Pro-Con Debate: Tracheostomy Timing in the PICU

CHARMAINE CROOKS-EDWARDS & MICHAEL DERYNCK
Objectives

- Tracheostomy overview
- Benefits of early tracheostomy
- Benefits of late tracheostomy
Tracheostomy

Life saving procedure

Varied indications

- Acute airway management
- Upper airway obstruction
- Lower airway ventilation / access

Percentage Infection, Airway Abnormality, Neurologic Deficit, Craniofacial Abnormality

1963-1970
- Infection: 50%
- Airway Abnormality: 20%
- Neurologic Deficit: 10%
- Craniofacial Abnormality: 20%

1976-1985
- Infection: 40%
- Airway Abnormality: 30%
- Neurologic Deficit: 20%
- Craniofacial Abnormality: 10%

2000-2009
- Infection: 50%
- Airway Abnormality: 40%
- Neurologic Deficit: 10%
- Craniofacial Abnormality: 0%
To trach,
or not to trach...
Adult ICU

Percentage

1 - 7 d
8 - 14 d
15 - 21 d
> 21 d

COPD
ARF
Neuromuscular

Esteban, A et al. AJRCCM. 2000; Durbin, CG Jr. et al. Respir Care. 2010
Adult ICU

Durbin, CG Jr. et al. Respir Care. 2010
TIME TO GO!
THE BIG DEBATE
Early tracheostomy is beneficial in the pediatric population

MICHAEL DERYNCK
Tracheostomy is safe
Accidental decannulation
Stoma infection
Stoma bleeding
Subcutaneous emphysema
Suprastomal granulation
Infrastomal granulation
Tracheomalacia
Tracheoinnominate fistula
Tracheocutaneous fistula
Stoma granulation

Percentage

Chronic complications
Perioperative complications
Percentage


Accidental decannulation (no mortality)
Accidental decannulation (mortality)
Pneumothorax
Pneumomediastinum
Wound infection
Erosion
Size
Abscess
Total complications

1982 - 1991
1992 - 2001
2002 - 2011
Early tracheostomy improves health outcomes
Incidence of HAP

<table>
<thead>
<tr>
<th>Group by Week</th>
<th>Study name</th>
<th>Odds ratio</th>
<th>Lower Limit</th>
<th>Upper Limit</th>
<th>Z-Value</th>
<th>p-Value</th>
</tr>
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<tbody>
<tr>
<td>1st week</td>
<td>Rodriguez et al 1990</td>
<td>0.21</td>
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<td>1.09</td>
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<td>Rumbach et al 2004</td>
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<td>0.81</td>
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<td>Moller et al 2005</td>
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<td>0.95</td>
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<td>Barquist et al 2006</td>
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<td>0.38</td>
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<td>Yue et al 2012</td>
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<td>0.91</td>
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<tr>
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<td>Koch et al 2012</td>
<td>0.54</td>
<td>0.15</td>
<td>0.78</td>
<td>-2.57</td>
<td>0.01</td>
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<td>Tong et al 2012</td>
<td>0.72</td>
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<td>0.77</td>
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<td>Gessler et al 2015</td>
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<td>0.20</td>
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<td>Wang et al 2012</td>
<td>0.53</td>
<td>0.42</td>
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<tr>
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<td>Devrajn et al 2012</td>
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<td>Choi et al 2013</td>
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<td>Villwock et al 2014</td>
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<td>0.44</td>
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<td>-1.08</td>
<td>0.28</td>
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<tr>
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<td>Villwock &amp; Jones</td>
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<td>0.44</td>
<td>1.27</td>
<td>-1.08</td>
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<td>Jeon et al 2014</td>
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<td>Keenan et al 2015</td>
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<td>Mohaffen et al 2012</td>
<td>0.29</td>
<td>0.12</td>
<td>0.75</td>
<td>2.57</td>
<td>0.01</td>
</tr>
<tr>
<td>Overall</td>
<td></td>
<td>0.68</td>
<td>0.60</td>
<td>0.77</td>
<td>-6.09</td>
<td>0.00</td>
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</tbody>
</table>

Hospital Acquired Pneumonia
## Incidence of HAP

<table>
<thead>
<tr>
<th>Study name</th>
<th>Statistics for each study</th>
<th>Odds ratio and 95% CI</th>
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<tbody>
<tr>
<td></td>
<td>Odds ratio</td>
<td>Lower limit</td>
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<tr>
<td>Holscher et al 2014</td>
<td>0.22</td>
<td>0.04</td>
</tr>
<tr>
<td>Lee et al 2016</td>
<td>0.40</td>
<td>0.04</td>
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<tr>
<td></td>
<td>0.27</td>
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</table>

0.01 0.1 1 10 100

- **Favours Early**
- **Favours Late**
# Duration of Mechanical Ventilation

<table>
<thead>
<tr>
<th>Group by WEEK</th>
<th>Study name</th>
<th>Std diff in means</th>
<th>Standard error</th>
<th>Variance</th>
<th>Lower limit</th>
<th>Upper limit</th>
<th>Z-Value</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st week</td>
<td>Rodríguez et al 1990</td>
<td>-8.81</td>
<td>0.64</td>
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<td>Gatil et al 2004</td>
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<td>Arabi et al 2004</td>
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<td>-6.17</td>
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<td>-2.53</td>
<td>-1.64</td>
<td>-6.20</td>
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<td>Barquist et al 2006</td>
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<td>0.48</td>
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<td>0.91</td>
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<td>Bole et al 2012</td>
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<td>0.04</td>
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<td>-0.50</td>
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<td>Tong et al 2012</td>
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<td>Hyde et al 2014</td>
<td>-0.43</td>
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<td>0.04</td>
<td>-0.81</td>
<td>-0.04</td>
<td>-2.17</td>
<td>0.03</td>
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<td>1st week</td>
<td>Gessier et al 2015</td>
<td>-2.68</td>
<td>0.24</td>
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<td>-3.16</td>
<td>-2.21</td>
<td>-11.03</td>
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<td>0.52</td>
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<td>-1.93</td>
<td>-5.71</td>
<td>0.00</td>
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<tr>
<td>2nd week</td>
<td>Wang et al 2012</td>
<td>-0.91</td>
<td>0.30</td>
<td>0.09</td>
<td>-1.49</td>
<td>-0.32</td>
<td>-3.05</td>
<td>0.00</td>
</tr>
<tr>
<td>2nd week</td>
<td>Choi et al 2012</td>
<td>-1.39</td>
<td>0.49</td>
<td>0.24</td>
<td>-2.35</td>
<td>-0.44</td>
<td>-2.86</td>
<td>0.00</td>
</tr>
<tr>
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<td>Alhajhusain et al 2014</td>
<td>-1.21</td>
<td>0.22</td>
<td>0.05</td>
<td>-1.65</td>
<td>-0.78</td>
<td>-5.50</td>
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<td>-0.39</td>
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<td>Jeon et al 2014</td>
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<td>-0.37</td>
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<td>-5.88</td>
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<td>-0.93</td>
<td>-5.05</td>
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<tr>
<td>Overall</td>
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<td>-1.06</td>
<td>0.12</td>
<td>0.02</td>
<td>-1.30</td>
<td>-0.82</td>
<td>-8.61</td>
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All cases
Craniofacial anomalies
Upper airway obstruction
Neurologic deficit
Prolonged ventilation
Post-traumatic sequelae

Days on Ventilator

Early
Late

140 patients
SMD -0.99 (95% CI -1.45 to -0.52)
Days of Sedation

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Early tracheostomy</th>
<th>Prolonged intubation</th>
<th>Mean difference</th>
<th>Mean difference</th>
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<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Total</td>
<td>Mean</td>
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<tr>
<td>Blot et al 2008</td>
<td>12.5</td>
<td>6.75</td>
<td>61</td>
<td>13.75</td>
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<tr>
<td>Young et al 2013</td>
<td>5</td>
<td>4.44</td>
<td>455</td>
<td>7</td>
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<td>Trouillet 2011</td>
<td>6.4</td>
<td>5.9</td>
<td>109</td>
<td>9.6</td>
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<td>Bosel 2012</td>
<td>7.19</td>
<td>3.4</td>
<td>29</td>
<td>11</td>
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<tr>
<td>Zheng et al 2012</td>
<td>7.16</td>
<td>0.8</td>
<td>58</td>
<td>10.5</td>
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<tr>
<td>Total (95% CI)</td>
<td></td>
<td></td>
<td>712</td>
<td></td>
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</tbody>
</table>

Heterogeneity. Tau² = 0.61; Chi² = 15.14, df = 4 (P = 0.004); I² = 74%
Test for overall effect: Z = 6.05 (P < 0.00001)
### Sedation Free Days

#### Early, within 4 days; Late, after 10 days

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Early Mean SD</th>
<th>Late Mean SD</th>
<th>Weight</th>
<th>Mean Difference IV, Random, 95% CI Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blot 2008 [40]</td>
<td>18 6.75</td>
<td>61 15 6.75</td>
<td>62 9.9%</td>
<td>3.00 [0.61, 5.39] 2008</td>
</tr>
<tr>
<td>Zheng 2012 [41]</td>
<td>20.64 2.35</td>
<td>58 17.05 2.3</td>
<td>61 80.7%</td>
<td>3.79 [2.95, 4.63] 2012</td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>119</td>
<td>123</td>
<td>90.6%</td>
<td>3.70 [2.91, 4.49]</td>
</tr>
</tbody>
</table>

Heterogeneity: Tau² = 0.00; Chi² = 0.38, df = 1 (P = 0.54); I² = 0%
Test for overall effect: Z = 9.20 (P < 0.00001)

#### Early, within 10 days; Late, after 10 days

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Early Mean SD</th>
<th>Late Mean SD</th>
<th>Weight</th>
<th>Mean Difference IV, Random, 95% CI Year</th>
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</thead>
<tbody>
<tr>
<td>Subtotal (95% CI)</td>
<td>109</td>
<td>107</td>
<td>9.4%</td>
<td>3.50 [1.05, 5.95]</td>
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</table>

Heterogeneity: Not applicable
Test for overall effect: Z = 2.80 (P = 0.005)

Total (95% CI)

<table>
<thead>
<tr>
<th>Early Mean SD</th>
<th>Late Mean SD</th>
<th>Weight</th>
<th>Mean Difference IV, Random, 95% CI Year</th>
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</thead>
<tbody>
<tr>
<td>228</td>
<td>230</td>
<td>100.0%</td>
<td>3.68 [2.93, 4.44]</td>
</tr>
</tbody>
</table>

Heterogeneity: Tau² = 0.00; Chi² = 0.40, df = 2 (P = 0.82); I² = 0%
Test for overall effect: Z = 9.61 (P < 0.000001)
Test for subgroup differences: Chi² = 0.02, df = 1 (P = 0.88), I² = 0%
<table>
<thead>
<tr>
<th>Endotracheal intubation</th>
<th>Tracheostomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Ease of placement</td>
<td>• Safety of reinsertion</td>
</tr>
<tr>
<td>• No surgery</td>
<td>• Reduced laryngeal damage</td>
</tr>
<tr>
<td>• Low initial cost / resource use</td>
<td>• Improved oral hygiene</td>
</tr>
</tbody>
</table>
<pre><code>                                                             | • Vocalization and communication                |
                                                             | • Improved patient comfort                      |
                                                             | • Better swallowing function                    |
                                                             | • Improved weaning from mechanical ventilation  |
</code></pre>

Durbin, CG Jr. et al. Respir Care. 2010
Early tracheostomy improves healthcare resource utilization
## ICU Length of Stay

<table>
<thead>
<tr>
<th>Week</th>
<th>Study Name</th>
<th>Std diff in means</th>
<th>Standard error</th>
<th>Variance</th>
<th>Lower limit</th>
<th>Upper limit</th>
<th>Z Value</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st week</td>
<td>Rodriguez et al 1990</td>
<td>-7.08</td>
<td>0.52</td>
<td>0.27</td>
<td>-8.11</td>
<td>-6.06</td>
<td>-13.52</td>
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<td>1st week</td>
<td>Armstrong et al 1998</td>
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<td>0.17</td>
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<tr>
<td>1st week</td>
<td>Gatti et al 2004</td>
<td>-1.39</td>
<td>0.46</td>
<td>0.21</td>
<td>-2.28</td>
<td>-0.49</td>
<td>-3.02</td>
<td>0.00</td>
</tr>
<tr>
<td>1st week</td>
<td>Arabi et al 2004</td>
<td>-7.89</td>
<td>0.52</td>
<td>0.27</td>
<td>-9.82</td>
<td>-6.87</td>
<td>-15.11</td>
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<tr>
<td>1st week</td>
<td>Moller et al 2005</td>
<td>-7.89</td>
<td>0.44</td>
<td>0.19</td>
<td>-8.75</td>
<td>-7.04</td>
<td>-18.09</td>
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<tr>
<td>1st week</td>
<td>Rumbak et al 2004</td>
<td>-3.98</td>
<td>0.32</td>
<td>0.10</td>
<td>-4.60</td>
<td>-3.36</td>
<td>-12.63</td>
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</tr>
<tr>
<td>1st week</td>
<td>Ahmed and Kuo 2007</td>
<td>-0.68</td>
<td>0.28</td>
<td>0.08</td>
<td>-1.22</td>
<td>-0.14</td>
<td>-2.45</td>
<td>0.01</td>
</tr>
<tr>
<td>1st week</td>
<td>Barquist et al 2006</td>
<td>-0.05</td>
<td>0.26</td>
<td>0.07</td>
<td>-0.55</td>
<td>0.46</td>
<td>-0.19</td>
<td>0.85</td>
</tr>
<tr>
<td>1st week</td>
<td>Zagli et al 2010</td>
<td>-0.34</td>
<td>0.09</td>
<td>0.01</td>
<td>-0.52</td>
<td>-0.17</td>
<td>-2.88</td>
<td>0.00</td>
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<tr>
<td>1st week</td>
<td>Gauza et al 2011</td>
<td>-0.40</td>
<td>0.14</td>
<td>0.02</td>
<td>-0.67</td>
<td>-0.13</td>
<td>-2.88</td>
<td>0.00</td>
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<tr>
<td>1st week</td>
<td>Bosel et al 2012</td>
<td>-0.15</td>
<td>0.26</td>
<td>0.07</td>
<td>-0.66</td>
<td>0.36</td>
<td>-0.58</td>
<td>0.56</td>
</tr>
<tr>
<td>1st week</td>
<td>Koch et al 2012</td>
<td>-1.21</td>
<td>0.22</td>
<td>0.05</td>
<td>-1.64</td>
<td>-0.79</td>
<td>-5.58</td>
<td>0.00</td>
</tr>
<tr>
<td>1st week</td>
<td>Tong et al 2012</td>
<td>-9.62</td>
<td>0.30</td>
<td>0.09</td>
<td>-10.20</td>
<td>-9.03</td>
<td>-32.40</td>
<td>0.00</td>
</tr>
<tr>
<td>1st week</td>
<td>Young et al 2013</td>
<td>-0.01</td>
<td>0.08</td>
<td>0.01</td>
<td>-0.17</td>
<td>0.14</td>
<td>-0.18</td>
<td>0.85</td>
</tr>
<tr>
<td>1st week</td>
<td>Alali et al 2014</td>
<td>-0.94</td>
<td>0.06</td>
<td>0.00</td>
<td>-1.07</td>
<td>-0.82</td>
<td>-15.12</td>
<td>0.00</td>
</tr>
<tr>
<td>1st week</td>
<td>Jnid et al 2014</td>
<td>-0.52</td>
<td>0.20</td>
<td>0.04</td>
<td>-0.90</td>
<td>-0.17</td>
<td>-2.62</td>
<td>0.00</td>
</tr>
<tr>
<td>Overall</td>
<td>-2.61</td>
<td>0.49</td>
<td>0.18</td>
<td>-3.44</td>
<td>-1.77</td>
<td>-6.10</td>
<td>0.00</td>
<td></td>
</tr>
</tbody>
</table>

### 1st week

- **Wang et al 2012**: Std diff in means = -0.95, Standard error = 0.30, Variance = 0.09, Lower limit = -1.53, Upper limit = -0.36, Z Value = -3.17, p-Value = 0.00
- **Chi et al 2012**: Std diff in means = -1.22, Standard error = 0.49, Variance = 0.29, Lower limit = -2.16, Upper limit = -0.29, Z Value = -2.57, p-Value = 0.01
- **Devarajan et al 2012**: Std diff in means = -0.50, Standard error = 0.13, Variance = 0.02, Lower limit = -0.77, Upper limit = -0.24, Z Value = -3.74, p-Value = 0.00
- **Alahjusani et al 2014**: Std diff in means = -1.24, Standard error = 0.22, Variance = 0.05, Lower limit = -1.67, Upper limit = -0.80, Z Value = -5.59, p-Value = 0.00
- **Bhavani et al 2014**: Std diff in means = -0.18, Standard error = 0.14, Variance = 0.02, Lower limit = -0.46, Upper limit = 0.10, Z Value = -1.27, p-Value = 0.21
- **Huang et al 2013**: Std diff in means = -1.10, Standard error = 0.38, Variance = 0.14, Lower limit = -1.84, Upper limit = -0.36, Z Value = -2.90, p-Value = 0.00
- **Jeon et al 2014**: Std diff in means = -0.69, Standard error = 0.20, Variance = 0.04, Lower limit = -1.08, Upper limit = -0.30, Z Value = -3.49, p-Value = 0.00
- **Villwock et al 2014**: Std diff in means = -0.30, Standard error = 0.02, Variance = 0.00, Lower limit = -0.34, Upper limit = -0.27, Z Value = -17.14, p-Value = 0.00
- **Villwock et al 2014**: Std diff in means = -0.83, Standard error = 0.01, Variance = 0.00, Lower limit = -0.85, Upper limit = -0.82, Z Value = -14.20, p-Value = 0.00

### 2nd week

- **Villwock et al 2014**: Std diff in means = 0.00, Standard error = 0.19, Variance = 0.00, Lower limit = 0.00, Upper limit = 0.00, Z Value = 0.00, p-Value = 0.00
- **Villwock et al 2014**: Std diff in means = -0.66, Standard error = 0.13, Variance = 0.02, Lower limit = -0.91, Upper limit = -0.41, Z Value = -5.13, p-Value = 0.00
<table>
<thead>
<tr>
<th></th>
<th>&lt;14 days (N= 24)</th>
<th>≥ 14 days (N=49)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU</td>
<td>15 (7.5-22.5)</td>
<td>19 (12, 35)</td>
<td>0.047</td>
</tr>
<tr>
<td>Post-tracheostomy hospital</td>
<td>17 (13.5, 23.5)</td>
<td>22 (16, 41)</td>
<td>0.02</td>
</tr>
<tr>
<td>Total hospital</td>
<td>32 (25.5-47.5)</td>
<td>62 (45, 108)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
ICU Length of Stay

SMD -1.65 (95% CI -2.85 to -0.46)

Adly, A et al. Eur Arch Otorhinolaryngol. 2018
Early Tracheostomy

- Low mortality
- Few severe complications
- Improved outcomes
  - HAP (adult)
  - Ventilator independence
  - Sedation (adult)
  - QOL
- Decreased hospital resource use
Late tracheostomy / prolonged intubation

CHARMAINE CROOKS-EDWARDS
To Trach or Not to Trach?

Many considerations in decision making
  ◦ Individualised

When is the appropriate time?

Implications of tracheostomy
Indications for Tracheostomy

Prolonged Ventilation

Bypass upper airway obstruction

Airway protection

Pulmonary hygiene to manage secretions.
To Trach or Not to Trach?

More critically ill patients requiring prolonged mechanical ventilation (PMV)

- By 2020, estimated > 600,000 patients in the USA will require PMV

Tracheostomy placement can facilitate this
Prolonged Ventilation

HOW LONG IS TOO LONG?
Prolonged Mechanical Ventilation

Great variability in terminology and definitions

- **National Association for Medical Direction of Respiratory Care (NAMDRC):** “the need for more than 21 consecutive days of MV for more than 6 h/day”.

- **European Respiratory Society (ERS) Task Force:** “the need of more than 7 days of weaning after the first spontaneous breathing trial (SBT)”.
Variation in Definition

Reviewed studies with the term prolonged mechanical ventilation or a synonym

Most common terms:
- Prolonged mechanical ventilation (60%)
- Admission to specialized unit (26%)
- Long-term mechanical ventilation (19%)

Some authors (67%) defined cohorts based on duration of mechanical ventilation
- 55% used this as the sole criterion

Variation in Definition

Identified 37 different durations of ventilation
  ◦ ranging from 5 hours – 1 year
  ◦ > 21 days most common

Surgical cohorts:
  ◦ minimum ventilation duration required for inclusion
    ◦ ≥ 24 hours for 20 of 66 studies (30%)

57% (237) of studies did not provide a reason/rationale for definitional criteria used

7% (28) of studies referred to a consensus definition

Conclusions

Substantial variation in terminology and definitional criteria for cohorts of subjects receiving prolonged mechanical ventilation

Standardisation is required for study data to be maximally informative

Early vs. Late

No overall consensus of exact timing
- Early: 48 hours – 10 days
- Late: > 10-14 days, 21-28 days

Paucity of pediatric studies vs. adult cases

What determines the timeframe?
Does timing matter?
Effect of Early vs Late Tracheostomy Placement on Survival in Patients Receiving Mechanical Ventilation. The TracMan Randomized Trial

Objective:
- To test whether early vs late tracheostomy would be associated with lower mortality in adult patients requiring mechanical ventilation in critical care units.

Design & Setting:
- Open multicentered randomized clinical trial
- Conducted between 2004 – 2011
- Involving 70 adult general and 2 cardiothoracic critical care units in 13 university and 59 non-university hospitals in the United Kingdom.

Effect of Early vs Late Tracheostomy Placement on Survival in Patients Receiving Mechanical Ventilation. The TracMan Randomized Trial

Participants:
- 1032 eligible patients
- 909 adult patients breathing with the aid of mechanical ventilation for < 4 days
- Identified by the treating physician as likely to require at least 7 more days of mechanical ventilation.

Effect of Early vs Late Tracheostomy Placement on Survival in Patients Receiving Mechanical Ventilation. The TracMan Randomized Trial

Interventions:
- Patients randomized 1:1
  - Early tracheostomy (within 4 days) or
  - Late tracheostomy (after 10 days if still indicated).

Main Outcomes & Measures:
- The primary outcome measure was 30-day mortality and the analysis was by intention to treat.

Effect of Early vs Late Tracheostomy Placement on Survival in Patients Receiving Mechanical Ventilation. The TracMan Randomized Trial

Results:
- Of 455 patients assigned to early tracheostomy, 91.9% (95% CI, 89.0%-94.1%) received a tracheostomy
- Of 454 assigned to late tracheostomy, 44.9% (95% CI, 40.4%-49.5%) received a tracheostomy.

- All-cause mortality 30 days after randomization:
  - 30.8% (95% CI, 26.7%-35.2%) in the early
  - 31.5% (95% CI, 27.3%-35.9%) in the late group
  - (absolute risk reduction for early vs late, 0.7%; 95% CI, 5.4% to 6.7%).

2 year mortality:
- 51.0% (95% CI, 46.4%-55.6%) in the early group
- 53.7% (95% CI, 49.1%-58.3%) in the late group \((P=.74)\)

Median critical care unit length of stay in survivors:
- 13.0 days in the early group
- 13.1 days in the late group \((P=.74)\)

The survival of patients by treatment group for 2 years after randomization \((P=.45\text{, Cox-Mantel log rank test})\).
Effect of Early vs Late Tracheostomy Placement on Survival in Patients Receiving Mechanical Ventilation. The TracMan Randomized Trial

Conclusions & Relevance:

◦ For patients breathing with the aid of mechanical ventilation treated in adult critical care units in the United Kingdom, tracheostomy within 4 days of critical care admission was not associated with an improvement in 30-day mortality or other important secondary outcomes.

◦ The ability of clinicians to predict which patients required extended ventilatory support was limited.

Tracheostomy in children: an ancient procedure still under debate

Angelo Barbato, Laura Botteccchia and Deborah Snijders

Optimal timing for tracheostomy in children is controversial, outweighing the risk of the procedure and the expected benefits

Expected benefits:
- reduction in duration of mechanical ventilation
- Reduced stay in the intensive care unit (ICU) and hospital
- decrease in morbidity and mortality
Surveys in ventilated adults indicate that tracheostomy should be performed medially at 9–13 days of mechanical ventilation.

In ventilated children, the option of tracheostomy is suggested after 21–28 days of mechanical ventilation.

- Possible explanation for this delay
  - *more rapid resolution of acute respiratory distress syndrome in children compared to adults.*
Conclusion:

- Tracheostomy is widely performed in children, despite the advances of noninvasive mechanical ventilation.

- However,
  - multicentered studies with large patient cohorts lacking
  - some aspects of tracheostomy still under debate need to be clarified
    - Eg. whether, when and how to perform tracheostomy, and when to stop it
Timing of Tracheostomy in Critically Ill Patients: A Meta-Analysis

Huibin Huang¹, Ying Li¹, Felinda Ariani², Xiaoli Chen¹, Jiandong Lin¹∗

Abstract

Objective: To compare important outcomes between early tracheostomy (ET) and late tracheostomy (LT) or prolonged intubation (PI) for critically ill patients receiving long-term ventilation during their treatment.

Method: We performed computerized searches for relevant articles on PubMed, EMBASE, and the Cochrane register of controlled trials (up to July 2013). We contacted international experts and manufacturers. We included in the study randomized controlled trials (RCTs) that compared ET (performed within 10 days after initiation of laryngeal intubation) and LT (after 10 days of laryngeal intubation) or PI in critically ill adult patients admitted to intensive care units (ICUs). Two investigators evaluated the articles; divergent opinions were resolved by consensus.
Table 1. Summary Characteristics of the Study.

<table>
<thead>
<tr>
<th>Study/year published</th>
<th>Ref. No.</th>
<th>ICU setting</th>
<th>Surgical approach</th>
<th>ET group</th>
<th>LT/PI group</th>
<th>Outcome pre-state / Jadad score</th>
<th>VAP definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young 2013</td>
<td>11</td>
<td>70 adult general and 2 cardiological CCU</td>
<td>PDT/ST</td>
<td>Within 4 days (n = 451)</td>
<td>After 10 days if still indicated (n = 448)</td>
<td>Mortality, length of ICU stay/3</td>
<td>Not reported</td>
</tr>
<tr>
<td>Zheng 2012</td>
<td>9</td>
<td>Surgical patients</td>
<td>PDT</td>
<td>Day 3 of MV (n = 56)</td>
<td>Day 15 of MV (n = 61)</td>
<td>Mortality, duration of MV, length of ICU stay, VAP/5</td>
<td>Using the modified CPIS.</td>
</tr>
<tr>
<td>Trouillet 2011</td>
<td>13</td>
<td>Postcardiac surgery ICU</td>
<td>PDT</td>
<td>Before 5 days after surgery (n = 109)</td>
<td>15 d after initiation of MV (n = 107)</td>
<td>Mortality, duration of MV, length of ICU stay, VAP/4</td>
<td>Clinical features with positive BAL cultures</td>
</tr>
<tr>
<td>Terragni 2010</td>
<td>25</td>
<td>12 ICUs</td>
<td>PDT</td>
<td>After 6–8 days of laryngeal intubation (n = 209)</td>
<td>After 13–15 days of laryngeal intubation (n = 210)</td>
<td>Mortality, duration of MV, length of ICU stay, VAP/4</td>
<td>Using the modified CPIS.</td>
</tr>
<tr>
<td>Bolt 2008</td>
<td>12</td>
<td>25 Medical or surgical ICUs</td>
<td>PDT/ST</td>
<td>Within 4 days (n = 61)</td>
<td>Prolonged endotracheal intubation (n = 62)</td>
<td>Mortality, duration of MV, length of ICU stay, VAP/3</td>
<td>Clinical features with positive BAL cultures</td>
</tr>
<tr>
<td>Barquist 2006</td>
<td>26</td>
<td>Trauma center</td>
<td>ST</td>
<td>Before day 8 (n = 29)</td>
<td>After day 28 (n = 31)</td>
<td>Mortality, duration of MV, length of ICU stay, VAP/4</td>
<td>CDC criteria</td>
</tr>
<tr>
<td>Rumbak 2004</td>
<td>7</td>
<td>3 Medical ICUs</td>
<td>PDT</td>
<td>Within 48 hr (n = 60)</td>
<td>Days 14–16 of MV (n = 60)</td>
<td>Mortality, duration of MV, length of ICU stay, VAP/4</td>
<td>Clinical features with positive BAL cultures</td>
</tr>
<tr>
<td>Boudier 2004</td>
<td>8</td>
<td>Units for head injury patients</td>
<td>PDT</td>
<td>5–6 days after ICU admission (n = 31)</td>
<td>Prolonged endotracheal intubation (n = 31)</td>
<td>Mortality, length of ICU stay/3</td>
<td>CDC criteria</td>
</tr>
<tr>
<td>Saffle 2002</td>
<td>24</td>
<td>Burn ICU.</td>
<td>ST</td>
<td>4 days after burn injury (n = 21)</td>
<td>14 days after burn injury (n = 23)</td>
<td>Mortality, duration of MV, length of ICU stay, VAP/3</td>
<td>CDC criteria</td>
</tr>
</tbody>
</table>

ICU, intensive care unit; MV, mechanical ventilation; VAP, ventilator-associated pneumonia; CPIS, Clinical Pulmonary Infection Score; CDC, Centers for Disease Control and Prevention; ET, early tracheotomy; LT, late tracheotomy; PI, prolonged intubation; PDT, percutaneous dilatational tracheostomy; ST, surgery technique; BAL, bronchoalveolar lavage.

doi:10.1371/journal.pone.0092981.t001
Timing of Tracheostomy in Critically Ill Patients: A Meta-Analysis

Huibin Huang¹, Ying Li¹, Felinda Ariani², Xiaoli Chen¹, Jiandong Lin¹*

Results: A meta-analysis was evaluated from nine randomized clinical trials with 2,072 participants. Compared to LT/Pl, ET did not significantly reduce short-term mortality [relative risks (RR) = 0.91; 95% confidence intervals (CIs) = 0.81–1.03; p = 0.14] or long-term mortality (RR = 0.90; 95% CI = 0.76–1.08; p = 0.27). Additionally, ET was not associated with a markedly reduced length of ICU stay [weighted mean difference (WMD) = −4.41 days; 95% CI = −13.44–4.63 days; p = 0.34], ventilator-associated pneumonia (VAP) (RR = 0.88; 95% CI = 0.71–1.10; p = 0.27) or duration of mechanical ventilation (MV) (WMD = −2.91 days; 95% CI = −7.21–1.40 days; p = 0.19).

Conclusion: Among the patients requiring prolonged MV, ET showed no significant difference in clinical outcomes compared to that of the LT/Pl group. But more rigorously designed and adequately powered RCTs are required to confirm it in future.
### Table 1

<table>
<thead>
<tr>
<th>Study</th>
<th>ICU Population</th>
<th>Day of Early Placement</th>
<th>Day of Late Placement</th>
<th>Number of patients</th>
<th>Primary endpoint</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young 2013</td>
<td>General, Cardiothoracic</td>
<td>≤4</td>
<td>≥10</td>
<td>899</td>
<td>30-day mortality</td>
<td>No</td>
</tr>
<tr>
<td>Bösel 2012</td>
<td>Neuro (stroke)</td>
<td>1-3</td>
<td>7-14</td>
<td>60</td>
<td>ICU LOS</td>
<td>No</td>
</tr>
<tr>
<td>Zheng 2012</td>
<td>Surgical</td>
<td>3</td>
<td>15</td>
<td>119</td>
<td>Ventilator free days</td>
<td>Yes</td>
</tr>
<tr>
<td>Koch 2012</td>
<td>Neuro, neurosurgical, surgical</td>
<td>≤4</td>
<td>≥6</td>
<td>100</td>
<td>Hospital mortality</td>
<td>No</td>
</tr>
<tr>
<td>Trouillet 2011</td>
<td>Cardiac surgical</td>
<td>≤5</td>
<td>≥19</td>
<td>216</td>
<td>Ventilator free days</td>
<td>No</td>
</tr>
<tr>
<td>Terragni 2010</td>
<td>General</td>
<td>6-8</td>
<td>≥13</td>
<td>419</td>
<td>VAP incidence</td>
<td>No</td>
</tr>
<tr>
<td>Blot 2008</td>
<td>Medical, Surgical</td>
<td>≤4</td>
<td>Never/≥14*</td>
<td>123</td>
<td>28-day mortality</td>
<td>No</td>
</tr>
<tr>
<td>Barquist 2006</td>
<td>Trauma</td>
<td>≤7</td>
<td>≥29</td>
<td>60</td>
<td>Duration of MV</td>
<td>No</td>
</tr>
<tr>
<td>Rumbak 2004</td>
<td>Medical</td>
<td>≤2</td>
<td>14-16</td>
<td>120</td>
<td>Pneumonia</td>
<td>No</td>
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<tr>
<td>Bouderka 2004</td>
<td>Trauma</td>
<td>5-6</td>
<td>Never</td>
<td>62</td>
<td>Duration of MV</td>
<td>Yes</td>
</tr>
<tr>
<td>Saffle 2002</td>
<td>Burn</td>
<td>Next OR day</td>
<td>≥14</td>
<td>44</td>
<td>Duration of MV</td>
<td>No</td>
</tr>
<tr>
<td>Sugarman 1997</td>
<td>Trauma</td>
<td>3-5</td>
<td>≥10-14</td>
<td>112</td>
<td>ICU LOS</td>
<td>No</td>
</tr>
<tr>
<td>Rodriguez 1990</td>
<td>Surgical</td>
<td>≤7</td>
<td>≥8</td>
<td>106</td>
<td>Duration of MV</td>
<td>Yes</td>
</tr>
<tr>
<td>Dunham 1984</td>
<td>Trauma</td>
<td>3-4</td>
<td>14</td>
<td>74</td>
<td>Laryngotracheal pathology</td>
<td>No</td>
</tr>
<tr>
<td>El-Naggar 1976</td>
<td>General</td>
<td>3</td>
<td>10-11</td>
<td>52</td>
<td>Patient characteristics</td>
<td>No</td>
</tr>
</tbody>
</table>

*Study did not require late tracheostomy, but if placed had to be after day 14.

ICU = intensive care unit; LOS = length of stay; VAP = ventilator-associated pneumonia; MV = mechanical ventilation; OR = operating room;
To Trach or not to Trach: Uncertainty in the Care of the Chronically Critically Ill.

Conclusions:
- Clinicians struggle to accurately predict which patients will require PMV;
- This may be the major factor impacting the effectiveness of a uniform early tracheostomy protocol for mechanically ventilated patients.

- Based on the available evidence, routine placement of tracheostomy prior to day 10 of mechanical ventilation is not indicated.
The Child with ‘Trach & Vent’
SickKids’ LTV Discharge Pathway

SickKids®

Holland Bloorview Rehabilitation Hospital

Home
Tracheostomy and long term ventilation (LTV)

1. Find out if a tracheostomy and LTV are right for your child and family
2. Meet your child's team
3. Prepare for a tracheostomy and LTV
4. Tracheostomy surgery
5. Start education sessions
6. Have first trach change
7. Be stable on a ventilator
8. Transition to Holland Bloorview
9. Get your home and supports ready
10. Complete care by parent
11. Transition to home
Prerequisites

Minimum of 2 caregivers

Training ~ 8 weeks

Long-term anticipated uncovered costs – min. $4800 CA/yr
  ◦ Home/vehicle modifications
  ◦ Community nursing support
  ◦ Equipment & supplies
  ◦ Hospital/follow up appointments
  ◦ Hospitalisation – PICU
  ◦ Caregivers - CPR trained
  ◦ Emergency kits

Knowledge of routine tracheostomy care & complications
What Home Looks Like!

Courtesy of Dr. Reshma Amin
Challenges

Significant burden for family

Financial
  ◦ Loss of income if one parent chooses to stay home
  ◦ Start up costs - $2400 CA
  ◦ Annual - $4800 CA (over government funding)
  ◦ Extra nursing cost not covered, site dependent

Lack of privacy with nurses

Caregiver burnout

Family stress
  ◦ Spousal
  ◦ sibling
Late(r) Tracheostomy

Careful consideration is key

Is it justified?

Informed decision & collaborative effort

Meet the patient’s goals of care
Rebuttal

MICHAEL DERYNCK
Early tracheostomy

Improvements beyond death
- HAP (adult)
- Ventilator independence
- Sedation (adult)
- QOL

Tracheostomy ≠ forever

Predicted trajectories of major pediatric indications
Rebuttal

CHARMAINE CROOKS-EDWARDS
Recent PICU Case

7 year old male

Complex Medical History –
- Hypomyelination with atrophy of basal ganglia and cerebellum (HABC)
- Hypoventilation – tracheostomy & ventilation
- Seizure disorder
- GDD
- Sialorrhea
- Severe GERD – GT/GJ, Ostomy

Tracheostomy done Jan 2013 (16 months old) – parental preference

Frequent readmissions to PICU
<table>
<thead>
<tr>
<th>Immediate Complications</th>
<th>Early Complications</th>
<th>Late Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemorrhage</td>
<td>Hemorrhage</td>
<td>Tracheal stenosis</td>
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<tr>
<td>Structure damage to trachea</td>
<td>Tube displacement</td>
<td>Granulation tissue</td>
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<tr>
<td>Failure of procedure</td>
<td>Pneumothorax</td>
<td>Tracheomalacia</td>
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<tr>
<td>Aspiration event</td>
<td>Pneumomediastinum</td>
<td>Pneumonia</td>
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<tr>
<td>Air embolism</td>
<td>Subcutaneous emphysema</td>
<td>Aspiration event</td>
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<tr>
<td>Loss of airway</td>
<td>Stomal infection</td>
<td>Tracheoarterial fistula</td>
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<tr>
<td>Death</td>
<td>Stomal ulceration</td>
<td>Tracheoesophageal fistula</td>
</tr>
<tr>
<td>Hypoxemia, hypercarbria</td>
<td>Accidental decannulation</td>
<td>Accidental decannulation</td>
</tr>
<tr>
<td></td>
<td>Dysphagia</td>
<td>Dysphagia</td>
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</tbody>
</table>

Nora H Cheung, and Lena M Napolitano Respir Care 2014;59:895-919
The timing of tracheostomy in critically ill patients undergoing mechanical ventilation: systematic review & meta-analysis of RCTS.

Early or late tracheotomy for critically ill ventilated patients

Systematic review of 7 RCT trials (n = 1,044)

No difference in:
- short-term or long-term mortality
- ventilator-associated pneumonia
- duration of mechanical ventilation
- Sedation
- duration of stay in ICU or hospital
- complications

Medical Advancements

Non-invasive ventilation
- Trilogy
- Heated High Flow Oxygen therapy
- Better fitting masks for BiPAP machines
- Inspiratory and expiratory muscle aids

Diaphragmatic pacing
Recent PICU Case

13 year old Male
- Previously well, athletic
- Severe ARDS, likely 2o Hemophagocytic Lymphohistiocytosis
  - Triggered by Parvovirus & an at risk genetic mutation for 2o HLH.
- VV ECMO with decannulation after 81 days
- Percutaneous Tracheostomy after 1~ month of endotracheal intubation
- Chronic mechanical ventilation weaned to NIV
- Current focus
  - Rehabilitation
  - Nocturnal BiPAP (12/5)
  - Physiotherapy
Summary
Summary

Tracheostomy - life saving

Adequate communication with caregivers/surrogates to allow informed decision making.

Limited available pediatric data re: ideal timing lends itself for further opportunities to evaluate this challenging task.

Difficult to accurately predict duration of mechanical ventilation