End-tidal Control

Introduction

End-tidal Control* provides automated target control for volatile anaesthetic agent and patient oxygen during general anaesthesia. End-tidal Control (EtC) is available on the Aisys* and Aisys CS2* anaesthesia systems from GE Healthcare.

NHS England commissioned NICE (National Institute for Health and Care Excellence) to produce a Medtech Innovation Briefing on End-tidal Control1. This document summarises the published evidence and insight into NICE Medtech Innovation Briefings.
What is a Medtech Innovation Briefing (MIB)?

NICE Medtech Innovation Briefings summarise the published evidence and information available for individual medical technologies. The briefings provide information to aid local decision-making by clinicians, managers, and procurement professionals. The briefing report aims to present information and review the strengths and weaknesses of the relevant evidence, but does not contain recommendations and are not formal NICE guidance.

How is the MIB report prepared?

The briefing was developed for NICE by an External Assessment Centre. The report was prepared according to NICE published methods – this involved searching the published literature back to 2008. The identified publications were filtered according to pre-defined inclusion / exclusion criteria and assessed to identify relevant primary research addressing the use of the medical technology within the defined indication. The best available evidence was selected for inclusion in the review by applying the conventional evidence hierarchy. This resulted in five clinical studies being included in the evidence review report.

CONCLUSIONS FROM THE MIB REPORT BASED ON THE CLINICAL STUDIES REVIEWED

End tidal Control supports:
- Improved workflow through fewer interventions with the anaesthesia machine
- Potential for significant cost savings due to conservation of volatile agent
- Lower environmental emissions due to conservation of volatile agent
- Agent delivery optimisation
- Wider participation in low flow anaesthesia
EVIDENCE SUMMARY

Improved workflow

The literature review identified 5 clinical studies evaluating the use of End-tidal Control with Aisys anaesthesia delivery systems.

Two of these studies showed a significant decrease in volatile anaesthetic agent consumption with End-tidal Control compared to manual control (Potdar et al.; Singaravelu et al). The service evaluation by Singaravelu et al reported a reduction in average anaesthetic agent use of 40-55% in the End-tidal Control group.

Using standardised fresh gas flow rates for manual and End-tidal Control study groups, Lucangelo et al, found no difference in anaesthetic agent or fresh gas consumption. Lucangelo also reported fewer interactions / fewer interventions by the anaesthetist with Aisys. In manual control 137 interventions were needed by the anaesthetist to stabilise the end-tidal anaesthetic agent concentration, and 107 interventions to stabilise the end-tidal oxygen concentration, whereas there were no interventions for agent or oxygen reported for the End-tidal Control group.

Users in the service evaluation by Singaravelu and Barclay reported a 50% reduction in the average number of key presses per patient with End-tidal Control compared to manual control.

Potential for cost savings

Four of the studies evaluated the impact of End-tidal Control on costs and resource use. Three of these studies showed a reduction in costs of anaesthetic gases with End-tidal Control compared to manual control. The UK service evaluation by Singaravelu and Barclay produced savings of £7.94 per hour for sevoflurane (relative reduction of 53%) and £4.83 per hour for desflurane (relative reduction of 41%) with End-tidal Control. Tay et al, reported a relative reduction of 27% in the cost of volatile anaesthetic use with End-tidal Control (resulting in an overall cost saving in volatile anaesthetic agent of approximately £3.32 per hour). The randomised trial (Potdar et al) reported a relative reduction in the total cost of oxygen, nitrous oxide and sevoflurane of 15%. One study (Lucangelo) reported no difference in cost with End-tidal Control as the fresh gas flow rates were the same for both study groups.

Potential for lower environmental emissions

One observational study (Tay et al) evaluated the potential environmental impact and reported a 44% reduction in greenhouse gas emissions when using End-tidal Control and wider participation in low flow anaesthesia.

Agent delivery optimisation

The randomised trial conducted by Potdar et al also showed that the use of End-tidal Control enabled a higher maximum inspired concentration of sevoflurane to be achieved (2.66% vs 2.11%) and that it reduced the time to achieve end-tidal concentration of sevoflurane of 1.5% by 10 minutes compared to manual control.
<table>
<thead>
<tr>
<th>Study</th>
<th>Summary of key results</th>
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<tbody>
<tr>
<td>Potdar et al. (2014)</td>
<td><strong>Randomised trial at single centre (Indian hospital). N=200</strong></td>
</tr>
</tbody>
</table>
| | **Consumption (litre/minute) of nitrous oxide**  
sevoflurane  
oxygen  
| 0.70  
0.17  
1.74 | 0.83  
0.20  
1.83 | **p=0.001**  
**p=0.0001**  
**p=0.21** |
| | **Time needed to achieve end-tidal concentration of sevoflurane of 1.5% (minutes)**  
| 3.08 | 13.40 | **p=0.0001** |
| | **Maximum inspired concentration of sevoflurane**  
| 2.66% | 2.11% | **p=0.0001** |
| | **Number of adjustments needed to maintain the depth of anaesthesia**  
| 3 per patient | varied from 5 to 12 | **p=0.0001** |
| | **Cost saving potential**  
Total cost of oxygen, nitrous oxide and sevoflurane consumption  
| 353.95 Indian rupees per hour | 417.76 Indian rupees per hour | This translated to a saving of £0.64 per hour with End-tidal Control. |
| Tay et al. (2013) | **Prospective before-and-after observational study at single tertiary hospital (Australia)**  
3,675 general anaesthesia cases |
| | **Mean volatile anaesthetic isoflurane, desflurane, sevoflurane cost per hour (in Australian dollars)**  
| $13.82 (SD $3.27) | $18.87 (SD $6.15) | Absolute reduction of $5.05 (95% CI: $0.88 to $9.22, **p=0.0243**)  
Relative reduction of 27% in mean volatile anaesthetic cost with End-tidal Control. This translated to an overall cost saving in volatile anaesthetic agent of £3.32 (95% CI: £0.58 to £6.06) per hour with End-tidal Control. |
| | **Carbon dioxide absorbent usage**  
| 144 kg ($4050) | 156 kg ($4108) | not statistically significant. |
| | **Rate of greenhouse gas emissions**  
| 13.0 kg/hour (SD 6.2) | 23.2 kg/hour (SD 10.8) | Absolute reduction in greenhouse gas emissions of 10.2 kg/hour (95% CI: 2.7 to 17.7 kg/hour, **p=0.0179**).  
Relative reduction in greenhouse gas emissions of 44% when using End-tidal Control. |
| Lucangelo et al. (2014) | **Prospective observational study in operating** |
| | **Machine characteristics**  
Median time to reach target end-tidal anaesthetic agent concentration (secs)  
| | Median time to maintain steady end-tidal anaesthetic agent concentration (secs)  
<p>| 145 | 360 | <strong>P&lt;0.00001</strong> |</p>
<table>
<thead>
<tr>
<th>Rooms in a single hospital N=80 (elective abdominal surgery)</th>
<th>tidal anaesthetic oxygen concentration (secs)</th>
<th>[130–171]</th>
<th>[278–531]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gas consumption</strong></td>
<td>Median oxygen delivery [litres]</td>
<td>87 [48–120]</td>
<td>74 [52–105]</td>
</tr>
<tr>
<td></td>
<td>Median sevoflurane uptake [ml/minute]</td>
<td>3.7 [2.3–4.4]</td>
<td>3.8 [3.0–4.4]</td>
</tr>
<tr>
<td><strong>Oxygen and sevoflurane efficiencies</strong></td>
<td>Median oxygen efficiency</td>
<td>47 [34–60] %</td>
<td>51 [44–62] %</td>
</tr>
<tr>
<td></td>
<td>Median sevoflurane efficiency</td>
<td>21 [12–39] %</td>
<td>22 [14–40] %</td>
</tr>
<tr>
<td>Singaravelu, S and Barclay, P (BJA 2013). Service evaluation in gynaecology theatres within a single UK centre</td>
<td><strong>Number of anaesthetist interventions</strong></td>
<td>Total number of interventions to reach the pre-established end-tidal anaesthetic agent concentration</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total number of interventions to maintain the end-tidal oxygen concentration</td>
<td>0</td>
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**Inhalation anaesthetic use**

Average fresh gas flow during End-tidal Control decreased significantly with increased duration of anaesthesia (Spearman r=−0.88, p=0.0016). When comparing anaesthetics of the same duration, the average volatile anaesthetic use was consistently reduced by 40–55% in the End-tidal Control group.

**User intervention**

The mean number of key presses was 6.5 [95% CI 6.0 to 7.0] with End-tidal Control, and 13.6 [95% CI 12.8 to 14.4] with manual control.

**Secondary outcomes**

With End-tidal Control, the measured end-tidal concentration was within 10% of the set target for 98% of the total time spent in steady state, allowing 5 minutes for equilibration after each change in the set target.

The mean difference between measured end-tidal concentration and target end-tidal concentration using End-tidal Control was 1.47 (95% CI: 1.29 to 1.66) %.

**Kennedy, R and French, R (2014). Audit study from 3 New Zealand hospitals using Datex ADUs and Aisys machines with End-tidal Control**

The mean difference between measured end-tidal concentration and target end-tidal concentration using End-tidal Control was 1.47 (95% CI: 1.29 to 1.66) %.

**Mean fresh gas flow rates**

| Christchurch Aisys | 1.50 litre/minute | 1.29 litre/minute |
| Christchurch Aisys | 1.29 litre/minute | 1.27 litre/minute |
| Christchurch Aisys | 1.09 litre/minute | 1.26 litre/minute |

The overall proportion of time spent in End-tidal Control mode with the Aisys machines was 34% in June 2011, 60% in December 2011 and 61% in June 2012. There is an association between reduction in flow rates and increasing proportion of time spent in End-tidal Control mode.
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REFERENCES


End tidal Control is not available in all markets. End tidal Control is not cleared or approved by the United States FDA. Not For Sale in the United States.

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