Stab, Slash, or Poke? treating tension pneumothorax

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Disclosure$$$$$

- None,
- Nada,
- Nein
- Bribes gratefully accepted

My chief researcher

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**Pneumothorax**
- Itard first coined the term pneumothorax in 1803.
- Second only to rib fractures as the most common sign of chest injury.
- However, Bailey in 2000 reported that fewer than 10% of blunt chest injuries and 15-30% of penetrating chest injuries require thoracotomy.
- Complication rates with thoracotomy as high as 36% have been reported.

**Tension Pneumothorax**
- Tension pneumothorax is life-threatening and manifests clinically as hypotension, elevated jugular venous pressure, hypoxemia, chest pain, and dyspnea, and can progress rapidly to sudden cardiac arrest.

**Tension pneumothorax**
- Occurs when "one way valve" allows air into pleural space but not out.
- Increasing volume leads to increasing pressure.
- Increasing pressure leads to decreased venous return.
- Shift of the mediastinum also puts pressure on vena cava.
- Decreased venous return leads to decreased cardiac output.
- That leads to shock and ultimately death.

**Pediatric tension pneumo**
- Same as adult except.
- Because mediastinal structures are very mobile can actually "kink" the vena cava and cause sudden complete obstruction.

**Bilateral pneumothoracies**
- The other killer.
- No mediastinal shift and may not have increased intrathoracic pressure.
- Ie not Tension pneumo just can't ventilate.

**When you put them in aircraft or intubate small pneumo's will kill them!!**
- As we go up will expand right?
  - 2000 ft climb will increase size about 10%.
- This study:
  - 66 Pts w pneumo transported 21% PPV
  - 6% required needle.
Simple physics problem right?

- Too much air in closed space what to do?
- Duh
- Remove the air right?
- But how is the question.

We all learned 14 g angio mid-clavicular line second ICS.
0.2 or 3 cm length

- Often got no response
- Kinked immediately
- Leading to the Pneumothorax flower

What else?

- Use wrong catheter?
- Maybe wrong location
- Loud environment maybe can’t hear “rush of air”

The real problem today
Wrong catheter?

- Ball et al 2010 Can J Surg: Thoracic needle decompression for tension pneumothorax: clinical correlation with catheter length
  - Looked at prehospital needle decompression over 48 months at trauma center
  - Conclusion: Tension pneumothorax decompression using a 3.2-cm catheter was unsuccessful in up to 65% of cases because too short.

Wrong Catheter

- Clemency et al Prehosp Disast Med 2015 Sufficient Catheter Length for pneumothorax needle decompression: a metanalysis
  - 13 Studies 2558 patients
  - Conclusion: A catheter length of at least 6.44 cm would be necessary to assure 95% success in reaching pleural cavity

Wrong catheter?

- Schroeder et al Injury 2013 Average chest wall thickness at two anatomic locations in trauma patients
  - Conclusion 2nd ICS Number with CWT >4.5 cm (angiocath) 29.4%
  - If BMI >30 62.5%

Wrong catheter 2

- Designed for IV access hence thin wall and flexible
- Designed for fluid to go through catheter INTO patient
- Once needle out often collapses or kinks.

So just use a 30 cm catheter right?

- Oops a lot of important structures in there
  - Heart
  - Great vessels
  - Etc.

What about different location?

- Typically put chest tubes in 4-5 ICS mid axillary line.
- Inaba et al Arch Surg 2012 Radiologic Evaluation of Alternative Sites for Needle Decompression of Tension Pneumothorax
  - Conclusion CW 1.4 cm narrower at 5 ICS AAL

<table>
<thead>
<tr>
<th>Needle Length, cm</th>
<th>L.S.S. MA (%)</th>
<th>M.S.S. MA (%)</th>
<th>Overall Injury to Critical Structures, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>0.0063</td>
<td>0.0063</td>
<td>6</td>
</tr>
<tr>
<td>55</td>
<td>0.0043</td>
<td>0.0043</td>
<td>6.1</td>
</tr>
<tr>
<td>60</td>
<td>0.0283</td>
<td>0.0283</td>
<td>4</td>
</tr>
<tr>
<td>65</td>
<td>0.0539</td>
<td>0.0539</td>
<td>6.1</td>
</tr>
<tr>
<td>70</td>
<td>0.1066</td>
<td>0.1066</td>
<td>7</td>
</tr>
<tr>
<td>80</td>
<td>0.2063</td>
<td>0.2063</td>
<td>21</td>
</tr>
</tbody>
</table>

Note: ICS, intercostal space; MA, mid axillary line.
Schroeder et al. Inj 2013 Average chest wall thickness at two anatomic locations in trauma patients.
- 201 trauma patients
- 4 ICS MCL 3.93-5.25 cm depending on BMI and Gender
- 5 ICS AAL 4.55-6.0 cm
- "so says higher in AAL opposite of prior study???

- Asked ED docs to put a marker on the 4-5th ICS
- Then took CXR Guess what happened?
  - Picked right spot 36.2% of the time
  - Slightly better in females?

Ferrie et al. Em Med J 2005
- 25 EM Docs asked to identify
  - 60% could identify 2 ICS mid clavicular site

So What?
- Spleen
- Liver
- Diaphragm

Table 3 Predicted Error for Injury Critical Structures by Needle Length

<table>
<thead>
<tr>
<th>Needle Length, mm</th>
<th>1.5 ICS MAL, Predictive % (n/N)</th>
<th>1.5 ICS MAL, Clinical % (n/N)</th>
<th>Overall Injury to Critical Structure, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>55</td>
<td>0 (0/0)</td>
<td>0 (0/0)</td>
<td>0</td>
</tr>
<tr>
<td>60</td>
<td>2 (2/10)</td>
<td>5 (1/10)</td>
<td>4</td>
</tr>
<tr>
<td>65</td>
<td>2 (2/10)</td>
<td>5 (1/10)</td>
<td>6</td>
</tr>
<tr>
<td>70</td>
<td>2 (2/10)</td>
<td>10 (1/10)</td>
<td>3</td>
</tr>
<tr>
<td>80</td>
<td>18 (9/10)</td>
<td>27 (13/10)</td>
<td>25</td>
</tr>
</tbody>
</table>

Notes: ICS, intercostal space; MAL, mid clavicular line.

Other options?
- Special needles
  - Turkel
  - Unfortunately I have no stock in company
  - 8.9 cm needle with indicator.
Upside: Should be able to tell if in
Downside: can be fooled by air pockets (think subQ air)
If going to use MUST be sure you hit rib and then as you slide over look for green not before

Scotty Bolleter has new catheter that should be available soon that corrects some of the faults of the Turkel

Larger catheter
No indicator
Has one way valve attachable to top
Supposed to be on market

Open thoracotomy
With or Without chest tube insertion?
Advantages
- Definitely should know in
- No other "organs" there
- Open
- Going to get chest tube anyway (although that is controversial)
- So why not just go ahead and make an incision
### Downside?
- Requires more training
- Requires sharp/slicing instruments
- Increased risk of bleeding
- Increased risk of infection
- Way more painful

### Two different options
- Do a chest tube and be done
  - Takes longer
  - More equipment
  - More chance for error
  - What do you do with the tube??
- Just do a thoracostomy and skip tube
  - Less time
  - Less equipment
  - Less chance for error
  - Requires intubated patient

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**Florian Air Medical Journal 2015** Letter to Ed

**Massunshi et al. Euro J Em Med 2006** Simple thoracostomy in prehospital trauma management is safe and effective: a 2-year experience by helicopter emergency medical crews

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**Table 2. Procedure-Related Complications**

<table>
<thead>
<tr>
<th>Complication</th>
<th>NA Cases</th>
<th>TT Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>No chest wall penetration</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Wrong site</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Distal lead</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Valve malfunction</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Excess blood</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Tube clamped</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Placement in tissue</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Organ perforation (abdomen)</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Difficult insertion</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>22</td>
</tr>
</tbody>
</table>

Number of procedure-related complications reported by flight nurses for prehospital NA and TT procedures.
Simple Thoracostomy: Moving Beyond Needle Decompression in Traumatic Cardiac Arrest
- Escott JEMS 2014
- Protocol for traumatic arrest patients.
- Description of how to introduce this
- No data reported.

So how do you do it?
- If not unresponsive/dead need pain med (ketamine)
- And maybe rethink?
- Mid Axillary line 4-5th ICS
- Skin incision with scalpel 2-3 cm cut over rib
- Dissect down to pleura with hemostat of Kelly
- Two choices at this point

Choices
- A. Dissect through with finger
  - Zero chance of injuring lung
  - Harder (impossible in some patients)
- B. Dissect through with hemostat
  - Easier
  - Small chance of lung injury
- In both cases need to put finger in and "sweep"

Outcomes?
- Rush of air Problem solved
- Rush of blood New problem answered
- Normal palpable lung Not the problem
- Liver or spleen too low or ruptured diaphragm

Conclusions
- Angiocath is too short and not durable
  - Not really designed for this job
  - Has very high failure rate
  - Failure rate goes up with BMI
  - Often get reoccurrence of Tension Pneumothorax
  - Kinks (again not designed for this)
  - Comes out (too short)
- On the other hand chances if causing additional injury are very low.
- May be should use different location Anterior or mid axillary line 4-5 ICS (but increases chance of injury

2010 Beer described in sheep
- This study in fresh cadavers
  - 8 tubes 4 with bougie
  - 100% in chest cavity
  - Faster with bougie
  - Smaller incision

Gottlieb et al. Bougie assisted thoracostomy
Conclusions

- Other tube options are much better if going to stick to needle aspiration.
  - Designed for this job
  - Length is more appropriate
  - They are an Actual tube less kinking stay in better
  - Better connectors (3 way valve)
  - Best with indicator of entry into chest cavity
  - Don’t push all the way in

Conclusion

- Thoracotomy for intubated or dead patients probably the highest success rate.
- If don’t put in a tube appears almost as fast as needle
  - Requires training and extra equipment
  - Don’t really know risks yet
  - Criteria are all important
  - Seems little reason in this group to put in the tube prehospital
  - Is important that you tell the receiving hospital you did this.

Questions ??????