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Clinical Practice

Greater intravenous fluid volumes are associated with prolonged recovery after colorectal surgery: a retrospective cohort study

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Abstract

Background: We carried out a retrospective assessment of whether perioperative fluid volume was associated with length of hospital stay (LOS) after colorectal surgery.

Methods: A single-centre chart review was conducted on colorectal surgeries that took place between January 2008 and December 2013. The primary outcome was LOS, with prolonged LOS defined as greater than median LOS. Secondary outcomes included postoperative pulmonary oedema, acute renal failure, myocardial infarction, and mortality. Univariate analysis, multivariable logistic regression, and quantile regression analyses were conducted to examine the association between perioperative fluid volume and prolonged LOS.

Results: Of the 1242 procedures, 57% were elective, 62% oncological, and 31% laparoscopic. The median LOS was 8.2 days (interquartile range 5.2, 14.7). Patients received 3.2 (SD 1.5) litres of fluid in the perioperative period (operating and recovery rooms), predominantly crystalloid. The volume (in litres) of perioperative fluid was independently associated with prolonged LOS (odds ratio 1.23, 95% confidence interval 1.10–1.36, $P<0.01$). This association persisted across the spectrum of definitions for prolonged LOS (10th–90th percentile). Logistic regression analysis also revealed that prolonged LOS was associated with age >65 yr, Charlson Co-morbidity Index ≥3, use of colloids, emergent surgery, estimated blood loss >200 ml, preoperative anaemia, erythrocyte transfusion, open surgeries, and surgical duration >4 h (C-statistic=0.79, Hosmer–Lemeshow=0.36).

Conclusions: Greater perioperative fluid volume was independently associated with prolonged duration of recovery across a spectrum of surgical risk profiles. Fluid restriction should be considered a part of the care package in enhanced recovery after surgery programmes for colorectal surgery.

Key words: colorectal surgery; fluid therapy; length of stay; perioperative care

Colorectal cancer remains a leading cause of morbidity and mortality worldwide.[1] Surgical resection is the primary treatment for non-metastatic colorectal cancer; therefore, it is imperative to identify modifiable perioperative risk factors that might influence recovery. The influence of perioperative fluid volume on recovery after major abdominal surgery remains poorly understood. Historical practice involves administration of large volumes of i.v. fluid with the rationale to replace deficits caused by preoperative fasting, to prevent anaesthesia-induced hypotension, and to adjust for haemodynamic changes influenced

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Editor's key points

- The impact of perioperative i.v. fluid volume on patient outcomes, such as length of hospital stay (LOS), is unclear.
- A single-centre retrospective review of patients undergoing colorectal surgery found an independent association between greater fluid volume and increased LOS.
- Although requiring confirmation by prospective randomized trials, these data suggest that restrictive fluid approaches could enhance recovery after colorectal surgery.

by bleeding and 'hypothetical' third space losses. However, the body of evidence supporting this management has been strongly contested.[2]

Despite inconclusive evidence, enhanced recovery after surgery (ERAS) programmes recommend fluid restriction within their bundle of care for colorectal surgery.[3] With the wide uptake of ERAS programmes worldwide, it is increasingly important to conduct meaningful studies on the influence of perioperative fluid therapy on patient outcome and recovery. To address this, we conducted a single-centre (two-hospital) retrospective chart review capturing a 6 yr window of elective and emergent colorectal surgeries before the initiation of a comprehensive ERAS programme. Our primary objective was to determine whether the volume of i.v. fluid administered in the perioperative period was associated with the length of hospital stay (LOS) after colorectal surgery. Ultimately, this may help to inform practice related to the inclusion of fluid restriction in ERAS programmes.

Methods

This retrospective study was approved by our institution's Research Ethics Board (reference 06-0193-AE), which waved the requirement for informed consent.

Study setting and patient cohort

The study was conducted at two hospitals (Toronto General Hospital and Toronto Western Hospital) within the University Health Network (UHN), which is a tertiary referral centre in Toronto, Ontario, Canada. A chart review was conducted on consecutive, adult patients (>18 yr old) who underwent inpatient colorectal surgery between January 1, 2008 and December 31, 2013. Importantly, the epoch chosen corresponded to a period immediately before systematic initiation of an ERAS programme.[3] Minor procedures and procedures without significant bowel resection were excluded, including the following: colostomies, ileostomies, jejunostomies, laparoscopic adhesiolysis, and laparotomies without bowel resection. Patients admitted to the intensive care unit (ICU) before surgery would not qualify for ERAS management and were excluded. During the study period, fluid management was at the discretion of the attending anaesthetist, and cardiac output monitoring was not available.

Data sources and linking of electronic data sets

Data were retrieved from an electronic data warehouse using methodology described previously by Beattie and colleagues.[4] The three primary databases used were as follows: (i) electronic patient records; (ii) the operating room scheduling office system bookings database (ORSOS™; McKesson Corporation, San Francisco, CA, USA); and (iii) the UHN blood transfusion database HCLL (Hemocare Lifeline; Mediware, Chicago, IL, USA). Records were linked using patient medical record numbers and then de-identified.

Predictor variables

Predictor variables were selected based on previous studies and factors felt *a priori* to affect outcome. To assess systemic illness and co-morbidities, the Charlson Co-morbidity Index (CCI)[5] based on ICD-10 codes[6] and Revised Cardiac Risk Index were used. Other variables that were analysed included age, BMI, sex, preoperative haemoglobin and creatinine, and the following intraoperative variables: type of surgery (emergent or elective, laparoscopic or open laparotomy), surgical duration, epidural use, oncological status, i.v. fluids administered (in litres) and estimated blood loss (EBL). The i.v. fluid data included normal saline, balanced salt solution, hydroxyethyl starch, and albumin (5 and 25%). Red blood cell (RBC) transfusion were also collected. The perioperative period was defined as the duration from the commencement of the surgical procedure to discharge from the postanaesthetic care unit (PACU). For patients who were admitted directly to the ICU from the operating room (OR), the perioperative period was restricted to their surgical duration.

Primary and secondary outcomes

The primary outcome measured was LOS, defined as the duration from date of surgery to date of discharge. A prolonged LOS was defined as being greater than the median LOS for the entire cohort (8.2 days, interquartile range 5.2–14.7). Values were truncated to the 90th percentile, and all patients who died in hospital were given an LOS of 26 days (90th percentile). Secondary outcomes included postoperative complications (myocardial infarction, acute renal failure, and pulmonary oedema) and postoperative mortality.

Statistical analysis

Statistical analysis was performed using SAS™ version 9.1.3 (SAS institute Inc., Cary, NC, USA). Categorical variables were summarized as the frequency (percentage) and continuous variables as the mean (SD).

Multivariable logistic regression

The outcome of interest was prolonged LOS (LOS>median of 8.2 days). Univariate analyses and cubic spline curves[7] were conducted to assess the unadjusted association of population characteristics and candidate variables with prolonged LOS. Variables that were significantly different between the two groups (LOS≤8.2 days and LOS>8.2 days) on univariate analysis or those demonstrated to influence surgical outcomes in previous publications[5] were then included in a stepwise multivariable logistic regression analysis. The fit of the logistic model was assessed using the Hosmer–Lemeshow test (where $P>0.05$ suggests a well-fitting model), whereas the performance of the model was assessed using the receiver operating characteristic curve C-statistic.

Quantile linear regression

Using the same variables included in the multivariable logistic regression analysis, quantile linear regression analysis was conducted by dividing the population into various quantiles of LOS (10th percentile, 25th percentile, 50th percentile etc.) and using least squares regression analysis to determine whether fluid volume had a similar influence on each quantile to provide