
Abstract

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Morbidity after colorectal surgery can be reduced with intraoperative oesophageal Doppler monitor (ODM) guided fluid therapy. We audited the effect of introducing ODM-guided fluid therapy in enhanced recovery laparoscopic colorectal surgery. ODM group (n=40) outcomes (toleration of diet, Post Operative Morbidity Survey (POMS) score, complications) were compared to matched patients (n=40) who had the same surgery using a conventional approach to fluid management. Mean (SD) time to tolerate diet was shorter in the ODM group (2.3 (1.6) days vs 3.8 (2.4) days, p = 0.003). The ODM group had a lower mean (SD) POMS score on post-operative day 1 (2 (1.4) vs 4 (1.1), p = 0.001), fewer postoperative complications and a lower rate of unplanned admissions to the Intensive Care Unit (ICU) (7 vs 15, p = 0.001). Introduction of intraoperative ODM-guided stroke volume optimization was associated with improved outcomes in patients undergoing enhanced recovery laparoscopic colorectal surgery.

Methods

The audit design permitted postoperative outcomes of ASA 1-3 adult patients undergoing elective laparoscopic colorectal surgery with intraoperative ODM fluid management during 2011 (ODM group) to be compared to the outcomes of patients who had the same surgical procedures with conventional fluid management (conventional group). Both groups followed a similar anaesthetic technique. The ODM group had intraoperative fluid management using the Deltex CardioQ-ODM" (Deltex Medical, Chichester, West Sussex, UK). The conventional group comprised patients from the institutions prospective colorectal surgery audit database who had undergone the same surgical procedure, but had intraoperative fluid therapy guided by conventional haemodynamic indices. Comparison of outcomes between the ODM and conventional groups was based on matching patients for age, procedure type, ASA grade, and Co-morbidity Index. POMS score and complications were compared using McNemar Chi Sq test. Length of stay was compared between groups. Our statistical analysis used Student's t test for independent samples. McNemar's ChiSq test was used for matched data. A p value <0.05 was considered statistically significant.

Outcomes audited were time to tolerate oral diet post-operatively, Post Operative Morbidity Survey (POMS) score, overall organ-specific complication rate, unplanned critical care area (HDU/ICU) admission rate and length of postoperative hospital stay. POMS score is a validated tool that assigns a score for the presence or absence of predicted postoperative organ-specific complications. A member of the surgical team who was not present in the operating room undertook postoperative patient data collection. The first post-operative day was assigned day 1 for the purpose of calculating length of hospital stay. The ODM probe was removed at the end of the procedure. Conventional group intraoperative fluid management was at the discretion of the attending anaesthetist using conventional hemodynamic indices.

Two groups of patients who had the same surgical procedures with conventional fluid management (ODM group). Both groups underwent similar anaesthetic techniques. The ODM group fluid management algorithm (Figure 1) was based on RCT algorithms that demonstrated improved outcome in colorectal surgery patients. The fluid used in this algorithm was 6% Hydroxyethyl Starch (HES) (Voluven, Fresenius Kabi AG, Bad Homburg, Germany) stroke volume optimization with the ODM was undertaken prior to the surgical incision. The ODM probe was inserted through the mouth under direct vision and volume, heart rate and collagen administration was recorded. Demographic and baseline characteristics were described using summary statistics for both groups. Our statistical analysis used Student's t test for independent samples. McNemar's Chi Sq test was used for matched data. A p value <0.05 was considered statistically significant.

Results

The audit included 80 patients; 40 in the ODM group and 40 in the conventional group. Age, surgical procedure, ASA grade, and co-morbidities were similar between the two groups. Two patients in the ODM group had intraoperative oesophageal Doppler monitoring. The first post-operative day was assigned day 1 for the purpose of calculating length of hospital stay. The ODM probe was removed at the end of the procedure. Conventional group intraoperative fluid management was at the discretion of the attending anaesthetist using conventional haemodynamic indices.

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Fewer ODM group patients experienced 1 postoperative complication (14 vs 20, p=0.009) (Table 3). In the conventional group, gastrointestinal complications developed in 5 patients. These complications included one anastomotic haematoma, one small bowel obstruction requiring operative intervention and 2 high output stomas. The fifth patient had a prolonged ileus and required total parenteral nutrition (TPN). All of the gastrointestinal complications in the ODM group were ileus, 2 of which required TPN. Fewer patients in the ODM group required unplanned postoperative critical care admission (3 vs 6, p = 0.037) (Table 2). Reasons for critical care admission included lower respiratory tract infection, hypovolaemic shock, acute kidney injury and prolonged ileus. Length of critical care stay ranged from 1-2 days in the conventional group and was 7 days for the patient in the ODM group. There was no difference between patients in the mean (SD) length of postoperative hospital stay (days) (8.7 (4.3) in the ODM group and 9.6 (5.6) in the conventional group).


Total volume (mean (SD)) of fluid administered was not different between the groups; ODM group 2124 (904) ml vs. conventional group 2447 (958) p = 0.07. Patients in the ODM group received more colloid (964 (525) ml vs 371 (421) ml, p < 0.0001), and less crystalloid (1140 (614) ml vs. 2076 (807) ml, p < 0.0001). Patients in the ODM group received less colloid (1355 (355) ml vs 1449 (306) ml, p = 0.0001). There were no statistically significant differences in the volumes of colloid administered over subsequent hours of surgery between the 2 groups. In contrast, the ODM group patients received less crystalloid during every hour of surgery. There were no complications related to ODM probe insertion and no patients in the ODM group developed signs or symptoms of fluid overload or cardiac failure.

Discussion
This audit showed that intraoperative ODM-guided SV optimisation was associated with a reduction in postoperative morbidity in patients undergoing laparoscopic colorectal surgery. Time to tolerate diet was shorter, and complication rate, number of complications and unplanned critical care admission rate was significantly lower in the ODM group. Fewer patients in the ODM group experienced postoperative complications (14 vs. 20, p = 0.009). Patients in the conventional group had more serious gastrointestinal morbidity. Splanchnic hypoperfusion may occur in up to 60% of patients undergoing major surgery, and has been shown to be a strong predictor of postoperative GI morbidity. Individualised timely optimization of stroke volume in the ODM group may have better maintained splanchnic perfusion and gut mucosal integrity, and could explain the observed reduction in complication rate. The total volume of intravenous fluid administered in the 2 groups was not different. Therefore, the type and / or temporal pattern of intravenous fluid administration may explain the observed outcome differences. The ODM group received more colloid and less crystalloid than the conventional group. Colloids may have a benefit by maintaining splanchnic micro-circulation. In the ODM group fluid administration was front loaded; they received a greater proportion of their total fluid in the first hour of surgery, prior to initiation of pneumoperitoneum and re-positioning of the patient from supine to Trendelenberg.

The sequence of operating room events in relation to the timing of fluid administration may be important in understanding the observed differences in outcome. Pneumoperitoneum during laparoscopic surgery is uniquely associated with acute cagiovular changes, including reduced venous return, increased afterload and a reduction in SV and cardiac index. Such haemodynamic responses to pneumoperitoneum may vary according to both the individual patient and the insufflation pressure. These cardiovascular changes may be amplified by the steep Trendelenberg position necessitated by laparoscopic colorectal surgery and the variable degrees of dehydration that exist in this surgical population. Pneumoperitoneum and re-positioning of the patient from supine to Trendelenberg may have a protective effect on the splanchnic circulation and gut mucosal integrity, and this may explain the lower rate of morbidity seen in the ODM group compared to the conventional group who did not have this front loaded pattern of fluid administration.

A potentially important effect may be observed from using the ODM to guide fluid administration only when pneumoperitoneum was absent. When pneumoperitoneum is introduced, reduced SV is detected by the ODM. If this reduced SV is inappropriately attributed to hypovolemia, rather than the physiological changes described above, and triggers further volume administration, the risk of harmful intravascular fluid overload has been created. Thus, the observed improvement in outcome in the ODM group in this audit accords with the benefits that have been observed when an approach is taken to intraoperative fluid management that avoids salt and water excess. This audit observed a reduction in postoperative complication rate, but no difference in length of postoperative hospital stay. The sample size may have been inadequate to detect any such difference, and length of stay may be influenced by non-medical factors. Time to fitness for medical discharge might be a more informative measure. Interestingly, the total number of beds day 384 was 348 in the ODM group compared to 383 in the conventional group, which represents significant cost saving at our institution on this metric.

On the basis of evidence of improved outcome and the published recommendations we introduced intraoperative ODM-guided fluid management as a quality improvement measure to an existing enhanced recovery pathway in laparoscopic colorectal surgery. This clinical audit formed an important part of this process, and found that intraoperative ODM-guided stroke volume optimisation was associated with earlier tolerance of diet, and a reduction in complication rate, total number of complications and unplanned critical care admission in patients undergoing laparoscopic colorectal surgery. This also illustrates the importance of audit when an evidence-based quality improvement change is implemented. Individualised fluid therapy has been adopted as one of the recommended elements for major elective surgical pathways by the British Society for Enhanced Recovery Partnership, and particularly in the area of laparoscopic surgery this has generated recent interest. The predicted expansion of enhanced recovery pathways in the future is likely to make this an ongoing focus of interest.

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References


