

# Crush Injury

## Aliases

Crush, compartment syndrome

## Patient Care Goals

1. Recognizing traumatic crush injury mechanism
2. Minimizing systemic effects such as rhabdomyolysis, hyperkalemia, acute kidney injury

## Patient Presentation

### Inclusion criteria

- Traumatic crush mechanism of injury
- Non-traumatic injuries that may cause compartment syndrome include prolonged immobilization, prolonged compression of the torso/limbs, electrical injury, or burns.

### Exclusion criteria

Non-crush injuries

## Patient Management

### Assessment

1. Identify any severe hemorrhage.
2. Assess airway, breathing, and circulation.
3. Evaluate for possible concomitant injury (e.g. fractures, solid organ damage, or spinal injury.)
4. Monitor for development of compartment syndrome (pain out of proportion to clinical exam, tense swelling, pain with passive stretch, muscle weakness, absent pulses, paresthesias).

## Treatment and Interventions

1. Treat crushed casualties as soon as they are discovered.
2. If severe hemorrhage is present, see [Extremity Trauma/External Hemorrhage Management guideline](#).
3. Administer oxygen as appropriate for dyspnea or distress with a target of achieving 94-98% saturation for most acutely ill patients.
4. Establish IV access. IV fluids should be administered prior to releasing the crushed body part. Administer 1000 mL normal saline (NS) bolus [AEMT]. Avoid lactated Ringer's solution as it contains potassium. Crush injury without adequate fluid resuscitation develops into crush syndrome.
5. Consider **Sodium Bicarbonate [PARA]**
  - **Adult/Pediatric 1mEq IV/IO (max 50mEq) over (5) minutes for significant crush injuries or prolonged entrapment of an extremity.**
6. Attach ECG cardiac monitor Obtain/interpret 12-lead ECG if available. Carefully monitor for dysrhythmias or signs of hyperkalemia before and immediately after release of pressure and during transport (e.g. peaked T waves, wide QRS, lengthening QT interval, loss of P wave).
7. Consider analgesics for pain control [see [Pain Management guideline](#)].
8. Consider the following post-extrication:
  - Continued resuscitation with normal saline (500-1000 ml/hr for adults, 10 cc/kg/hr for children)
  - If ECG suggestive of hyperkalemia, if findings of hyperkalemia, administer normal saline IV fluids and consider administration of **Calcium Gluconate** (preferred) [PARA]
    - **Adult: 1gm IV/IO push or infusion. May repeat up to 3gm max.**
    - **Pediatric: 60 mg/kg (max dose 3 grams) IV/IO push over 2 min**
  - If not already administered, for significant crush injuries with ECG suggestive of hyperkalemia, administer **Sodium Bicarbonate [PARA]**.

- If ECG suggestive of hyperkalemia, consider albuterol 5 mg via small volume nebulizer.

## **Patient Safety Considerations**

Scene safety for both rescuers and patients is of paramount importance.

## **Notes and Educational Pearls**

1. Causes of mortality in untreated crush syndrome:
  - a. Immediate
    - i. Severe head injury
    - ii. Traumatic asphyxia
    - iii. Torso injury with damage to intrathoracic or intra-abdominal organs
  - b. Early
    - i. Sudden release of a crushed extremity may result in reperfusion syndrome (acute hypovolemia, electrolyte abnormalities, and subsequent lethal arrhythmia)
    - ii. Hyperkalemia (potassium is released from injured muscle cells)
    - iii. Hypovolemia/shock
  - c. Late
    - i. Renal failure (from release of toxins from injured muscle cells)
    - ii. Coagulopathy and hemorrhage
    - iii. Sepsis

## **Key Considerations**

- Perform rapid extrication and evacuation to a definitive care facility (trauma center preferred).
- Maintain a high index of suspicion for any patient with a compressive mechanism of injury, as a patient with a crush injury may initially present with very few signs and symptoms.
- Recognize that a fatal medical complication of crush syndrome is hyperkalemia. Suspect hyperkalemia if T- waves become peaked, QRS becomes prolonged (greater than 0.12 seconds), P wave is absent, or QTc is prolonged.
- Avoid lactated Ringer's solution as it contains potassium.
- Continue fluid resuscitation through extrication and transfer to hospital.

## **Pertinent Assessment Findings**

- Evaluation of mental status, GCS
- Evaluation for fractures and potential compartment syndrome development (neurovascular status of injured extremity)
- Examination of spine
- Evidence of additional trauma, potentially masked by with other painful injuries

## **Quality Improvement**

### **Associated NEMESIS Protocol(s) (eProtocol.01)**

- 9914089—Injury-Crush Syndrome

## **Key Documentation Elements**

- Time of tourniquet application, if applied
- Neurovascular status of any crushed extremity
- ECG findings consistent with hyperkalemia
- Amount of IV fluid administered

## **Performance Measures**

- Initiation of fluid resuscitation prior to extrication
- ECG or monitor to monitor for dysrhythmias or changes related to hyperkalemia

- Treatment of hyperkalemia if evidence is noted on ECG

## References

1. Better OS. The crush syndrome revisited (1940-1990). *Nephron*. 1990;55:97-103.
2. Jagodzinski N, Weerasinghe C, Porter K. Crush injuries and crush syndrome – a review. *Trauma*. 2010;12:69–88.
3. Sever MS, Vanholder R, Lameire N. Management of crush-related injuries after disasters. *N Engl J Med*. 2006;354(10):1052-63.
4. Smith J, Greaves I. Crush injury and crush syndrome: a review. *J Trauma*. 2003;54(5):S226- 30.