

The effect of perioperative fluid management on postoperative ileus in rectal cancer patients

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Background. Postoperative ileus is a common cause of increased morbidity and cost after operative intervention. The aim of this study was to assess how fluid type, volume, and timing may affect incidence of postoperative ileus.

Methods. A retrospective cohort study was performed on patients undergoing operative intervention for rectal cancer from 2008 to 2015 at a single institution. Univariate and multivariate analyses were used to assess the effect of type (crystalloid versus colloid), volume by quartile, and timing (perioperative versus postoperative) on rate of postoperative ileus.

Results. A total of 300 patients were included, and the overall incidence of ileus in our cohort was 30% (n = 90). Both univariate and multivariate analyses showed that increasing volume of crystalloid volume administered was associated with increased postoperative ileus incidence (first quartile: 16.3%; second quartile: 31.5%, third quartile: 34.2%; and fourth quartile: 39.2%; P = .012), and administration of colloid was not shown to correlate. Furthermore, timing was not shown to be associated with the rate of postoperative ileus.

Conclusion. Increased volumes of crystalloid are associated with higher rates of ileus, while administration of colloid is not. Based on this retrospective data, limiting the volume of crystalloid perioperatively may help lower the rate of ileus postoperatively. (Surgery 2016;■:■-■.)

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POSTOPERATIVE ILEUS (POI) is a common complication following abdominal operation, occurring in approximately 17%–27% of patients undergoing partial colectomy.¹ It not only occurs at high incidence but also has significant consequences for

both the patient and the health care system. It has been reported that POI increases the mean hospital duration of stay by nearly 5 days and increases the cost of care by approximately \$8,000 per stay.^{2,3} Other analyses have shown higher complication, reoperation, readmission, and mortality rates in patients with ileus.⁴

Thus, a greater understanding of causes and possible preventative strategies has the potential to significantly improve quality and value of care for patients undergoing abdominal operations.³⁻⁶ While the development of POI can rarely be attributed to a single cause, several management considerations, such as fluid status, use of nasogastric decompression, opioid use, and operative approach have been implicated as potentially modifiable risk factors for POI.^{7,8}

Intravenous fluid (IVF) administration and volume status are clearly associated with POI. Bowel edema secondary to volume overload is associated with delayed recovery of gastrointestinal function and extended hospital stay.⁷ Conversely, relative intraoperative fluid restriction in patients undergoing major intra-abdominal surgery has

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been shown to shorten the time to recovery of gastrointestinal function.⁹

It remains unclear, however, if the primary effect of IVF administration on bowel function is due to net volume gain, hypoalbuminemia, or both. Studies performed using albumin replacement have not demonstrated any improvement in tolerance of enteral feeding or acceleration in return of bowel function, leaving the role of hypoalbuminemia unclear.^{10,11} While multiple previous studies have compared crystalloid and colloid, none have evaluated POI as an outcome.^{12,13} Furthermore, the timing of IVF administration in the perioperative period as it relates to development of POI has not been investigated previously.

The aim of this study was to characterize the impact of the volume, type, and timing of IVF administration during the perioperative period on risk of POI in patients undergoing surgery for rectal cancer. We hypothesized that greater volume of IVF, crystalloid fluids, and large relative volume administered intraoperatively would all increase the risk for POI.

METHODS

Study population. This study is a retrospective cohort study including all patients with a diagnosis of rectal cancer who underwent proctectomy or proctocolectomy at the University of Wisconsin Hospital from August 2008–June 2015. Patients for whom documentation of perioperative fluid administration was incomplete or unobtainable were excluded. Data were extracted from each subject's electronic medical record. This study was approved by the University of Wisconsin-Madison Institutional Review Board.

Variable definitions and end points. Retrospective chart review was performed to collect patient-, operative-, fluid-, and outcomes-related data for each subject. Patient-related variables included age, body mass index (BMI), ethnicity, American Society of Anesthesiologists (ASA) classification, smoking status (defined as current smoker or past smoker versus nonsmoker), receipt of neoadjuvant chemotherapy, tumor stage, and presence of comorbidities, including diabetes, congestive heart failure, hypertension, chronic obstructive pulmonary disease, and disseminated cancer. Operation-related variables included operation performed, operative time, operative approach, estimated blood loss, and wound classification.

Fluid type, volume, and day of administration were the primary exposure variables of interest. Fluid type was categorized as crystalloid (including

lactated ringers, 0.45% and 0.9% normal saline, dextrose 5%-water) or colloid (including 2.5% or 5% albumin, hetastarch, and packed red blood cells). Fluid timing was categorized as occurring intraoperatively, postoperatively on the day of operation, postoperative day (POD) 1, or POD 2 or later. Volume of fluid received for each time period was recorded separately for crystalloid and colloid fluids.

For analytic purposes, continuous variables were broken into clinically significant groups when possible and into quartiles when no clear clinically significant cutoffs were apparent. Intraoperative crystalloid volume was divided into quartiles, yielding 4 categories with the following cutoffs: 0–2,700 mL, 2,701–3,400 mL, 3,401–4,200 mL, and greater than 4,200 mL. Intraoperative colloid administration was defined as a binary variable based on whether the patient received any colloid versus no colloid fluids. Age was divided into 4 categories (less than 50 years, 50–64 years, 65–79 years, and greater than 80 years); BMI was defined as normal (BMI < 25), overweight (25–29.9), and obese (≥ 30); operative duration was divided into quartiles; and estimated blood loss was divided into categories (0–100 mL, 101–500 mL, 501–1,000 mL, and >1,000 mL).

The primary outcome for this study was occurrence of postoperative ileus, defined using the American College of Surgeons National Surgical Quality Improvement Program definition of presence of nasogastric tube or nil per os (NPO) status on POD 4 or later.

Statistical analysis. We investigated the relationship between perioperative fluid administration and POI. Initial univariate analysis using χ^2 tests was performed to identify patient and operative characteristics associated with the development of POI. Similarly, univariate analysis was used to explore the relationship between fluid volume and type with POI.

Multivariate analysis using binary logistic regression was then performed to examine the independent effect of both fluid volume and fluid type using POI as the outcome. All variables for which there was a statistically significant association with POI on univariate analysis ($P < .05$) were included in the multivariate model: age, BMI, smoking status, and operative approach. Additionally, we adjusted for operative duration and estimated blood loss.

The impact of timing of fluid administration on POI was assessed by comparing the rate of fluid administration intraoperatively (mL/min) to the rate of fluid administered during POD 1 (mL/min). Thus, this value, termed the "rate ratio," was

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