Cost-effectiveness of Insufflation of Warm Humidified CO₂ During Open and Laparoscopic Colorectal Surgery in the United States

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BACKGROUND AND OBJECTIVES

Patients undergoing surgery with general and regional anaesthesia are at risk of developing unintentional perioperative hypothermia, defined as a core body temperature below 36°C, which results from heat loss during surgery from the patient’s body to the surrounding operating room¹. Studies have shown that the peri-operative hypothermia is associated with an increased risk of cardiac complications, wound infections and mortality².

Surgical humidification systems (e.g. HumiGard™, Fisher & Paykel Healthcare Ltd, Auckland, New Zealand) provide insufflation of warmed (37°C), fully humidified CO₂ (WH - CO₂) during open surgery (OS) and laparoscopic surgery (LS). The systems aim to reduce evaporation and subsequent cooling, assisting in maintaining normothermia and therefore reduce the likelihood of potential post-surgery complications. The objective of this study was to estimate the cost-utility of the use of WH- CO₂ in patients undergoing open and laparoscopic colorectal surgery compared with usual care (i.e. insufflation with cold-dry CO₂) from a United States (US) payer perspective.

METHODS

Two decision analytic models were developed to estimate the cost-effectiveness of the insufflation of warmed humidified CO₂ versus usual care in patients undergoing either OS or LS. In the OS model, all patients undergoing colorectal surgery were at risk of hypothermia and a number of complications following surgery, with the risk of each complication dependent on the patient’s temperature status (Figure 1). For OS usual care comprises doing nothing.

Patients entering the LS model were at risk of surgical site infection or pneumonia following surgery. Usual care comprises insufflation of cold dry CO₂. In both models complications were not mutually exclusive with each having a cost and utility loss applied.

Figure 1: Model structure (OS)

<table>
<thead>
<tr>
<th>Method</th>
<th>Open surgery</th>
<th>Laparoscopic surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Source</td>
<td>Probability of hypothermia: WH-CO₂: 0% (Frey et al., 2012)</td>
<td>Probability of wound infection: WH-CO₂: 4.7% (Nor et al., 2015)</td>
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<tr>
<td>Probability of myocardial infarction (normothermia/hypothermia): 1.1% / 3.3% (Billeter et al., 2014)</td>
<td>Probability of wound infection: usual care: 12% (Nor et al., 2015)</td>
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<td>Probability of stroke (normothermia/hypothermia): 1.0% / 6.5% (Billeter et al., 2014)</td>
<td>Probability of pneumonia: WH-CO₂: 0.8% (Nor et al., 2015)</td>
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<tr>
<td>Probability of sepsis (normothermia/hypothermia): 2.6% / 7.5% (Billeter et al., 2014)</td>
<td>Probability of pneumonia: usual care: 3.2% (Nor et al., 2015)</td>
<td></td>
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<tr>
<td>Probability of wound infection (normothermia/hypothermia): 3.3% / 5.0% (Billeter et al., 2014)</td>
<td>Probability of mortality (normothermia/hypothermia): 4.0% / 17.0% (Billeter et al., 2014)</td>
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RESULTS

Over a one-year time horizon, WH-CO₂ dominated over usual care in both OS and LS (Table 2). WH-CO₂ was cost-saving in 99.9% of model iterations in OS patients and 99.2% of model iterations in LS patients. Extending the time horizon generated greater cost savings.

A scenario with 70% LS patients and 30% OS patients estimated WH-CO₂ to dominate over usual care and with net monetary benefit of $2,574 per patient (based upon a $50,000 per QALY threshold). WH-CO₂ was cost-saving in 99.8% of iterations. The key drivers of the analysis were the probability of hypothermia in OS patients and the probability of wound infection in LS patients.

CONCLUSIONS

From a US payer perspective, insufflation of WH-CO₂ during open and laparoscopic colorectal surgery is estimated to dominate over usual care, in that, lower costs and greater QALYs are generated. These results are subject to limitations surrounding the data used to populate the model, notably that marginal complication costs were not used. However, the results appear robust to variation in model inputs.

REFERENCES


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