Tension Pneumothorax: What Is an Effective Treatment?

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CE Earn Up to 5.5 Hours. See page 590.

Many emergency nurses have memorized the phrase "needle decompression 2ICS MCL" (translation: second intercostal space, mid clavicular line) as the intervention for a tension pneumothorax. However, if you believe in using an evidence-based approach to emergency nursing practice and examine the effectiveness of this intervention, you may be surprised at the challenges related to site placement and needle length, along with failure rates. For example, consider the following cases that have been reported in the literature.[1]

Case 1

An 18-year-old man was admitted to the emergency department after crashing his car into a shop window. He had been trapped at scene by the displaced steering wheel, which was pressing against his chest. Upon arrival at the emergency department he was complaining of severe left-sided chest pain and difficulty in breathing. The patient was in severe respiratory distress, and further examination revealed a resonant left hemithorax with absent breath sounds. A diagnosis of a left-sided tension pneumothorax was made, and a 14-gauge cannula was placed in the left second intercostal space in the mid clavicular line. There was a small release of air, which stopped almost immediately, and the patient's condition continued to deteriorate. A scalpel and a pair of clamps was then used to rapidly blunt dissect through the 4th intercostal space in the mid axillary line to create a thoracostomy. This procedure resulted in a large rush of air and an immediate improvement in the patient's condition. A size 28 French gauge chest tube was placed through the thoracostomy and connected to an underwater seal. The patient made an unremarkable recovery.[1]

Case 2

A 35-year-old woman was admitted to the emergency department with a history of shortness of breath and left-sided chest pain of 2 hours duration. On examination she was conscious and alert and appeared to be in pain. She had a resonant left hemithorax with decreased breath sounds. A chest radiograph revealed a moderate left-sided pneumothorax with no evidence of mediastinal shift. Some 1500 mL of air was aspirated with a needle aspiration set (14-gauge cannula) through the second intercostal space. A follow-up chest film showed a near complete resolution of the pneumothorax. Symptomatically the patient also felt better. However, about 20 minutes after the aspiration of the pneumothorax, the patient's pain returned and she developed severe respiratory distress. She had a resonant left-sided hemithorax with absent breath sounds. Two attempts at immediate needle decompression with a 14-gauge cannula (second intercostal space, mid clavicular line) were made, both without success. An immediate blunt dissection left thoracostomy (mid axillary line, 4th intercostal space) was performed with immediate pressure release and rapid resolution of the patient's symptoms. Subsequently, a size 28 French gauge chest tube was placed. The patient made an uneventful recovery.[1]

Needle decompression was never meant to be the definitive care of a tension pneumothorax. The procedure should always be followed up by insertion of a chest tube as soon as possible. Needle decompression is meant to be a lifesaving but temporary measure until a chest tube can be placed.[1]

The Evidence

The medical literature includes many sources that cite insufficient cannula length as the cause for needle decompression failure as a result of increased patient chest sizes.[2-9] As far

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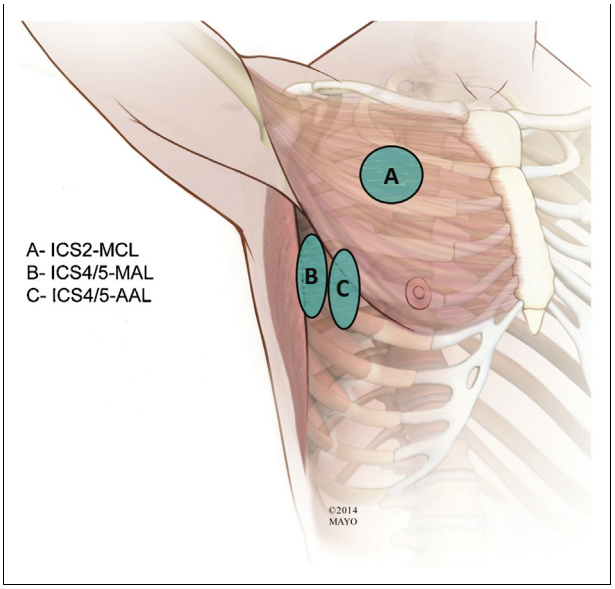
back as 1996, authors of a case report on failed needle decompression recommended the use of longer cannulas.[2] They further suggested that for patients with a thick chest wall and a possible failed attempt, one should proceed directly to insertion of a chest tube without local anesthetic because of the urgency of the situation. Cases 1 and 2 were reported in the literature in 2002.[1] The authors concluded that their reported failures could not be attributed to inadequate cannula length or from air leaking from the lung faster than it could escape through the cannula because both patients did have a release of air. The authors theorized the failed needle decompression was due to kinking or compression of the flexible cannula.[1] In 2003 other researchers determined that insufficient cannula length, differences in chest wall thickness, and provider inexperience also may increase the risk of complications and cited several cases of hemorrhage as a result of punctured vascular structures.[8] These researchers recommended the use of a lateral approach needle decompression at the 5ICS anterior axillary line (AAL).[8]

In 2007 the United States military published a study involving the measurement of chest wall thickness at 2ICS MCL in 100 virtual autopsies of deployed male military personnel.[9] Mean horizontal thickness measured 5.36 cm, and perpendicular or angled thickness was reported to be 4.86 cm. Based on these findings, the research team concluded that use of an 8-cm angiocatheter would have been successful in extending into the pleural space in 99% of the cases.[9]

A retrospective analysis of 10 years of data involving patients in the prehospital environment who underwent a needle decompression revealed a failure rate from 39% to 76%.[7] The failure rate was attributed to catheters that did not reach the pleural space.[7] The potential risk of patient injury related to the procedure was 42%. It also was determined that the wall thickness of an injured chest is greater than the wall thickness of an uninjured chest at both insertion sites: 2ICS MCL and 5ICS AAL.[7] A comparison evaluation of needle thoracostomy with tube thoracostomy reported all needle thoracostomies to be patent immediately after insertion, with 26% subsequently failing as a result of kinking, obstruction, or dislodgement.[10] Of those remaining patent after 5 minutes, 43% failed to relieve the tension.[10]

Putting Evidence into Practice

The 9th edition of the *Advanced Trauma Life Support Student Manual* (ATLS), published in 2012, described the step-by-step process for insertion at 2ICS MCL, noting that the success rate was 50% to 75%.[11] The 10th edition



FIGURE

Potential sites for relieving a tension pneumothorax. (A) Second intercostal space, midclavicular line (2ICS MCL). (B) Fourth or fifth intercostal space, midaxillary line (ICS4-5 MAL). (C) Fourth or fifth intercostal space anterior axillary line (ICS4-5 AAL). Reproduced with permission from Elsevier, from Laan, et al.[4]

of the ATLS, published in 2018, notes that as many as 44% of prehospital needle decompressions are placed too medially and emphasizes the use of an 8-cm needle, pointing out that use of a 5-cm needle 2ICS MCL is successful more than 50% of the time, whereas use of an 8-cm needle 2ICS MCL is successful more than 90% of the time.[12] Both the 2018 ATLS manual and the 8th edition of the Trauma Nursing Core Course support the lateral approach as an alternative for needle decompression (Figure).[12,13] ATLS emphasizes that the definitive intervention continues to be chest tube placement at the 5ICS AAL.[12]

The 2018 US Tactical Combat Casualty Care guidelines offer the following directives:[14]

1. Be aggressive and assess for and treat tension pneumothorax before shock develops.
2. If the patient is in cardiac arrest, carry out needle decompression to both chest walls.
3. Use either a 14- or 10-gauge needle that is 3.25 inches in length.
4. Use either 2ICS MCL or 5ICS AAL.
5. Insertion is made perpendicular to the chest. Hold the needle/catheter in place for 10 to 15 seconds to allow the air to escape before removing the needle.
6. Success is evidenced by an observed escape of air, reduction in respiratory distress, and improved oxygen saturation.[14]

The 2018 US Tactical Combat Casualty Care guidelines also mention "finger thoracostomy" as an option. This procedure is very similar to what was described in cases 1 and 2 as a blunt dissection thoracostomy. A 2- to 3-cm incision is made and the tissue is bluntly dissected. A clamp may be used to make an opening into the pleura and a finger is used to open the pleura and relieve the tension. That same site subsequently can be used for insertion of the chest tube.[11,12]

Implementation of Science

The literature reveals that it takes up to 17 years to translate evidence into practice.[15] A rigorous effort is required to effect system change. The emerging science of "implementation" offers a systematic method to identify and address barriers and determine "who" can organize, implement, and expedite system change.[16] This type of "implementation" involves using the science to endorse and advocate for change at the level of patient care, the provider, and the policymakers. One such example of applying "science to the bedside" involved The Iowa Model of Evidence-Based Practice to Promote Quality Care, a nationally recognized process that was utilized to improve patient care by reducing restraint usage.[17] Another theory proposed by Melnyk uses a problem-based approach and includes not only the current best evidence but also considers nursing theory and the clinical competence of the provider.[18] Regardless of the theory or model, the question is always "How can we improve patient care?"[17,18] Knowledge of the evidence can improve needle decompression practice and outcomes in patients with tension pneumothorax.

Implications for Emergency Nurses

Why is this evidence important to emergency nurses? Awareness of needle decompression failure rates can be useful in preparing equipment for the trauma room. When you listen to the prehospital report, raise your suspicion for the patient's risk of tension pneumothorax based on mechanism of injury and be prepared by having a thoracostomy tray ready with various sizes of chest tubes. This preparation includes having 5- and 8-cm needles readily available. If a needle decompression 2ICS MCL is the intervention of choice, monitor the patient closely for possible and immediate failure, as well as potential hemorrhagic complications and the need for emergent chest tube insertion.

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