COST-BENEFIT ANALYSIS FOR DIRECT VISUAL OBSERVATION OF NASOGASTRIC ENTERAL FEEDING TUBE PLACEMENT

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OBJECTIVES: Requirement for assisted nutrition is common in healthcare and is often achieved via an enteral feeding tube (EFT). Misplacement and use of an EFT in the respiratory tract can lead to serious patient harm and is a ‘rare event’ for certain national health services. Standard EFTs are placed ‘blind’ and must be confirmed by X-ray. Here, cost-benefit of an EFT with a built-in camera is estimated.

Methods: Comparison of direct visual observation (DVO) and blind EFT tube placement was performed using a decision tree. For each blind procedure, the EFT was placed correctly (lymphoid 94.5%, postpyloric 64.8%), placed in the stomach 11.3%, range 1.5% - 21.6% or otherwise misplaced in the gastric tract. Misplaced EFTs were replaced, with replacement failure for a blind insertion having a misplacement rate of 32%. A mean of 1.4 and 1.8 X-ray per EFT were required to confirm pyloric and postpyloric placement, respectively. Pneumothorax incidence was 10.2% (9.5% - 13.3%) after tracheal placement, with associated mortality being 4.5% (0.0% - 44.6%). The DVO and standard EFT costs were $5.82 and $150 per X-ray, respectively. X-rays cost $150 ($100 - $300). Early studies indicate that each DVO placement takes 5 minutes, 45 seconds required two attempts, no severe AE occur, and X-ray was used in 95% of cases.

RESULTS: Assuming reuse of the DVO-EFT, this methodology was cost saving. If each replacement required a new EFT, the methodology would likely be considered beneficial at a cost-benefit threshold at $10,000 per pneumothorax avoided. DVO is cost-saving in this scenario if costs for care, provider time, and ICU are considered. Other AE also require confirmation, but pneumothorax rates could be increased and the cost-benefit of DVO would still be realized under the current model conditions.

Conclusions: The incremental cost DVO is fully or partially offset by reduced X-ray use. Avoidance of radiation and saved time are additional benefits.

BACKGROUND

The Feeding Tube Awareness Foundation reports that >300,000 enteral feeding tubes are placed each year in the United States of America (USA) [2]. In 2007, 0.6% of short-stay hospital patients in the USA National Inpatient Sample received enteral nutrition (EN) [3]. The majority of feeding tubes are placed blind, with rates of malposition reported to be in the range of 0.5 - 16 per 100 insertion attempts [4].

New technology allows for direct visual observation (DVO) of EFT tube placement via a camera and external monitor (Figure 1). To estimate the cost-benefit ratio of DVO during enteral feeding tube placement in the stomach, we conducted a decision tree analysis. Figure 1. Direct visual observation of anatomical markers allows the path of the feeding tube to be observed during placement.

AIM

To estimate the cost-benefit ratio of DVO during enteral feeding tube placement in the stomach

Figure 1. Model representing enteral feeding tube placement and verification thereof

In accordance with guidelines, enteral feeding tube placement can be confirmed with X-ray as gold standard.

OUTCOMES

• The cost of physician time in DVO placement, interpretation of X-ray, and cost of DVO tubes and X-rays
• Correct feeding was driven by correct X-ray interpretation and the percent of blind tube placements confirmed by X-ray

Sensitivity analysis

• DVO dominated blind placement in 87.0% of simulations
• 11.5% of simulations were in the cost-benefit plane (Figure 3), in total DVO would be considered a cost-benefit as <$10,000 per pneumothorax avoided in 97.6% of cases.

Scenario analyses

• Considering nurse time at $48 per hour, [14] or reuse of the original EFT for reinsertion, the cost saving with DVO increased to $151 and $110, respectively
• Including both nurse time and reuse of the EFT together, the cost saving reached $163, with DVO having a cost-benefit in 99.8% of simulations
• In addition, if DVO was available at $200, it would be considered a cost-benefit in 99.3% of simulations
• Trebling the DVO misplacement rate (7.1%, 2.5%) resulted in DVO being a cost-benefit in 96.9% of simulations
• Excluding training data, [6] there were no EFT misplacements with DVO, giving a saving of $154 and making DVO dominate in 90.8% and a cost-benefit in 97.8% of simulations

CONCLUSIONS

• Our estimates indicate that compared with blind placement, direct visual observation (DVO) of enteral feeding tube placement:
  • Will likely reduce the incidence of pneumothorax
  • Would probably be considered at a positive cost benefit to healthcare payers in the USA setting
• A reduction in X-rays required with DVO results in savings in both nurse time and direct hospital costs

ACKNOWLEDGMENTS

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REFERENCES


Table 1. Base case model inputs and variance

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Blind</th>
<th>DVO</th>
</tr>
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<tbody>
<tr>
<td>Misplacement, %</td>
<td>5.00 (1.99)</td>
<td>2.38 (2.35)</td>
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<tr>
<td>Tracheal placement, %</td>
<td>1.90 (0.19)</td>
<td>0.82 (1.39)</td>
</tr>
<tr>
<td>Use of X-ray, %</td>
<td>100 (10)</td>
<td>5 (5)</td>
</tr>
<tr>
<td>EFT cost, $</td>
<td>5 (0.5)</td>
<td>150 (15)</td>
</tr>
<tr>
<td>X-ray cost, $</td>
<td>179 (17.9)</td>
<td>11 (11)</td>
</tr>
<tr>
<td>Fluoroscopy cost, $</td>
<td>223 (48)</td>
<td>12</td>
</tr>
<tr>
<td>Pneumothorax, %</td>
<td>27,399 (2,700)</td>
<td>13</td>
</tr>
</tbody>
</table>

Table 2. Base case results

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Blind</th>
<th>DVO</th>
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</thead>
<tbody>
<tr>
<td>Correctly fed, %</td>
<td>98.84</td>
<td>99.65</td>
</tr>
<tr>
<td>EFT insertions, N per patient</td>
<td>1.22</td>
<td>1.10</td>
</tr>
<tr>
<td>X-rays, N per patient</td>
<td>1.28</td>
<td>0.06</td>
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<tr>
<td>Pneumothorax, %</td>
<td>0.27</td>
<td>0.14</td>
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<tr>
<td>Death, %</td>
<td>0.04</td>
<td>0.02</td>
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<tr>
<td>Total cost, $</td>
<td>312</td>
<td>215</td>
</tr>
</tbody>
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DVO: Direct Visual Observation; EFT: Enteral Feeding Tube

Figure 2. Cost-benefit plane for DVO of EFT placement

DVO: Direct Visual Observation; EFT: Enteral Feeding Tube; Orange line at $150 per pneumothorax avoided

Graph 1. Direct visual observation of anatomical markers allows the path of the feeding tube to be observed during placement.