Cost-Utility Analysis of the Provision of Warmed Humidified Carbon Dioxide During Open and Laparoscopic Colorectal Surgery

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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 room[1]. Studies have shown that the peri-operative hypothermia is associated with an increased risk of cardiac complications, wound infections and an increased risk of mortality[2].

A humidification system (F&P HumiGard™, Fisher & Paykel Healthcare Ltd, Auckland, New Zealand) exists to provide local insufflation of warmed (37°C), fully humidified CO_2 (WH-CO_2) during open surgery (OS) and laparoscopic surgery (LS) in order to maintain 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- CO_2 in patients undergoing open and laparoscopic colorectal surgery compared with usual care from a UK National Health Service (NHS) perspective.

METHODS

Two decision analytic models were developed to estimate the cost-effectiveness of the local insufflation of warmed humidified CO_2 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 CO_2 . In both models complications were not mutually exclusive with each having a cost and utility loss applied.

Figure 1: Model structure (OS)

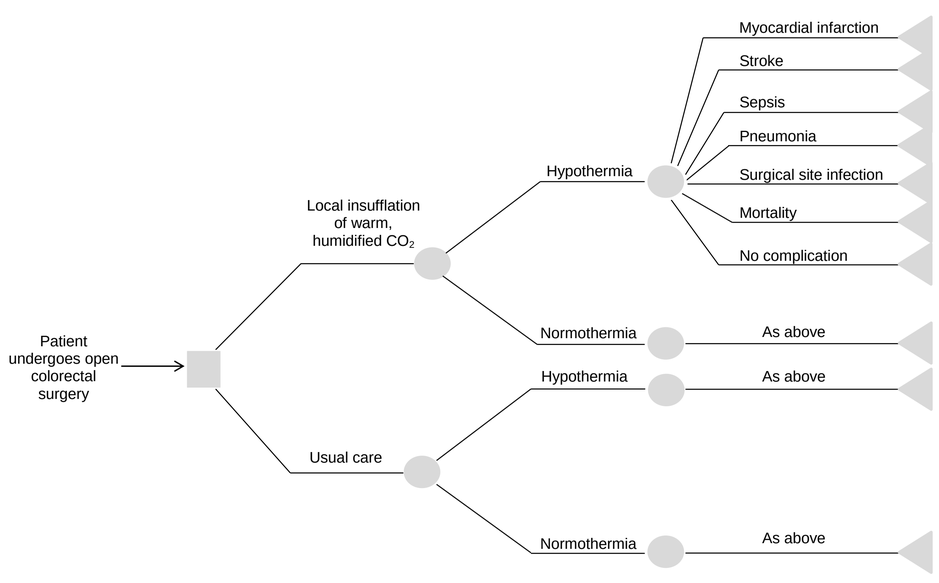

Table 1: Effectiveness input parameters

Open surgery	Input	Source
Probability of hypothermia: WH-CO_2	0%	Frey *et al.* (2012)[3]
Probability of hypothermia: usual care	18%	Frey *et al.* (2012)[3]
Probability of myocardial infarction (normothermia/hypothermia)	1.1% / 3.3%	Billeter *et al.* (2014)[2]
Probability of stroke (normothermia/hypothermia)	1.0% / 6.5%	Billeter *et al.* (2014)[2]
Probability of sepsis (normothermia/hypothermia)	2.6% / 7.5%	Billeter *et al.* (2014)[2]
Probability of wound infection (normothermia/hypothermia)	3.3% / 5.0%	Billeter *et al.* (2014)[2]
Probability of pneumonia (normothermia/hypothermia)	1.3% / 5.1%	Billeter *et al.* (2014)[2]
Probability of mortality (normothermia/hypothermia)	4.0% / 17.0%	Billeter *et al.* (2014)[2]
Laparoscopic surgery	**Input**	**Source**
Probability of wound infection: WH-CO_2	4.7%	Noor *et al.* (2015)[4]
Probability of wound infection: WH-CO_2	12%	Noor *et al.* (2015)[4]
Probability of pneumonia: HumiGard	0.8%	Noor *et al.* (2015)[4]
Probability of pneumonia: usual care	3.2%	Noor *et al.* (2015)[4]

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METHODS (continued)

Model input parameters were obtained from the published literature. The costs of each complication were obtained primarily from NHS reference costs 2013/14. Disutilities for complications were taken from the published literature and ranged from 0.006 for surgical wound infection to 0.05 for stroke. The disutility associated with mortality was conservatively assumed to be 0.5 lost per year. For stroke and myocardial infarction both an initial acute cost and disutility and longer term costs and disutilities were applied. These longer term costs and disutilities were discounted at a rate of 3.5%. The cost of the humidifier and the consumables required were obtained from Fisher & Paykel Healthcare Ltd.

RESULTS

Over a one year time horizon, WH-CO_2 dominated over usual care in both OS and LS (Table 2). At a £20,000 per QALY threshold, WH-CO_2 was cost-effective in 99.6% of model iterations in OS patients and 97.8% of model iterations in LS patients. WH-CO_2 was cost-saving in 69.4% of model iterations in OS patients and 97.7% 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-CO_2 to dominate over usual care and with net monetary benefit of £390 per patient. WH-CO_2 was cost-effective in 99.3% of iterations at a £20,000 threshold. The key drivers of the analysis were the probability of hypothermia in OS patients and the probability of wound infection in LS patients.

Table 2: Estimated results at one-year

OS	WH-CO_2	Usual care	Incremental	ICER
Total cost per person	£504	£537	-£33	
QALYs lost per person	0.023	0.036	-0.013	Dominant
LS	**WH-CO_2**	**Usual care**	**Incremental**	**ICER**
Total cost per person	£396	£834	-£438	
QALYs lost per person	0.0003	0.0009	-0.0006	Dominant

CONCLUSIONS

From a UK NHS perspective, local insufflation of WH-CO_2 during open and laparoscopic colorectal surgery is estimated to dominate over usual care, in that, lower costs and greater QALYs are generated.

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