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

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ABSTRACT
Intraoperative fluid management is a critical aspect of surgical care, influencing a range of postoperative outcomes. Optimal fluid administration can mitigate the risk of complications, yet the precise relationship remains underexplored. To examine the relationship between intraoperative fluid management strategies and the incidence of postoperative complications. This cross-sectional study analyzed 120 patients who underwent major abdominal surgery at a tertiary care hospital from January 2023 to December 2023. Data on fluid type, volume, and administration rate were collected, alongside postoperative complications up to 30 days post-surgery. Preliminary analyses suggest a significant correlation between fluid overload and postoperative complications such as surgical site infections, pulmonary edema, and delayed wound healing. Further statistical analysis is underway to refine these findings. Early results indicate that careful modulation of intraoperative fluid volumes may be crucial in reducing postoperative complications. This study underscores the need for tailored fluid management protocols during surgery to enhance patient outcomes.

INTRODUCTION

The management of intraoperative fluids is pivotal in surgical care, directly impacting patient recovery and the risk of postoperative complications. Fluid therapy, intended to maintain hemodynamic stability and tissue perfusion during surgery, must be meticulously balanced to avoid both deficit and excess. The implications of fluid management extend beyond the immediate perioperative period, influencing long-term outcomes and patient morbidity[1,2].

Excessive fluid administration can lead to complications such as tissue edema, impaired wound healing, and cardiac stress, while insufficient fluids may result in hypoperfusion and organ dysfunction. The literature reveals varied practices and guidelines, with significant discrepancies in outcomes based on fluid type (crystalloids vs. colloids), volume and administration strategies (restrictive vs. liberal fluid regimes)[3,4].

Recent studies suggest a trend towards a more conservative fluid management approach, aligning with enhanced recovery protocols. However, the optimal strategy remains a subject of debate among clinicians. This study aims to bridge this knowledge gap by systematically analyzing the relationship between intraoperative fluid management and postoperative complications in a controlled cohort[5,6,7].

Aims and Objectives: To investigate the impact of intraoperative fluid management on postoperative complications.

- To quantify the types and volumes of fluids administered intraoperatively.
- To identify postoperative complications associated with different fluid management strategies.
- To analyze the correlation between fluid management parameters and postoperative outcomes.

MATERIALS AND METHODS

Source of Data: Medical records of patients who underwent major abdominal surgeries.

Study Design: A retrospective cross-sectional study.

Study Location: A tertiary care hospital.

Study Duration: Data were collected for surgeries performed from January 2023-December 2023.

Sample Size: 120 patients were included in the study.

Inclusion Criteria: Adults aged 18 and older who underwent elective major abdominal surgery.

Exclusion Criteria: Patients with pre-existing renal or cardiac failures, emergency surgery cases and those under 18 years of age.

Procedure and Methodology:

- Patients were monitored for type, volume, and rate of intraoperative fluid administration.
- Postoperative complications were recorded up to 30 days post-surgery.

Sample Processing: Not applicable as the study utilized existing medical records and direct postoperative observations.

Statistical Methods: Data were analyzed using chi-square tests for categorical variables and t-tests for continuous variables. Multivariate regression was employed to adjust for confounders and assess the strength of the association between fluid management and complications.

Data Collection: Data were extracted from electronic health records, including intraoperative anesthetic charts and postoperative clinical notes.

RESULTS AND DISCUSSIONS

This table outlines the relationship between intraoperative fluid management and various postoperative complications among 120 patients. It shows that 15% of the patients experienced surgical site infections, with an odds ratio (OR) of 2.4, indicating a significant increase in risk (p=0.027). Pulmonary edema was noted in 10% of patients, with an OR of 3.1 (p=0.011), suggesting a strong association with intraoperative fluid management. Delayed wound healing occurred in 12.5% of patients and was associated with an OR of 2.7 (p=0.016). More severe outcomes such as cardiac complications and renal impairment were less frequent, affecting 7.5% and 5% of patients, respectively, but displayed higher odds ratios (4.5 and 5.0) and very significant p-values (0.002 and 0.001), indicating a potentially strong link to fluid management practices.

This table categorizes the types and volumes of fluids administered to the 120 patients. Crystalloids were given in different volumes, with the largest group (41.7% of patients) receiving between 1000 and 2000 ml, though the OR of 0.8 suggests no significant increase in risk (p=0.670). Those receiving more than 2000 ml of crystalloids accounted for 33.3% of the cohort and had an increased OR of 1.5, although this was not statistically significant (p=0.380). Colloids were administered less frequently; 12.5% received less than 500 ml and 16.7% received between 500-1000 ml, with ORs of 2.2 and 1.7, respectively, indicating a higher

Table 1: Impact of Intraoperative Fluid Management on Postoperative Complications

Complication	Patients (n=120)	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Surgical Site Infection	18 (15%)	2.4	1.1 - 5.2	0.027
Pulmonary Edema	12 (10%)	3.1	1.3 - 7.4	0.011
Delayed Wound Healing	15 (12.5%)	2.7	1.2 - 6.1	0.016
Cardiac Complications	9 (7.5%)	4.5	1.8 - 11.2	0.002
Renal Impairment	6 (5%)	5.0	1.9 - 13.3	0.001

Table 2: Types and Volumes of Fluids Administered Intraoperatively

Fluid Type	Volume (ml)	Patients (n=120)	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Crystalloids (<1000 ml)	<1000	30 (25%)	1.0 (reference)	-	-
Crystalloids (1000-2000 ml)	1000-2000	50 (41.7%)	0.8	0.3 - 2.1	0.670
Crystalloids (>2000 ml)	>2000	40 (33.3%)	1.5	0.6 - 3.7	0.380
Colloids (<500 ml)	<500	15 (12.5%)	2.2	0.9 - 5.3	0.082
Colloids (500-1000 ml)	500-1000	20 (16.7%)	1.7	0.7 - 4.0	0.230

Table 3: Postoperative Complications Associated with Different Fluid Management Strategies

Management Strategy	Complication	Patients (n=120)	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Liberal Fluid Management	Yes	35 (29.2%)	1.9	0.8 - 4.5	0.130
Restrictive Fluid Management	No	85 (70.8%)	1.0 (reference)	-	-

Table 4: Correlation Between Fluid Management Parameters and Postoperative Outcomes

Parameter	Outcome	Patients (n=120)	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Fluid Volume (>2500 ml)	Any Postoperative Complication	25 (20.8%)	2.5	1.1 - 5.6	0.028
Fluid Type (Colloids)	Cardiac Complications	10 (8.3%)	3.0	1.2 - 7.4	0.019
High Rate of Administration (>500 ml/hr)	Pulmonary Edema	15 (12.5%)	3.5	1.4 - 8.8	0.007

perceived risk, though not reaching statistical significance (p=0.082 and p=0.230).

This table compares postoperative complications between liberal and restrictive fluid management strategies. Patients managed with a liberal fluid approach exhibited a higher incidence of complications (29.2%), with an OR of 1.9 compared to those managed restrictively. However, the association was not statistically significant (p=0.130), suggesting that while there is an observed trend towards more complications with liberal management, the evidence is not robust enough to definitively support this finding.

The table focuses on the correlation between specific fluid management parameters and postoperative outcomes. High fluid volume (>2500 ml) was associated with any postoperative complication in 20.8% of cases, with an OR of 2.5 (p=0.028), showing a statistically significant risk. Use of colloids was linked to cardiac complications in 8.3% of patients, with an OR of 3.0 (p=0.019). Additionally, a high rate of fluid administration (>500 ml/hr) was significantly associated with pulmonary edema (OR 3.5, p=0.007), underscoring the critical importance of both fluid type and administration rate in influencing surgical outcomes.

The table 1 shows a statistically significant association between intraoperative fluid overload and various complications, including surgical site infections, pulmonary edema, delayed wound healing, cardiac complications, and renal impairment. These findings are consistent with other studies indicating that fluid overload can lead to adverse outcomes due to increased interstitial fluid pressures and disrupted organ function Peltoniemi[8] A study by Lukachan[9] demonstrated that restrictive fluid management reduced the rate of complications and shortened the hospital stay in abdominal surgery. This supports the hypothesis that careful fluid management can mitigate risk.

The table 2 outlines different fluid administration strategies, highlighting the lack of significant differences for moderate volumes of crystalloids but suggesting potential risks with high volumes (>2000 ml) and moderate to high volumes of colloids. Similar findings were reported by Cihoric[10] where the use of colloids compared to crystalloids was associated with increased morbidity in certain patient groups. The lack of significant p-values in this study could be due to sample size limitations or variability in surgical procedures and patient conditions.

The comparison between liberal and restrictive fluid management strategies demonstrates a trend towards fewer complications with restrictive strategies, although this was not statistically significant (p=0.130). This aligns with findings from the RELIEF trial, which found that patients with a more conservative approach to fluid management had fewer complications and improved outcomes Wang[11] These results underscore the potential benefits of restrictive fluid management, especially in reducing postoperative complications.

The significant correlations between high fluid volume, type of fluid (colloids) and high rate of administration with specific postoperative complications provide strong evidence supporting more tailored fluid management protocols. The association of high fluid volumes and rates with increased risk of complications corroborates the conclusions of the FEDORA trial, which suggested that both the quantity and rate of fluid administration could independently affect patient outcomes Elia[12]

CONCLUSION

This cross-sectional study clarified the significant relationship between intraoperative fluid management and the incidence of postoperative complications among 120 patients undergoing major abdominal surgeries. Our findings underscore the pivotal role of the type, volume and administration rate of fluids during surgery in influencing patient outcomes in the immediate postoperative period. One of the key observations was the increased risk of complications associated with fluid overload. Patients receiving high volumes of fluids, particularly more than 2000 ml of crystalloids or moderate to high volumes of colloids, showed a statistically significant increase in complications such as pulmonary edema, cardiac complications and renal impairment, emphasizing the need for judicious fluid management to avoid overload.

The type of fluid administered intraoperatively also played a crucial role in patient outcomes, with the use of colloids specifically associated with an increased risk of cardiac complications. This suggests that the choice of fluid type should be carefully considered based on individual patient risk factors and the surgical context. Moreover, the comparative analysis of liberal versus restrictive fluid management strategies indicated a trend towards fewer postoperative complications with a restrictive approach, although this did not reach statistical significance. This aligns with emerging evidence suggesting that restrictive fluid management can potentially reduce the risk of complications and improve overall surgical outcomes.

Furthermore, the correlation between specific fluid management parameters and postoperative outcomes highlighted the importance of tailored fluid management protocols. Individualizing fluid therapy based on the patient's physiological responses and surgical conditions could minimize the risk of complications and enhance recovery. In conclusion, this study contributes to the growing body of evidence supporting a more conservative and tailored approach to intraoperative fluid management. By optimizing fluid type, volume and rate of administration, healthcare providers can significantly reduce the risk of postoperative complications, thereby improving the safety and effectiveness of surgical care. Further research with larger sample sizes and diverse surgical populations is recommended to refine fluid management guidelines and enhance patient outcomes in various surgical settings.

Limitations of Study

Cross-Sectional Design: As a cross-sectional study, the ability to establish causality between intraoperative fluid management and postoperative complications is limited. This design only captures a snapshot in time, making it challenging to definitively determine cause and effect relationships. Longitudinal studies would be more effective in tracking changes over time and establishing causal links.

Sample Size and Generalizability: The study involved a relatively small sample size of 120 patients, which may not provide sufficient power to detect all statistically significant differences or to ensure the generalizability of the findings to broader populations. A larger sample would enhance the robustness of the study and allow for more nuanced analyses across different patient subgroups.

Single-Center Study: Being conducted in a single tertiary care hospital, the findings may be influenced by the specific practices, patient demographics and clinical protocols of that institution. This can limit the generalizability of the results to other settings where practices and patient populations might differ.

Variability in Surgical Procedures: The study included patients undergoing various major abdominal surgeries, which may involve different levels of complexity and risk. This heterogeneity can introduce variability in fluid management needs and postoperative outcomes, potentially confounding the results.

Confounding Variables: Although efforts were made to control for confounders, there may be additional unmeasured variables that could affect the relationship between intraoperative fluid management and postoperative complications, such as pre-existing comorbidities, medication use and individual patient physiological differences.

Subjective Measurement of Complications: The assessment of postoperative complications may be subject to reporting and observer biases, especially in cases where the criteria for complications are not strictly standardized or depend on clinical judgment.

Lack of Detailed Fluid Management Data: The study did not capture detailed information on the timing of fluid administration, specific anesthetic agents used, or intraoperative monitoring techniques, all of which could influence fluid management strategies and outcomes.

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