COMPARISON OF DIRECT VERSUS INDIRECT LARYNGOSCOPY FOR INTUBATION IN THE PREHOSPITAL SETTING: A SYSTEMATIC REVIEW AND META-ANALYSIS

A PROGRESS UPDATE
BRIAN SAVINO
Laryngoscopy as practiced today was developed in the 1940s.

Classically the Macintosh and Miller blades are used to intubate, especially in the acute-care settings (ED, ICU).
INDIRECT LARYNGOSCOPY

- National Overall Success of Direct: 85%

- Indirect video devices introduced in early 2000s and rapidly gained acceptance in ED settings.

- Hospital studies show improved first-pass success rates and time to successful intubation, especially among novice intubators.

DIRECT VS INDIRECT LARYNGOSCOPY

Direct

Indirect
INDIRECT DEVICE EXAMPLES

- Macintosh Reusable Blades and Handles
- Glidescope Ranger
- AirTraq
- King Vision LT
PREHOSPITAL INTUBATION

• Studies show paramedics outcomes are worse than physicians.

• Can we apply hospital success with novice intubators to the prehospital setting?

• Is there evidence for benefit for indirect laryngoscopy in the prehospital setting when compared to direct?
WHY LOOK INTO THIS?

• Prehospital treatment isn’t always the same as in-hospital treatment.

• EMS systems vary – what’s good for one isn’t necessarily good for all.

• Cost/Benefit: These Indirect devices cost money and require training!
RESEARCH QUESTION

• For definitive airway management in the prehospital setting, does indirect laryngoscopy lead to better overall intubation success and first-pass success than direct laryngoscopy?

• PICO
  • P – patients requiring intubation in the prehospital setting
  • I – Indirect Laryngoscopy
  • C – Direct Laryngoscopy
  • O – Overall Success, First-pass success
WHAT RESEARCH EXISTS?

• We can do: A Systematic Review and Meta-analysis
DEFINITIONS

• Direct Laryngoscopy: Insertion of the endotracheal tube by a method of directly visualizing the vocal cords.
  • Examples: Macinotosh blade, Miller Blade.

• Indirect Laryngoscopy: Insertion of the endotracheal tube by a method of indirectly visualizing the vocal cord, either using a video camera or optics (mirrors).
  • Examples: (GlideScope, Airtraq, King Vision LT)
Inclusion Criteria:
- Prehospital Setting
- Human Studies

Exclusion Criteria:
- No comparison to direct laryngoscopy
- Case Reports and Case Series studies
- Studies restricted to pediatrics
- Studies comparing indirect laryngoscopy to rescue airway devices (supraglottic airways, oral airways, bag-valve mask)
- In-hospital settings (ED, OR, ICU etc.)
- Non-human studies, manikin studies
- Cadaver Studies
SYSTEMATIC REVIEW

• Outcomes:
  • Overall Success
  • First Pass Success

• Search Terms:
  • EMS, Emergency Medical Services, Prehospital, Pre-hospital, Paramedic, Air Medical, Helicopter, Out-of-Hospital/Out of Hospital AND
  • Video laryngoscopy
  • Video Intubation
  • Indirect Laryngoscopy
  • Indirect Intubation
  • Glidescope
  • Airtraq
  • Vividtrac
  • CMAC, C-MAC
  • King Vision
OUTCOME DEFINITIONS

• Overall Success Rate: Proportion of patients successfully intubated with the intended device

• First-Pass Success Rate: Proportion of patients successfully intubated with the intended device on the first attempt.
WHY THE PROXY MEASURES OF OUTCOME?

- Traditionally, EMS and Hospital systems do not share data. This is starting to change, but still very difficult to follow up on patients.

- Developing a proxy measure of outcome versus longitudinal follow-up is more cost-effective, especially for regular QI activities.

- Acute-care in-hospital studies show the most predictive variable for poor outcomes is the number of intubation attempts:
  - 1 attempt: 14% adverse event rate
  - 2 attempts or more: 47% adverse event rate
PubMed: 282
SCOPUS: 230
Total: 364
Excluded on Title: 289
Abstracts Reviewed: 74
Papers Reviewed: 16
Final: 7

Excluded on abstract review: 58
No IDL Comparison: 1
Not in English: 1
Different Outcome Measure: 1
Glottic Airway Comparison: 1
Letter to Editor: 2
No DL Comparison: 4
Hospital Setting: 8
Case Report/Series: 10
Reviews: 14
Simulation Study: 16
Excluded on paper review: 9
Case Report: 1
Hospital Setting: 4
Letter to Editor: 4
# SYSTEMATIC REVIEW – STUDY CHARACTERISTICS

<table>
<thead>
<tr>
<th>Reference</th>
<th>Study Type</th>
<th>Device</th>
<th>Country</th>
<th>Operators</th>
<th>Setting</th>
<th>Baseline intubations per year</th>
<th>Outcomes</th>
<th>Age (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arima 2013 (16)</td>
<td>Randomized controlled trial</td>
<td>Airway Scope</td>
<td>Japan</td>
<td>Physicians</td>
<td>Ground</td>
<td>≥100</td>
<td>Overall and first-pass success</td>
<td>≥18</td>
</tr>
<tr>
<td>Boehringer 2015 (19)</td>
<td>Retrospective chart review</td>
<td>C-MAC</td>
<td>USA</td>
<td>Nurses and Paramedics</td>
<td>Air</td>
<td>Not reported</td>
<td>Overall and first-pass success</td>
<td>All</td>
</tr>
<tr>
<td>Guyette 2013 (20)</td>
<td>Non-randomized controlled trial</td>
<td>C-MAC</td>
<td>USA</td>
<td>Nurses and Paramedics</td>
<td>Air</td>
<td>12</td>
<td>Overall and first-pass success</td>
<td>≥18</td>
</tr>
<tr>
<td>Jarvis 2015 (17)</td>
<td>Retrospective chart review</td>
<td>King Vision</td>
<td>USA</td>
<td>Paramedics</td>
<td>Ground</td>
<td>2.9</td>
<td>Overall and first-pass Success</td>
<td>All</td>
</tr>
<tr>
<td>Selde 2014 (12)</td>
<td>Retrospective chart review</td>
<td>AirTraq</td>
<td>USA</td>
<td>Nurses and Paramedics</td>
<td>Air</td>
<td>Not Reported</td>
<td>First-pass success</td>
<td>≥18</td>
</tr>
<tr>
<td>Trimmel 2011 (22)</td>
<td>Randomized controlled trial</td>
<td>AirTraq</td>
<td>Austria</td>
<td>Physicians</td>
<td>Air</td>
<td>≥80</td>
<td>Overall success</td>
<td>≥18</td>
</tr>
<tr>
<td>Wayne 2010 (18)</td>
<td>Non-randomized controlled trial</td>
<td>GlideScope Ranger</td>
<td>USA</td>
<td>Paramedics</td>
<td>Ground</td>
<td>6-10</td>
<td>Overall success</td>
<td>≥6</td>
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</tbody>
</table>

Table 1 – Study Characteristics
# Overall Success Stratified By Operator

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>RR (95% CI)</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors</td>
<td>Design</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Physician</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boehringer et al</td>
<td>Observational</td>
<td>0.20 (0.05, 0.84)</td>
<td>16.80</td>
</tr>
<tr>
<td>Guyette et al</td>
<td>Observational</td>
<td>1.20 (0.50, 2.86)</td>
<td>18.39</td>
</tr>
<tr>
<td>Jarvis et al</td>
<td>Observational</td>
<td>0.24 (0.16, 0.36)</td>
<td>19.25</td>
</tr>
<tr>
<td>Wayne et al</td>
<td>Observational</td>
<td>0.57 (0.25, 1.29)</td>
<td>18.53</td>
</tr>
<tr>
<td>Subtotal (I-squared = 76.6%, p = 0.005)</td>
<td></td>
<td>0.44 (0.19, 1.00)</td>
<td>72.96</td>
</tr>
<tr>
<td>Physician</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arima et al</td>
<td>RCT</td>
<td>42.63 (2.65, 685.54)</td>
<td>12.09</td>
</tr>
<tr>
<td>Trimmel et al</td>
<td>RCT</td>
<td>56.00 (7.90, 397.15)</td>
<td>14.94</td>
</tr>
<tr>
<td>Subtotal (I-squared = 0.0%, p = 0.875)</td>
<td></td>
<td>51.15 (10.32, 253.57)</td>
<td>27.04</td>
</tr>
<tr>
<td>Overall (I-squared = 93.4%, p = 0.000)</td>
<td></td>
<td>1.56 (0.33, 7.47)</td>
<td>100.00</td>
</tr>
</tbody>
</table>

**NOTE:** Weights are from random effects analysis
META-ANALYSIS
OVERALL SUCCESS WITH IDL VS DL

Funnel plot with pseudo 95% confidence limits
OBSERVATIONS

• Significant heterogeneity when physician/non-physicians grouped together, but not when separated.

• Physicians (experienced operators) do better with DL for overall success while non-physicians (inexperienced operators) do better with IDL.

• RCTs show better results with DL than observational studies (although RCTs both used physicians).
First-Pass Success Stratified by Operator

<table>
<thead>
<tr>
<th>Authors</th>
<th>Trial Type</th>
<th>RR (95% CI)</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arima et al</td>
<td>RCT</td>
<td>1.77 (1.00, 3.15)</td>
<td>18.99</td>
</tr>
<tr>
<td>Subtotal (I-squared = .%, p = .)</td>
<td></td>
<td>1.77 (1.00, 3.15)</td>
<td>18.99</td>
</tr>
<tr>
<td>Non-Physician</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boehringer et al</td>
<td>Observational</td>
<td>0.21 (0.11, 0.39)</td>
<td>18.45</td>
</tr>
<tr>
<td>Guyette et al</td>
<td>Observational</td>
<td>1.03 (0.74, 1.44)</td>
<td>21.61</td>
</tr>
<tr>
<td>Jarvis et al</td>
<td>Observational</td>
<td>0.49 (0.39, 0.61)</td>
<td>22.52</td>
</tr>
<tr>
<td>Selde et al</td>
<td>Observational</td>
<td>0.79 (0.42, 1.47)</td>
<td>18.43</td>
</tr>
<tr>
<td>Subtotal (I-squared = 88.2%, p = 0.000)</td>
<td></td>
<td>0.55 (0.31, 0.98)</td>
<td>81.01</td>
</tr>
<tr>
<td>Overall (I-squared = 89.7%, p = 0.000)</td>
<td></td>
<td>0.68 (0.38, 1.23)</td>
<td>100.00</td>
</tr>
</tbody>
</table>

NOTE: Weights are from random effects analysis
META-ANALYSIS
FIRST-PASS SUCCESS WITH IDL VS DL

Funnel plot with pseudo 95% confidence limits
OBSERVATIONS

• Only one study used physicians, only study is an RCT.

• Again, non-physicians seem to perform better with IDL than DL.

• Still some significant heterogeneity.
SO WHAT SHOULD WE DO?

• There is not currently evidence to support or discourage the use of indirect laryngoscopy in the prehospital setting. Studies are heterogeneous.

• Medical directors and EMS/Public Health agencies interested in deploying these devices should consider looking at studies that mirror their systems (i.e. helicopter, physician-based etc, experience)

• Training is crucial. Many studies suggested the reason for their results had to do with inadequate training.

• Non-studied benefits: Recording intubations for QI/Training, more unified training, ease/quickness of learning skill

• Non-studied harms: Device failure, cost, loss of skills

• MORE STUDIES ARE NEEDED HERE!
REFERENCES

WIDE CI

<table>
<thead>
<tr>
<th></th>
<th>Failure</th>
<th>Success</th>
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<tbody>
<tr>
<td>IDL</td>
<td>56</td>
<td>50</td>
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<td>DL</td>
<td>1</td>
<td>105</td>
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<td></td>
<td>57</td>
<td>155</td>
</tr>
</tbody>
</table>

\[
RR = \frac{56}{106}/\left(\frac{1}{106}\right) = \frac{.5283}{.009433} = 56
\]

\[
\ln(56) \pm 1.96 \sqrt{\frac{50/56}{106} + \frac{(105/1)}{106}} = 4.02535 \pm 1.959 = (e^{2.06}, e^{5.98435})
\]

95% CI = (7.896, 397.1543)