**WORKSHEET for Evidence-Based Review of Science for Emergency Cardiac Care**

**Worksheet author(s)**

Diana Fendya
Peter Morley

**Date Submitted for review:**
10/9/2009 Revised 2-10-2010, Final revision: 6 March 2010

**Clinical question.**

In infants and children with respiratory failure who undergo endotracheal intubation (prehospital [OHCA], in-hospital [IHCA]) (P), does the use of devices (eg. CO2 detection device, CO2 analyzer or esophageal detector device) (I) compared with usual management (C), improve the accuracy of diagnosis of airway placement (O)?

**Is this question addressing an intervention/therapy, prognosis or diagnosis?** Intervention/therapy

**State if this is a proposed new topic or revision of existing worksheet:** Revision/update of two 2005 worksheets

**Conflict of interest specific to this question**

Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet?

I have no commercial associations, research grants or conflicts of interest that might pose a conflict with this worksheet. Conflict of interest form has been uploaded in file attachments.

**Search strategy (including electronic databases searched).**

Pub med utilizing mesh search terms, Ovid, Cochrane ad Embase were all utilized to identify new studies, 2005 – present, that addressed the clinical question for this worksheet.

**Pub Med and Mesh search terms 5-09**

<table>
<thead>
<tr>
<th>Search Code</th>
<th>Search Term</th>
<th>Time</th>
<th>Results</th>
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<td>#2</td>
<td>Search intubation, intratracheal</td>
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<td>#1</td>
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</tbody>
</table>

**EMBASE SEARCH**

'carbon dioxide'/exp AND (measurement OR detection OR device OR devices OR detector OR detect OR analyze OR analyzer) OR 'capnography'/exp

AND'respiratory failure'/exp OR 'resuscitation'/exp

AND 'respiratory tract intubation'/exp

AND([newborn]/lim OR [infant]/lim OR [child]/lim)

EMBASE.com Search Results - 37 Records - Fri Aug 21 14:53:02 EDT 2009
Cochrane Search
No new listing as of 2003 were identified.

OVID Search (10-24-09)
Esophageal detector specific - no new listings meeting criteria.

<table>
<thead>
<tr>
<th>State inclusion and exclusion criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inclusion criteria:</strong></td>
</tr>
<tr>
<td>Capnography used as a tool in confirming successful pediatric/infant tracheal intubation.</td>
</tr>
<tr>
<td>Esophageal detectors used as a tool in confirming pediatric/infant tracheal intubation.</td>
</tr>
<tr>
<td><strong>Exclusion Criteria:</strong></td>
</tr>
<tr>
<td>Abstracts and review articles</td>
</tr>
<tr>
<td>Capnography used as a tool to assess ventilation effectiveness</td>
</tr>
<tr>
<td>Capnography used as a tool in resuscitation to predict prognosis.</td>
</tr>
<tr>
<td>Animal studies</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of articles/sources meeting criteria for further review:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Five new studies were identified specific to children, one of which was a review article. Four publications met the criteria for further review. Three new studies were case series reporting on the use of capnography to confirm tracheal tube placement in neonates or low birth weight infants, while one was a case series of intubated children undergoing interfacility transport.</td>
</tr>
</tbody>
</table>
## Summary of evidence

### Evidence Supporting Clinical Question

<table>
<thead>
<tr>
<th>Level of evidence</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Evidence Supporting Clinical Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level of evidence</th>
<th>A = Return of spontaneous circulation</th>
<th>C = Survival to hospital discharge</th>
<th>E = Other endpoint</th>
<th>Italics = Animal studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>B = Survival of event</td>
<td>D = Intact neurological survival</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(https://circ.ahajournals.org/content/vol0/issue2005/images/data/CIRCULATIONAHA.105.170522/DC38/W25_Kleinman.doc)
# Evidence Neutral to Clinical question

| Good | | | | | |
|------|---|---|---|---|
|      | | Sharieff 2003 (303) (E) | Andersen 1989 (E) | Zaleski 1993 (E) |
| Fair | | | | |
| Poor | | | | |

<table>
<thead>
<tr>
<th>Level of evidence</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
</table>

A = Return of spontaneous circulation  
B = Survival of event  
C = Survival to hospital discharge  
D = Intact neurological survival  
E = Other endpoint  
*Italicics = Animal studies*

# Evidence Opposing Clinical Question

| Good | | | | | |
|------|---|---|---|---|
|      | | | | |
| Fair | | Bozeman 1996 (E)  
Lang 1996 (E)  
Li 2001 (E)  
Puntervoll 2002 (E) | |
| Poor | | Haynes 1990 (E) | |

<table>
<thead>
<tr>
<th>Level of evidence</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
</table>

A = Return of spontaneous circulation  
B = Survival of event  
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D = Intact neurological survival  
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*Italicics = Animal studies*
REVIEWER’S FINAL COMMENTS AND ASSESSMENT OF BENEFIT / RISK:

This is an update of a 2005 worksheet.

2005 Treatment Recommendations:

1) In all settings (ie, prehospital, emergency departments, intensive care units, operating rooms), confirmation of tracheal tube placement should be achieved using detection of exhaled CO2 in intubated infants and children with a perfusing cardiac rhythm. This may be accomplished using a colorimetric detector or capnometry. During cardiac arrest, if exhaled CO2 is not detected, tube position should be confirmed using direct laryngoscopy.

2) We recommend monitoring tracheal tube placement and patency in infants and children with a perfusing rhythm by continuous measurement or frequent intermittent detection of exhaled CO2 during prehospital and intra- and interhospital transport.

3) The esophageal detector device may be considered for confirmation of tracheal tube placement in children weighing >20 kg.

Since 2005, 5 additional studies were identified looking at the use of capnography and/or end-tidal CO2 for confirmation of tracheal tube placement. No new studies were found addressing the use of esophageal detectors for confirmation of tracheal tube placement. All of the new studies further support the use of colorimetric detectors and capnometry for confirmation of endotracheal tube placement following intubation and during transport.

Three of the additional studies are LOE 5 (Hosono, 2009, 79; O'Donnell, 2006, 16; Salth, 2006,1033) and focused upon intubation in neonates in the delivery room and the use of end-tidal CO2 in very low birthweight infants. Resuscitation at birth is a unique situation due to the transition from fetal circulation to postnatal circulation. Authors of all 3 studies showed that the time taken to verify proper placement of the ETT was less with midstream capnography and ETCO2 detectors than with clinical assessments of tube placement in this population. The only caution to use of capnography or end-tidal CO2 detector for confirmation of tracheal tube position was the possibility of a false negative when the child/infant was/is in cardiac arrest, at which time confirmation by direct laryngoscopy should be employed.

One new study reported the results of capnometry use for 50 intubated children during inter-hospital transport. The specific capnometer used was found to be accurate for monitoring ETT position in all cases.

One additional study (Wyllie, 2006, 111) was a review paper of evidence on the secondary confirmation of tracheal intubation in the newly born. The author identified 21 relevant studies looking at secondary confirmation of endotracheal tube placement. Four key studies were discussed, of which one reported tracheal tube confirmation in 40 patients, both infants and children. All studies were assessed by two reviewers, assessing levels of evidence, design and method. All papers were supportive of their hypothesis – “1.) Monitoring of exhaled CO2 can be useful in the secondary confirmation of tracheal intubation in the newly born, particularly when clinical assessment is equivocal. 2.) Tracheal tube placement must be confirmed after intubation, especially in infants with a low heart rate that is not rising. During cardiac arrest, if exhaled carbon dioxide is not detected, tube placement should be confirmed with direct laryngoscopy.” Because this was primarily a review article, this article was not included on the evidence evaluation tables.

Acknowledgements: Monica Kleinman
Dianne Atkins
Citation List


LOE 5, Good, neutral.


LOE 5 (adults), Fair, supportive


LOE 5 - Supports exclusion of pregnant patients from recommendations for use of EDD. Not included in evidence tables.


LOE 5 - Piglet model using syringe device. Of note, no difference noted with cuffed and uncuffed endotracheal tubes, but overall accuracy of the device was low. Larger syringe size (20 mL) appears best in terms of maximizing sensitivity and specificity. Not included in evidence tables.


LOE 4 Quality of Study – Good. Supportive. Evaluation of adult-sized colorimetric detector in children. With a perfusing rhythm, device was 100% sensitive and specific for confirming tracheal tube position. During cardiac arrest, sensitivity was 88% and specificity was 100% for confirmation of tracheal tube.


LOE 4 Quality of Study – Good, supportive.


LOE 5 (adults), Fair, Opposing. In this series, the EDD performed as well in patients with a perfusing rhythm as it did for those in cardiac arrest, with 99 - 100% sensitivity for confirming ETT placement. In the cardiac arrest population, the EDD was a superior diagnostic device compared with exhaled CO$_2$ detection.


LOE 5 (adults), Fair, Supportive.


LOE 5 (adults), Fair, Supportive.

LOE 5, Good, Supportive: Animal study using “adult-sized” pigs. This study showed that prior ventilation via an esophageal tube did not affect the EDD’s ability to correctly identify esophageal intubation. This is relevant because during resuscitation, gastric insufflation during positive-pressure ventilations commonly occurs prior to endotracheal intubation.


LOE 5, adults. Fair, supportive


LOE 5, Fair, Supportive. (animal)


LOE 5, poor, supportive (adults)


LOE 4 Quality of Study – Poor, Opposing. Although this study showed that the EDD was unreliable in intubated infants, it is supportive of limiting the use of the EDD to children >20kg, who are most likely to be over two years of age.


LOE 5, Fair, Neutral – adults - showed that the EDB functioned reliably in the aeromedical environment, suggesting it is not affected significantly by changes in altitude or pressurization. However, was only 80% sensitive in the detection of esophageal intubations, which is lower than the sensitivity found in most adult studies.


LOE 5 Quality of Study – Fair, Supportive.
Focus of study directly relates to question being examined but study population was only low weight infants/neonates. Extrapolation of findings may provide support to the intervention being studied.


LOE 5, Fair, Supportive (adults)


LOE 5, Fair, Supportive (adults)

LOE 4 Quality of Study – Good, Supportive.


LOE 5, Fair, Opposing – adults (morbidly obese)


LOE 5, Fair, Opposing (adults) – metanalysis


LOE 5, Fair, Supportive (adults)


LOE 5, Good, Supportive (adults)


LOE 5, Fair, Neutral (cadavers)


LOE 5 Quality of Study – Fair, Supportive
This study was not designed to look at tube confirmation via capnography or ETCO2 but a secondary finding of the study reported that flow signals and ETCO2 may be useful in determining ETT positions more quickly than clinical assessment alone in neonates. Extrapolation of findings may provide support to the intervention being studied.


LOE 5, Fair, Supportive (adults)


LOE 5, Fair, Supportive (adults)


LOE 5, Fair, Neutral: In this adult pre-hospital study, the EDD was sensitive for confirming tracheal intubation but not sensitive for detecting esophageal placement.


LOE 5, Fair, Supportive (animal)

LOE 5, Fair, Opposing (adult)


LOE 5, Fair, Supportive (adult)


LOE 5 Quality of Study – Fair, Supportive
Utilizing 4 case studies, this paper reported the effectiveness of capnography in confirming correct placement of endotracheal tubes in neonates. Extrapolation of findings from this very limited study may provide support to the intervention being studied.


LOE 5, Fair, Supportive (adult)


LOE 5, Fair, Supportive (adults)


LOE 5, Fair, Supportive (adult)


LOE 2 Quality of Study – Good, Supportive


LOE 4, Good, Neutral


LOE 4; Fair Quality, Supportive


LOE 5, Fair, Neutral (adult) - This study showed that the EDD may be unreliable in the setting of cardiac arrest. It also emphasizes that direct visualization is important to confirm tracheal tube placement in settings where other detection devices may be equivocal.

LOE 5, Fair, Supportive (animals)


LOE 5, Fair, Supportive (adults)


LOE 2 Quality of Study – Fair, Supportive


LOE 5, Good, Supportive (adults)


This was a review article and based upon discussion during presentation to the Pediatric Subcommittee on 10-19-2009, this article was removed from the evidence table.


LOE 5, Good, Neutral (adults)