Computer-based Quantitative Assessment of Learner Performance during Neonatal Endotracheal Intubation: A Pilot Study

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Introduction

Neonatal endotracheal intubation (ETI) is a life saving procedure that pediatric trainees are frequently unskilled at performing.

Traditional teaching techniques employing task trainers/animal models coupled with instructor feedback have not led to improvement in acquired ETI skills during residency.

The limited view of the neonatal airway, large class size and inadequate class time pose barriers to the detection of specific causes of procedural failure by the instructor.

Automated detection of procedural failures may allow directive feedback to trainees that can accelerate learning.

Published studies have measured learner performance during neonatal intubation of task trainers, however, no studies have utilized these measurements to develop an assessment tool for directive feedback.

Objective

1) To develop a computer based quantitative assessment tool capable of measuring and recording learner performance during simulated neonatal ETI attempts

2) To compare novice ETI performance to expert performance

Methods/Description

Tools:

1. standard neonatal resuscitation head, laryngoscope and 3.0 endotracheal tube (ETT) were used (Fig. 1,2)

2. Electromagnetic trackers captured mannequin head motion, motion of the laryngoscope and ETT with 6 degrees of freedom.

3. 3D virtual computer models of the head and laryngoscope were developed and registered to align with physical counterparts. Captured motions were mirrored by the 3D model which consisted of articulated non-deformable objects that moved based on its tracker position (Fig. 3,4)

4. A computer based quantitative analysis technique was developed to allow the recording and review of endotracheal intubation attempts. Preliminary results suggest that this approach may show differences between expert and novice performance. Computerized performance analysis may serve as a valuable tool for instructors allowing directive feedback to learners during neonatal ETI.

Methods:

To compare novice ETI performance to expert performance.

Participants: Experts (>60 patient intubations) and Novice nurse practitioners / residents (<25 patient intubations)

Procedure:

1. Participants were recorded performing endotracheal intubation after warm up period

2. Continuous, real-time display of the mannequin, laryngoscope and ETT position and orientation were obtained as shown in Fig. 1,2 but could only be viewed by the instructor

3. Recording allowed detailed review of operator motion and orientation at a later period

4. The number of attempts, time to intubation, time in each phase, number of corrections, 3D trajectory, geometry, and approximate forces applied were measured and analyzed

Results:

1. Four experts and five novices were recorded performing 28 total ETIs

2. Experts were more successful at first ETI attempt and had smoother motions than novice learners (Table 1)

3. Both experts and novices had similar time to intubation

4. Experts moved the head more often than novices and used more force on regression analysis

5. While the differences between experts and novices did not reach statistical significance, this preliminary data supports the feasibility

Conclusion

A computer based quantitative analysis technique was developed to allow the recording and review of endotracheal intubation attempts. Preliminary results suggest that this approach may show differences between expert and novice performance. Computerized performance analysis may serve as a valuable tool for instructors allowing directive feedback to learners during neonatal ETI.

Table 1. Comparison of Expert vs. Novice ETI performance

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Expert (n=4)</th>
<th>Novice (n=5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total no. of recorded trials</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>Intubation on 1st attempt (%)</td>
<td>92%</td>
<td>73%</td>
</tr>
<tr>
<td>Raising at gums (median number)</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Depth of penetration of laryngoscope in oropharynx (mm)</td>
<td>62.4</td>
<td>72.4</td>
</tr>
<tr>
<td>Side to side laryngoscope motion (median number)</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Corrections during attempt (median number)</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Time to intubation (median) (sec)</td>
<td>12.2</td>
<td>13</td>
</tr>
<tr>
<td>Movement of Head (median pitch in degrees)</td>
<td>26.28</td>
<td>11.87</td>
</tr>
</tbody>
</table>

Figure 1 and 2. Equipment set up and Software

Figure 3. 3D computer model

Figure 4. 3D model (Sagittal Section)