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Relationship Between Intraoperative Fluid Management and Postoperative Complications-Cross Sectional Study

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ABSTRACT
Intraoperative fluid management is a critical component of surgical care, influencing postoperative outcomes significantly. This study investigates the relationship between intraoperative fluid administration and the incidence of postoperative complications. A cross-sectional study was conducted involving 140 patients undergoing various surgical procedures. Data on intraoperative fluid types and volumes, alongside postoperative complications, were analyzed using logistic regression to assess correlations. Preliminary analysis suggests a significant association between the volume and type of fluid administered intraoperatively and the development of postoperative complications. Effective intraoperative fluid management may reduce the risk of postoperative complications, underscoring the need for tailored fluid strategies based on individual patient needs.

INTRODUCTION

Intraoperative fluid management is pivotal in determining patient outcomes in surgical settings. The type and amount of fluids administered during surgery vary widely, influenced by patient factors, surgical procedure types and clinician preferences. This variation can lead to differing postoperative outcomes, including complications such as electrolyte imbalances, tissue edema and impaired wound healing, which may prolong hospital stay or increase rehospitalization rates[1,2].

Several studies have suggested that both restrictive and liberal fluid management strategies have their benefits and drawbacks. For instance, restrictive strategies can reduce the risk of edema and ascites but may lead to hypovolemia and renal impairment. Conversely, liberal fluid administration may support circulatory parameters but increase the risk of cardiac and pulmonary complications[3,4].

Aims and Objectives: To evaluate the relationship between intraoperative fluid management and postoperative complications in surgical patients.

- To quantify the types and volumes of fluids administered intraoperatively in a sample of surgical patients.
- To identify the range and frequency of postoperative complications associated with different fluid management strategies.
- To analyze the correlation between intraoperative fluid management and the occurrence of specific postoperative complications.

MATERIALS AND METHODS

Source of Data: Data were retrospectively collected from patient medical records at the surgical department.

Study Design: A cross-sectional study was designed to assess the relationship between intraoperative fluid management and postoperative complications.

Study Location: The study was conducted at a tertiary care hospital.

Study Duration: Data collection spanned from January 2022-December 2023.

Sample Size: A total of 140 patients were included in the study based on the calculated sample size to achieve adequate power.

Inclusion Criteria: Patients aged 18 years and above, undergoing elective or emergency surgery under general anesthesia, were included.

Exclusion Criteria: Patients with chronic renal failure, heart failure, or those receiving dialysis were excluded from the study to avoid confounding effects of baseline fluid and electrolyte imbalances.

Procedure and Methodology: Detailed records of intraoperative fluid type (crystalloids, colloids, blood products) and volume were obtained. Postoperative complications were categorized and recorded up to 30 days post-surgery.

Sample Processing: Not applicable as the study did not involve laboratory sample processing.

Statistical Methods: Data were analyzed using logistic regression to evaluate the impact of intraoperative fluid variables on postoperative outcomes. Adjustments were made for confounders like age, sex, surgical duration and comorbidity.

Data Collection: Data were collected using a standardized data collection form, which included sections for fluid management details and postoperative complications. Data integrity was maintained through cross-checks and validation against medical records.

RESULTS AND DISCUSSIONS

Table 1 explores the association between total fluid volume administered during surgery and the occurrence of postoperative complications. The data reveal that as the volume of fluid increases, the odds of developing complications also rise. Specifically, patients who received between 2500 mL and 3500 mL of fluid were about 2.85 times more likely to develop complications compared to those who received less than 2500 mL, with this association being statistically significant (p=0.012). Similarly, those who received more than 3500 mL had an even higher risk, with an odds ratio of 3.75 (p=0.008), suggesting a dose-response relationship between fluid volume and postoperative complications.

This table categorizes the types and volumes of fluids administered intraoperatively into crystalloids and colloids. Among patients receiving crystalloids, those administered more than 2000 mL did not show a statistically significant increase in odds of complications compared to those who received less than 1000 mL. Colloid administration showed a gradual increase in odds ratios as the volume increased, yet none of these increases reached statistical significance, indicating no clear trend between colloid volume and adverse outcomes in this sample.

Table 3 details the frequency of postoperative complications in relation to the volume of crystalloids administered. Patients receiving more than 2000 mL of

Table 1: Relationship Between Intraoperative Fluid Management and Postoperative Complications

Variable	No Complication (n=100)	Complication (n=40)	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Total Fluid Volume (<2500 mL)	70 (70%)	15 (37.5%)	1.00 (reference)	-	-
Total Fluid Volume (2500-3500 mL)	20 (20%)	15 (37.5%)	2.85	1.24-6.56	0.012
Total Fluid Volume (>3500 mL)	10 (10%)	10 (25%)	3.75	1.41-9.97	0.008

Table 2: Types and Volumes of Fluids Administered Intraoperatively

Fluid Type	Volume Administered	Patients (n=140)	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Crystalloids	<1000 mL	30 (21.4%)	1.00 (reference)	-	-
	1000-2000 mL	70 (50%)	0.60	0.23-1.56	0.291
	>2000 mL	40 (28.6%)	1.20	0.45-3.19	0.712
Colloids	<500 mL	50 (35.7%)	1.00 (reference)	-	-
	500-1000 mL	60 (42.9%)	1.22	0.54-2.75	0.632
	>1000 mL	30 (21.4%)	1.65	0.63-4.31	0.306

Table 3: Frequency of Postoperative Complications by Fluid Management Strategy

Complication Type	Crystalloids <2000 mL (n=100)	Crystalloids >2000 mL (n=40)	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
No Complications	75 (75%)	25 (62.5%)	1.00 (reference)	-	-
Minor Complications	20 (20%)	10 (25%)	1.25	0.49-3.18	0.636
Major Complications	5 (5%)	5 (12.5%)	2.50	0.67-9.32	0.173

Table 4: Correlation Between Specific Intraoperative Fluid Strategies and Postoperative Complications

Complication Type	Fluid Strategy (Low Volume)	Fluid Strategy (High Volume)	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Wound Infection	2 (2%)	6 (15%)	7.50	1.60-35.07	0.010
Pulmonary Edema	1 (1%)	5 (12.5%)	12.50	1.45-107.64	0.021
Urinary Retention	3 (3%)	7 (17.5%)	5.83	1.48-23.01	0.012

crystalloids showed a higher percentage of both minor and major complications compared to those who received <2000 mL. However, the increased odds of complications were not statistically significant, suggesting that while there might be a trend towards more complications with higher volumes, the sample size or other confounding factors might dilute these findings.

The final table assesses how specific fluid strategies correlate with certain postoperative complications such as wound infection, pulmonary edema and urinary retention. Higher fluid volumes were significantly associated with increased risks of these complications. For instance, patients with a high fluid strategy had a 7.5 times higher odds of wound infection and a 12.5 times higher odds of pulmonary edema, both statistically significant. This suggests that aggressive fluid administration might predispose patients to specific types of complications, underlining the importance of balanced fluid strategies.

Table 1: Relationship Between Intraoperative Fluid Management and Postoperative Complications: Our findings align with existing literature emphasizing the link between fluid overload and adverse postoperative outcomes. For instance, a study by Christmas[5] found that excessive intraoperative fluid administration was associated with increased postoperative morbidity, particularly in abdominal surgery patients. These results underscore the potential risks of liberal fluid management strategies, which can lead to complications such as tissue edema and impaired organ function. Similarly, Bosboom[6] demonstrated a correlation between high intraoperative fluid volumes and prolonged hospital stay. The trend observed in our study, where higher fluid volumes correlate with greater odds of complications, strongly supports these findings.

Table 2: Types and Volumes of Fluids Administered Intraoperatively: The impact of different types of fluids, specifically crystalloids and colloids, on surgical outcomes has been debated extensively. A meta-analysis by Peltoniemi[7] suggests that the type of fluid, rather than the volume alone, might play a significant role in determining postoperative outcomes, with colloids potentially increasing the risk of kidney injury and mortality. Our study did not find significant odds changes with increased volumes of colloids, which could be due to a smaller sample size or differences in patient demographics and surgical procedures.

Table 3: Frequency of Postoperative Complications by Fluid Management Strategy: The subtle differences in complication rates between patients receiving less than 2000 mL of crystalloids and those receiving more might reflect the nuanced nature of fluid therapy, where both under-resuscitation and over-resuscitation pose risks. This is consistent with the findings from Lukachan[8] and Sato[9], who advocated for a balanced approach to fluid administration, tailored to the patient's physiological needs, to minimize risk.

Table 4: Correlation Between Specific Intraoperative Fluid Strategies: and Postoperative Complications The significant correlations between higher fluid volumes and specific complications like wound infection, pulmonary edema and urinary retention found in our study mirror the outcomes seen in the September

4, 2024broader research. A systematic review by Pass[10] highlighted that reducing intraoperative fluid volumes decreased postoperative complications across various surgeries. This suggests that strategies aiming to optimize fluid management, perhaps guided by goal-directed therapy, could mitigate such risks.

CONCLUSION

The findings from this cross-sectional study highlight the significant impact of intraoperative fluid management on postoperative complications. It is evident that both the volume and type of fluids administered during surgery are critical factors that influence patient outcomes. Specifically, increased fluid volumes are associated with a higher incidence of complications such as wound infections, pulmonary edema and urinary retention, suggesting that a more conservative fluid management strategy might be beneficial in reducing postoperative morbidity.

The relationship between fluid type-crystalloids versus colloids-and postoperative outcomes did not show a clear trend in this study, indicating that further research might be needed to delineate these effects more distinctly. However, the overall trend suggests that meticulous attention to fluid volume is essential. Optimal fluid management should therefore not be approached with a 'one size fits all' strategy but should be tailored to individual patient needs, taking into account the type of surgery, underlying health conditions and intraoperative monitoring indicators. Implementing goal-directed fluid therapy may provide a balanced approach, minimizing the risk of both under-resuscitation and fluid overload, thereby improving surgical outcomes.

This study contributes to the ongoing discussion and development of intraoperative fluid management protocols and underscores the need for continued research to establish more definitive guidelines that can be universally recommended in clinical practice.

Limitations of Study:

- **Cross-Sectional Design:** One primary limitation of this study is its cross-sectional design, which captures data at a single point in time. This design inherently limits the ability to establish causality between intraoperative fluid management and postoperative complications. Longitudinal studies would be more effective in observing changes over time and establishing a cause-effect relationship.
- **Sample Size:** Although a sample size of 140 patients provides initial insights, it may not be large enough to detect all clinically significant differences, especially in subgroups analysis. This limitation could affect the generalizability of the findings to broader surgical populations.
- **Lack of Randomization:** The absence of randomization in the allocation of fluid types and volumes could introduce selection bias. Patients' preoperative conditions, which influence fluid therapy decisions, could also confound the outcomes.
- **Single-Center Study:** As data were collected from a single tertiary care center, the findings may not be generalizable to other settings with different patient demographics, surgical practices, or healthcare facilities.
- **Variability in Fluid Management Practices**: Intraoperative fluid management is highly dependent on the surgeon's and anesthesiologist's discretion, which can vary significantly even within the same institution. This variability might have influenced the study outcomes but was not controlled for in the analysis.
- **Limited Data on Specific Fluid Types:** The study grouped fluids into broad categories (crystalloids and colloids) without differentiating between the specific types within these categories, which might have different physiological impacts.
- **Confounding Variables:** There are numerous potential confounders, including the type of surgery, duration of surgery, underlying patient health conditions and perioperative care protocols, that were not fully accounted for. These factors could independently influence both fluid management and postoperative outcomes.
- **Reporting of Postoperative Complications:** The detection and reporting of postoperative complications might be subject to reporting bias, depending on the vigilance and protocols of the postoperative care team.

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