Clinical Pearls from the Preventable Mortality Review Committee

Management of Acute Traumatic Spinal Cord Injury (SCI)

Management of traumatic spinal cord injury is directed at preventing secondary insults, most notably hypotension with subsequent cord hypoperfusion. This can occur because cervical and upper thoracic spine injuries injuries can result in vasoplegia and spinal shock due to loss of sympathetic tone.[1-5]

It is *vitally* important to first assess for and rule out hemorrhage as a source of hypotension. After hemorrhage has been excluded, resuscitation efforts initially include volume resuscitation with caution against fluid overload while being mindful of patient comorbidities and concomitant injuries (CHF, pulm contusions, etc).

Inotropic support: Based on low-grade retrospective studies, current recommendations are to maintain the MAP (mean arterial pressure) of at least 85 for seven days after injury or a stable neurologic exam is achieved for 24 hrs post decompression.[1-5] CVL and arterial lines are recommended.

Levophed (norepinephrine) is the agent recommended to achieve this because it has alpha and beta adrenergic activity.[1-5]

It is essential to rule out bleeding, anemia, or volume depletion because they can be missed if vasopressor requirements are increased without reevaluation. Maintaining a hemoglobin of > 8g/dl may help minimize the required volume of vasopressors.[6] Minimizing vasopressor support is important because of sizable percentage of patients started on them to maintain MAP develop cardiac complications, most commonly arrhythmias.

Steroid therapy: NO definitive proof exists for using steroids to treat SCI.[7-8] Additionally, steroids increase risk of infections, GI bleeding, hyperglycemia and death.

"IDEAL" Timing of surgical Decompression/Stabilization:[13]

1. Cervical SCI should ideally be addressed within 24 hours of presentation
2. Thoracolumbar SCI ideally should be addressed within 72 hours of presentation

Venous thromboembolism (VTE) prophylaxis: SCI patients are at increased risk for developing VTE ranging as high as 40 to 70% typically developing between 72hrs and two weeks after SCI.[9] Mechanical prophylaxis can be initiated immediately after injury. Chemoprophylaxis using low molecular weight heparin (LMWH) should be started as soon as possible or 24 hrs after surgical decompression.[10] Giving chemical VTE prophylaxis before spinal cord injury and holding it the morning of surgery should be considered if surgery is going to be delayed for a few days. Sequential compression Devices (SCDs) should be used while chemical VTE prophylaxis is being held for surgery. Prophylactic IVC filters have no identified benefit.[11-12]

Tracheostomy: Early tracheostomy following high SCI, especially cervical injuries that affect the phrenic nerve and diaphragm (above C5), improves outcomes, reduces morbidity and mortality, and decreases hospital length of stay.[14-15] Patients with thoracic SCI may also benefit from tracheostomy if the respiratory failure results from thoracic injuries, e.g., rib fx, contusions, etc.

Continued on next page

Management of Acute Traumatic Spinal Cord Injury (SCI)

References

1. American College of Surgeons TQP Best practice Guidelines https://www.facs.org/quality-programs/trauma/quality/best-practices-guidleines/ (March 2022)

2. Inoue T, Manley GT, Patel N, Whetstone WD. Medical and surgical management after spinal cord injury: Vasopressor usage, early surgerys, and complications. J Neurotrauma. 2014 Feb1;31(3): 284-291. Doi:10.1089/ner2013.3061. Epub 2013 Dec 11.PMID: 24020382

3. Saadeh YS, Smith BW, Joseph JR, et al. The impact of blood pressure management after spinal cord injury: A systematic review of the literature. Neurosurg Focus. 2017 Nov; 43(5): E20.doi:10.3171;2017.8.FOCUS17428

4. Ploumis A, Yadlapalli N, Fehlings MG, et al. A systematic review of the evidence supporting a role for vasopressor support in acute SCI. Spinal Cord. 2010 May: 48(5): 356-362. Doi: 10.1038/sc2009.150.Epub 2009 Nov 24. PMID: 1995758

5. Hawryluk G, Whetstone W, Saigal R, et al. Mean arterial blood pressure correlates with neurological recovery after human spinal cord injury: Analysis of high frequency physiological data. J Neurotrauma. 2015 Dec 15: 32(24): 1958-1967

6. Management of Traumatic spinal cord injury: UAMS clinical practice guidelines 1/2023

7. Hurlbert RJ, Hadley MN, Walters BC, etal. Pharmacological therapy for acute spinal cord injury. Neurosurgery. 2013; 72(supp2): 93-105

8. Bracken, MB. Steroids for acute spinal cord injury. Cochrane Database Syst Rev. 2012, 1:CD001046.

9. Chung WS, Lin CK, Chang SN, et al. Increased risk of deep vein thrombosis and pulmonary thromboembolism in patients with spinal cord injury: A nationwide cohort prospective study. Thromb Res. 2014: 133 (4): 579-584

10. Tran A, Fernando SM, Carrier M, et al. Efficacy and safety of low molecular weight heparin vs unfractionated heparin for prevention of venous thromboembolism in trauma patients: A systematic review and meta-analysis. Ann Surg. 221 Aug 13

11. Rajasekhar A, Lottenberg L, Lottenberg, R, et al. A pilot study on the randomization of inferior vena cava filter placement for venous thromboembolism prophylaxis in high-risk trauma patients. J Trauma. 2011; 71(2): 323-329.

12. Kidane B, Madani AM, Vogt K, et al. The use of prophylactic inferior vena cava filters in trauma patients: A systematic review. Injury. 2012;43(5): 542-547

13. Kerwin, et al. The effect of early spine Fixation on Non-Neurologic Outcome. J Trauma; 58:15-21. 2005.

14. Flanagan CD, Childs BR, Moore TA, Vallier HA. Early tracheostomy in patients with traumatic cervical spinal cord injury appears safe and may improve outcomes. Spine. 2018: 43: 1110-1116.

15. Anand T, Hanna K, Kulvatunyou N, et al. Time to tracheostomy impacts overall outcomes in patients with cervical spinal cord injury. Journal of Trauma and Acute Care Surgery. 2020; 89: 358-364.

These guidelines were prepared by the ADH (trauma medical consultant) and members of the Arkansas State Preventable Mortality Committee. They are intended to serve as guidelines based on a review of the current medical literature. They are not intended to be used as strict policies or protocols. Their use is at the discretion of the managing physician.

Arkansas Trauma System

Open Abdomen

Damage control laparotomy (DCL) and the management of the open abdomen (OA) or temporary abdominal closure (TAC) often go together. DCL is usually done emergently in major abdominal trauma to gain control of bleeding and stop contamination from bowel perforations.

If the patient has liver bleeding that will only stop with packing or is coagulopathic, hypothermic, or hemodynamically unstable, leaving the abdominal fascia open with specialized techniques allows time to resuscitate, stabilize, and warm the patient. OA is also used for a badly infected or contaminated peritoneal cavity or bowel with questionable vascular flow to allow a "second look" into the abdomen to check for integrity of GI anastomoses or assess bowel viability before more resection or anastomosis.

Usually, the abdomen is temporarily closed with negative pressure wound therapy (NPWT) over a plastic sheet covering the bowel. This can be hand-constructed from abdominal draping sheets OR towels, & suction drains, or commercially available kits (such as Abthera©).[i]

The patient is typically returned to the OR for a second look procedure within 12-36 hours to remove packs and complete the index operation.

This take-back and closure of the abdomen fascia should be attempted as early as possible, as abdomen fascial closure becomes much more difficult each day, increasing the risk of hernia, infection, and entero-atmospheric GI fistulas.[ii]

Edema of the bowel and intraabdominal contents may prevent the closure of the fascia. Several techniques can be used. An infusion of 3% saline at 30ml per hour IV for the first 72 hours of an open abdomen has been shown to increase first closure rates without causing harm to the patient. During this protocol, additional iv fluids should be given as indicated, but other "maintenance fluids" should not be ordered.[iii] [iv]

Direct peritoneal resuscitation with 2.5% peritoneal dialysis solution to irrigate the abdomen while it is left open has been shown to increase the chances of fascial closure and decrease abscesses. In these cases, a catheter is placed in the abdomen to infuse the dialysis solution at ~400ml per hour while a negative-pressure dressing removes the fluid from the abdomen until the patient returns to the OR for fascial closure.[v] [vi]

Use of soft plastic sheeting (Mepitel© or Abthera©) between the abdominal wall and bowel, while the patient has an open abdomen is important and will help prevent the dreaded complication of enteroatmospheric fistula formation.[vii] These fistulas are often caused by adhesions between the bowel and underside of the abdominal wall, leading to excess tension across the bowel as the abdominal wall muscles contract. This tension and pressure can lead to bowel perforation and the development of an enteroatmospheric fistula.

References

[i] Diaz Jr JJ, Dutton WD, Ott MM, et al. Eastern Association for the Surgery of Trauma: a review of the management of the open abdomen—part 2 "management of the open abdomen". Journal of Trauma and Acute Care Surgery. 2011 Aug 1;71(2):502-12.

[ii] Loftus TJ, Efron PA, Bala TM, et al. The impact of standardized protocol implementation for surgical damage control and temporary abdominal closure after emergent laparotomy. The journal of trauma and acute care surgery. 2019 Apr;86(4):670.

[iii] Harvin JA, Mims MM, Duchesne JC, et al. Chasing 100%: the use of hypertonic saline to improve early, primary fascial closure after damage control laparotomy. Journal of Trauma and Acute Care Surgery. 2013 Feb 1;74(2):426-32.

[iv] Loftus TJ, Efron PA, Bala TM, et al. Hypertonic saline resuscitation following emergent laparotomy and temporary abdominal closure. The journal of trauma and acute care surgery. 2018 Feb;84(2):350.

[v] Smith JW, Garrison RN, Matheson PJ, et al. Direct peritoneal resuscitation accelerates primary abdominal wall closure after damage control surgery. Journal of the American College of Surgeons. 2010 May 1;210(5):658-64.

[vi] Smith JW, Matheson PJ, Franklin GA, et al. Randomized controlled trial evaluating the efficacy of peritoneal resuscitation in the management of trauma patients undergoing damage control surgery. Journal of the American College of Surgeons. 2017 Apr 1;224(4):396-404.

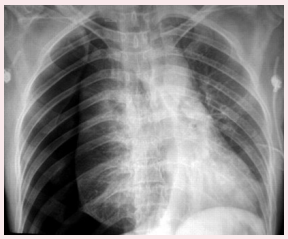
[vii] Pereboom IT, Hofker HS. A mechanical explanation for the development of enteroatmospheric fistulas in open abdomen. Diseases of the Colon & Rectum. 2016 May 1;59(5):471-5.

These guidelines were prepared by the ADH (trauma medical consultant) and members of the Arkansas State Preventable Mortality Committee. They are intended to serve as guidelines based on a review of the current medical literature. They are not intended to be used as strict policies or protocols. Their use is at the discretion of the managing physician.

Arkansas Trauma System

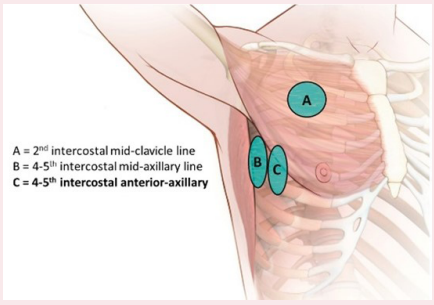
Tension Pneumothorax Needle Decompression

Tension pneumothorax is a well-described cause of early and rapid death in trauma patients (3-4% of military trauma deaths). It results from an obstructive (or cardiogenic) shock from high pressure outside of the lung in the chest, preventing the return of venous blood to the heart.



The treatment is rapid decompression of this excess air in the pleural space. This is typically done in a hospital with a chest tube; however, this is more difficult in the prehospital setting. As a result, needle decompression with an angiocatheter over an introducer needle was described. Initially, the second intercostal space at the mid-clavicular line was described. Unfortunately, this location is often difficult to discern, thicker than other areas of the chest, and potentially dangerous with mammary arteries traversing near this location.

As a result, the **4-5 intercostal space at the anterior axillary line is now recommended (C below; between the pectoralis major and latissimus dorsi)**. Numerous studies have also shown that 14-gauge 8-cm long angiocatheters are required to reliably gain access to and decompress the pleural space.



Finger thoracostomy is another method for decompressing a tension pneumothorax, but it is more challenging in the pre-hospital space, and it results in a large wound that is more prone to infection; thus, we believe it should be reserved for patients in cardiac arrest.

Other notes on needle decompression or finger thoracotomy:

- It can take up to a minute for the lung to fully expand after needle decompression so do not expect immediate results.
- Angiocatheters with “blood control valves” prevent fluid or air from flowing through the catheter, so they should not be used for needle decompression.
- Angiocatheters used for needle decompression can become kinked, so decompression may need to be repeated, esp. during extended transport.
- Needle decompression or finger thoracotomy are not definitive treatments for tension pneumothorax, so if there is a pneumothorax and the patient survives, a chest tube will need to be placed.
- Needle decompression attempts do not always enter the pleural space and are often attempted for patients who do not need them, so not every patient who received one in the pre-hospital space needs a chest tube, esp. patients in whom the catheter did not enter the chest or in whom there is not a pneumothorax on CT of the chest.

References

- McPherson JJ, et. Prevalence of tension pneumothorax in fatally wounded combat casualties. J Trauma Acute Care Surg. 2006 Mar 1;60(3):573-8.
- Inaba K, et al. Optimal positioning for emergent needle thoracostomy: a cadaver-based study. J Trauma Acute Care Surg 2011 Nov 1;71(5):1099-103.
- Inaba K, et al. Radiologic evaluation of alternative sites for needle decompression of tension pneumothorax. Arch Surg. 2012 Sep 1;147(9):813-8.
- Inaba K, et al. Cadaveric comparison of the optimal site for needle decompression of tension pneumothorax by prehospital care providers. J Trauma Acute Care Surg. 2015 Dec 1;79(6):1044-8.
- Laan DV, et al. Chest wall thickness and decompression failure: a systematic review and meta-analysis comparing anatomic locations in needle thoracostomy. Injury. 2016 Apr 1;47(4):797-804.
- Kaserer A, et al. Failure rate of prehospital chest decompression after severe thoracic trauma. Am J Emerg Med. 2017 Mar 1;35(3):469-74.
- Leatherman ML, et al. Relative device stability of anterior versus axillary needle decompression for tension pneumothorax during casualty movement: preliminary analysis of a human cadaver model. J Trauma Acute Care Surg. 2017 Jul 1;83(1):S136-41.
- Chang SJ, et al. Evaluation of 8.0-cm needle at the fourth anterior axillary line for needle chest decompression of tension pneumothorax. J Trauma Acute Care Surg. 2014 Apr 1;76(4):1029-34.
- Aho JM, et al. Needle thoracostomy: clinical effectiveness is improved using a longer angiocatheter. J Trauma Acute Care Surg. 2016 Feb;80(2):272.
- Norris EA, et al. Comparison of 10-versus 14-gauge angiocatheter for treatment of tension pneumothorax and tension-induced pulseless electrical activity with hemorrhagic shock: Bigger is still better. J Trauma Acute Care Surg. 2020 Aug 1;89(2S):S132-6.

These guidelines were prepared by the ADH (trauma medical consultant) and members of the Arkansas State Preventable Mortality Committee. They are intended to serve as guidelines based on a review of the current medical literature. They are not intended to be used as strict policies or protocols. Their use is at the discretion of the managing physician.

Arkansas Trauma System