6	1.2	0.24
8	1.6	0.32
10	2	0.4
12	2.4	0.48
14	2.8	0.56
16	3.2	0.64
18	3.6	0.72
20	4	0.8
22	4.4	0.88
24	4.8	0.96

Pearls

- Recommended exam: Mental Status, Musculoskeletal, Neuro**
- Scene safety is of paramount importance as typical scenes may pose hazards to rescuers. Call for appropriate resources.**
- Crush Injury is a localized crush injury with systemic signs and symptoms causing muscle breakdown and release of potentially toxic muscle cell components and electrolytes into the circulation.**
- Crush syndrome typically manifests after 1 – 4 hours of crush injury.**
- Fluid resuscitation strategy:**
If possible, administer IV / IO fluids prior to release of crushed body part, especially with crush > 1 hour.
If access to patient and initiation of IV / IO fluids occurs after 2 hours, give 2 liters of IV fluids in adults and 20 mL/kg of IV fluids in pediatrics, and then begin > 2 hour dosing regimen.
- If not able to perform IV / IO fluid resuscitation immediately, place tourniquet on crushed limb until IV / IO fluids can be initiated (even if tourniquet is not being used for hemorrhage control).**

Pediatric IV Fluid maintenance rate:

4 mL for the first 10 kg of weight +
2 mL for the second 10 kg of weight +
1 mL for every additional kg in weight after 20 kg

Example: 28 kg pediatric

First 10 kg: 4 mL/kg/hr = 40 mL/hr
Second 10 kg: 2 mL/kg/hr = 20 mL/hr
Final 8 Kg: 1 mL/kg/hr = 8 mL/hr

Total: 68 mL/hr rate

- Consider all possible causes of shock and treat per appropriate protocol.
- Majority of decompensation in pediatrics is airway or respiratory related.
- Decreasing heart rate and hypotension occur late in children and are signs of impending cardiac arrest.
- Shock may be present with a normal blood pressure initially or even elevated.
- Shock often is present with normal vital signs and may develop insidiously. Tachycardia may be the only sign.
- Patients may become hypothermic even in warm environments. Maintain warmth.
- Hyperkalemia from crush syndrome can produce ECG changes described in protocol, but may also be a bizarre, wide complex rhythm. Wide complex rhythms should also be treated using the VF/ Pulseless VT Protocol if indicated (AC 9 VF Pulseless VT Protocol and/ or PC 7 Pediatric VF Pulseless VT Protocol).