



Early changes in serum electrolytes after ileostomy in patients with colorectal cancer: implications for hydration and nutritional care

Perubahan dini elektrolit serum pascaileostomi pada pasien kanker kolorektal: implikasi terhadap hidrasi dan asuhan gizi

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Abstract

Ileostomy reduces colonic fluid and electrolyte reabsorption and could increase the risk of early postoperative dehydration and electrolyte disturbances. This study described early changes in serum sodium, potassium, and chloride levels after ileostomy in patients with colorectal cancer and their implications for hydration and nutritional care. This retrospective longitudinal study reviewed medical records at H. Adam Malik General Hospital, Medan, Indonesia, during 2025; data were extracted from April to June 2026. Of 263 patients with ileostomy identified, 75 patients with colorectal cancer who met the eligibility criteria and had complete electrolyte measurements preoperatively and on postoperative days 1 and 3 were analyzed. Global temporal differences were assessed using the Wilcoxon test at $\alpha = 0.05$. Results, mean sodium decreased from 141.6 ± 5.7 mmol/L preoperatively to 137.9 ± 6.9 mmol/L on day 3, while chloride decreased from 104.7 ± 3.5 to 101.0 ± 9.3 mmol/L; both showed significant temporal differences ($p < 0.001$). Potassium showed no significant difference ($p = 0.573$). On day 3, normal sodium, potassium, and chloride values were observed in 56%, 60%, and 68% of patients, respectively. In conclusion, early post-ileostomy electrolyte changes were most apparent for sodium and chloride. These findings support serial electrolyte and hydration monitoring and integration of hydration assessment with nutritional care.

Keywords: Colorectal neoplasms, dehydration, electrolytes, ileostomy, water-electrolyte balance

Abstrak

Ileostomi mengurangi reabsorpsi cairan dan elektrolit di kolon serta dapat meningkatkan risiko dehidrasi dan gangguan elektrolit pada fase awal pascaoperasi. Penelitian ini mendeskripsikan perubahan dini natrium, kalium, dan klorida serum setelah ileostomi pada pasien kanker kolorektal serta implikasinya terhadap hidrasi dan asuhan gizi. Metode, studi longitudinal retrospektif ini menelaah rekam medis di RSUP H. Adam Malik, Medan, Indonesia, selama 2025; data diekstraksi pada April–Juni 2026. Dari 263 pasien ileostomi yang teridentifikasi, 75 pasien kanker kolorektal yang memenuhi kriteria eligibilitas dan memiliki pengukuran elektrolit lengkap pada praoperatif serta hari ke-1 dan ke-3 pascaoperasi dianalisis. Perbedaan temporal global dianalisis menggunakan uji Wilcoxon pada $\alpha = 0,05$. Hasil, rerata natrium menurun dari $141,6 \pm 5,7$ mmol/L praoperatif menjadi $137,9 \pm 6,9$ mmol/L pada hari ke-3, sedangkan klorida menurun dari $104,7 \pm 3,5$ menjadi $101,0 \pm 9,3$ mmol/L; keduanya menunjukkan perbedaan temporal bermakna ($p < 0,001$). Kalium tidak menunjukkan perbedaan bermakna ($p = 0,573$). Pada hari ke-3, kadar normal natrium, kalium, dan klorida ditemukan masing-masing pada 56%, 60%, dan 68% pasien. Kesimpulan, perubahan elektrolit dini pascaileostomi paling nyata pada natrium dan klorida.

Temuan ini mendukung pemantauan serial elektrolit dan hidrasi serta integrasi penilaian hidrasi dalam asuhan gizi.

Kata Kunci: Dehidrasi, elektrolit, ileostomi, kanker kolorektal, keseimbangan air-elektrolit

Introduction

Colorectal cancer frequently requires surgical bowel resection, which may involve the creation of a temporary or permanent ileostomy to divert fecal flow and protect anastomosis. Although ileostomy plays an important role in surgical safety, it directly alters gastrointestinal physiology, particularly in terms of maintaining fluid and electrolyte balance. Compared with colostomy, loop ileostomy is associated with a higher incidence of dehydration and electrolyte disturbance (Yang et al., 2024). These concerns are particularly relevant in patients with colorectal cancer, some of whom are already at risk of malnutrition before surgery, potentially affecting postoperative recovery and the continuation of cancer treatment (Gupta et al., 2021; Muscaritoli et al., 2021).

The colon plays a key role in the reabsorption of water, sodium, and chloride and contributes to acid-base balance. Following ileostomy creation, the contribution of the colon to the final stage of absorption is reduced, while the ileal effluent continues to contain substantial amounts of water and sodium. During the early postoperative period, intestinal adaptation, dietary intake, and tolerance of food and fluids have not yet fully stabilized. Under these conditions, increased stoma output can lead to rapid fluid and electrolyte losses (Becker & Seidler, 2024; Kiela & Ghishan, 2016; Ma et al., 2022; Negussie et al., 2022; Santucci & Velez, 2024). However, early postoperative changes in serum electrolyte concentrations are influenced by factors beyond the ileostomy itself. The volume and composition of intravenous fluids, surgical stress response, vomiting, renal function, and changes in acid-base balance may also affect electrolyte concentrations (Becker & Seidler, 2024; Santucci & Velez, 2024). Accordingly, electrolyte changes following ileostomy should be interpreted within the broader perioperative context rather than attributed solely to the procedure.

Fluid imbalances following ileostomy creation have important clinical consequences. A systematic review found that approximately one

in five patients was readmitted after ileostomy creation, with dehydration being the leading potentially preventable cause (Vogel et al., 2022). Older age, high stoma output, and elevated creatinine levels at discharge have also been associated with dehydration-related readmission (Assaf et al., 2023; Justiniano et al., 2018; Lee et al., 2021; Takeda et al., 2019). A prediction model developed specifically for patients with an ileostomy indicates that patient characteristics and the inpatient clinical course can help identify individuals at risk before discharge (Chen et al., 2018). These findings are consistent with reviews emphasizing the importance of early detection of dehydration, high-output stoma, and metabolic disturbances in patients with a stoma (Nightingale, 2022; Parini et al., 2023; Solitano et al., 2024).

Sodium warrants particular attention because serum sodium concentrations do not necessarily reflect total body sodium stores. Sodium depletion and secondary hyperaldosteronism have been observed in some clinically stable outpatients with ileostomy (Rud et al., 2023). Urinary sodium measurement may help identify sodium depletion that is not fully reflected in serum sodium concentration (Pedersen et al., 2020). Potassium and chloride concentrations also require monitoring because they may be affected by the combined effects of gastrointestinal losses, fluid therapy, renal function, and changes in the acid-base balance.

Fluid and electrolyte management following ileostomy is closely linked to nutritional care (Andjarwati et al., 2022; Retnoningrum & Dahlia, 2024; Weimann et al., 2021). Consuming large amounts of plain water may be inappropriate for patients with high stoma output because hypotonic fluids can increase sodium loss. In contrast, oral rehydration solutions containing appropriate concentrations of sodium and glucose may support fluid absorption, whereas highly hyperosmolar products or supplements may increase the stoma output (Culkin et al., 2022; Hoeg et al., 2026; Quist et al., 2024; Rud et al., 2024). Evidence regarding the optimal dietary patterns for patients with ileostomies remains

inconclusive. Therefore, nutritional care should be individualized according to dietary intake, food tolerance, effluent consistency, hydration status, and malnutrition risk (Andjarwati et al., 2022; Michońska et al., 2023; Mitchell et al., 2021; Retnoningrum & Dahlia, 2024; Weimann et al., 2021; Wyer, 2022).

Although fluid and electrolyte disturbances following ileostomy have been widely reported, most previous studies have focused on high-output stomas, readmissions, and complications after discharge (Assaf et al., 2023; Lee et al., 2021; Nightingale, 2022; Parini et al., 2023; Solitano et al., 2024; Takeda et al., 2019; van Loon et al., 2020; Vogel et al., 2022). Data on serial changes in sodium, potassium, and chloride concentrations during the immediate postoperative period remain limited, particularly among patients with colorectal cancer in Indonesian surgical settings. Repeated measurements in the same patients before surgery and on postoperative days 1 and 3 may provide a clearer picture of early electrolyte changes and inform the clinical monitoring needs.

This study aimed to describe the changes in serum sodium, potassium, and chloride concentrations before surgery and on days 1 and 3 after ileostomy in patients with colorectal cancer at H. Adam Malik General Hospital in Medan, Indonesia. The findings are intended to provide a clinical basis for strengthening hydration and electrolyte monitoring and integrating hydration assessment into early postoperative nutrition care without implying a causal relationship between ileostomy and the observed electrolyte changes.

Methods

Study Design, Setting, and Period

This retrospective longitudinal study used medical records to assess repeated measurements in the same patients. The study was conducted in the Division of Digestive Surgery at H. Adam Malik General Hospital in Medan, Indonesia. Medical records of patients who underwent ileostomy between January and December 2025 were reviewed, and data extraction and processing were performed from April to June 2026. Reporting followed the principles of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.

Serum electrolyte levels were assessed at three time points: before surgery and on postoperative days 1 and 3. The preoperative value was defined as the most recent serum electrolyte measurement documented before ileostomy creation. Values for postoperative days 1 and 3 were obtained from laboratory results recorded on the corresponding days. Because the study relied on routinely collected clinical data, blood sampling times within each day were not standardized prospectively.

Study Population and Sample Selection

All medical records of patients with ileostomy documented during the study period were screened for eligibility. A total of 263 patients with ileostomy were identified. Consecutive sampling was used to select eligible patients with colorectal cancer who underwent ileostomy and had complete serum sodium, potassium, and chloride measurements at all three time points.

Records missing one or more electrolyte measurements at any of the three time points were excluded from the analyses. To reduce the influence of other clinical conditions that could affect fluid and electrolyte balance, patients with acute kidney injury, chronic kidney disease, active diarrhea, sepsis, documented cardiac disorders, malnutrition recorded in the medical record, or use of diuretics, renin-angiotensin system inhibitors, or insulin were excluded. These conditions were identified from diagnoses, treatments, or clinical status documented during index hospitalization; no reassessment using prospective diagnostic criteria was performed.

Of the 263 patients identified, 75 met all eligibility criteria and had complete electrolyte data for analysis. The remaining 188 records were excluded because the patients did not have the target diagnosis, lacked electrolyte data at one or more time points, and/or met at least one exclusion criterion. Separate counts for individual reasons for exclusion were unavailable in the extracted dataset. Accordingly, a complete-case analysis was conducted using data from 75 patients with complete measurements.

Variables and Data Collection

The primary study variables were serum sodium, potassium, and chloride concentrations expressed in mmol/L. Each electrolyte was

evaluated before surgery and on postoperative days 1 and 3, respectively. Age and sex were collected as baseline patient characteristics.

Laboratory data were obtained from the test results documented in the hospital medical records. Electrolyte concentrations were classified as normal according to the H. Adam Malik General Hospital laboratory reference ranges in effect at the time of testing. However, the numerical reference limits were not consistently retained in the extracted dataset; therefore, the values were not reclassified using alternative reference limits.

Several clinical variables that could influence hydration status and electrolyte balance were not consistently available in medical records. These included stoma output volume, ileostomy type, surgical procedure, cancer stage, intravenous fluid volume and composition, oral intake, vomiting, serial renal function measurements, nutritional status, magnesium, and bicarbonate. Consequently, these factors were not included in the analysis or used as adjustment variables. This study also did not directly evaluate hydration interventions, oral rehydration therapy, energy and protein intake, dietary patterns, or the effectiveness of nutrition care. Therefore, the implications for hydration and nutrition care were interpreted in light of the observed electrolyte patterns and available clinical evidence.

Statistical Analysis

Categorical data are presented as frequencies and percentages. Numerical data are presented as means and standard deviations, consistent with the format of the source data. The analysis focused on changes in sodium, potassium, and chloride concentrations across the three repeated measurements in the same patients.

In the original analysis, overall differences across time points were reported using a nonparametric approach, with statistical significance defined as $p < .05$. Data were processed using IBM SPSS Statistics version 22. The analysis was not used to infer a causal relationship between ileostomy and electrolyte changes because there was no comparison group, and data on several potentially confounding perioperative factors were incomplete.

Pairwise comparisons between time points, adjustments for multiple comparisons, effect sizes, confidence intervals, and reassessment of outliers could not be

reconstructed because individual-level data were unavailable during manuscript revision. Therefore, the interpretation was limited to overall temporal patterns without asserting statistically significant differences between specific pairs of time points.

Ethical Considerations

This study was approved by the Health Research Ethics Committee of the Faculty of Medicine, Universitas Sumatera Utara (approval no. 2603284-KEPK-USU). All data were obtained from medical records and analyzed anonymously to protect patient confidentiality. The data were used exclusively for research purposes.

Result and Discussion

Participant Characteristics

A total of 263 patients with ileostomies were identified during the study period. After applying eligibility and data completeness criteria, 75 patients with colorectal cancer who had complete serum sodium, potassium, and chloride measurements before surgery and on postoperative days 1 and 3 were included in the analysis. The remaining 188 medical records were excluded because the patients did not have the target diagnosis, lacked electrolyte measurements at one or more time points, and/or met at least one exclusion criterion. Separate counts for individual reasons for exclusion were unavailable in the extracted dataset.

The largest proportion of patients were aged 56–65 years (41.3%), followed by those aged 36–45 years (17.3%) and 46–55 years (16.0%). Male patients slightly outnumbered female patients (54.7% vs. 45.3%).

Table 1. Participant characteristics (n = 75)

Characteristic	n	%
Age (years)		
17–25	3	4,0
26–35	6	8,0
36–45	13	17,3
46–55	12	16,0
56–65	31	41,3
>65	10	13,3
Sex		
Male	41	54,7
Female	34	45,3

Other clinical characteristics, including ileostomy type, surgical procedure, cancer stage, measured nutritional status, intravenous fluid volume and composition, stoma output volume, oral intake, and serial renal function measurements, were not consistently available and, therefore, could not be presented as baseline characteristics.

Changes in Serum Electrolyte Concentrations

Changes in electrolyte concentrations during the first three days after ileostomy were most apparent for sodium and chloride. The mean serum sodium was 141.6 ± 5.7 mmol/L before surgery, decreased slightly to 141.0 ± 5.08 mmol/L on postoperative day 1, and declined further to 137.9 ± 6.9 mmol/L on day 3. The

overall analysis indicated a statistically significant difference in sodium concentrations across time points ($p < 0.001$).

A similar pattern was observed for chloride. The mean serum chloride was 104.7 ± 3.5 mmol/L before surgery, 104.9 ± 4.0 mmol/L on postoperative day 1, and 101.0 ± 9.3 mmol/L on day 3. The overall difference across time points was also statistically significant ($p < 0.001$).

In contrast, potassium concentrations showed smaller changes. The mean serum potassium was 4.2 ± 3.7 mmol/L before surgery, 3.8 ± 0.7 mmol/L on postoperative day 1, and 3.9 ± 1.04 mmol/L on day 3, with no statistically significant overall difference across time points ($p = 0.573$).

Table 2. Serum electrolyte concentrations at each measurement time point (n = 75).

Electrolyte	Preoperative	Postoperative day 1	Postoperative day 3	p-value ¹
Sodium (mmol/L)	141.6 ± 5.7	141.0 ± 5.08	137.9 ± 6.9	<0.001
Potassium (mmol/L)	4.2 ± 3.7	3.8 ± 0.7	3.9 ± 1.04	0.573
Chloride (mmol/L)	104.7 ± 3.5	104.9 ± 4.0	101.0 ± 9.3	<0.001

Data are presented as the mean $\pm$ standard deviation. ¹p-values represent overall comparisons across the three repeated measurement time points. Statistical significance was set at $p < 0.05$.

Based on differences between group means, sodium concentrations on postoperative day 3 were 3.7 mmol/L, or approximately 2.6% lower than preoperative concentrations, while chloride concentrations were 3.7 mmol/L, or approximately 3.5% lower. The corresponding mean difference for potassium was 0.3 mmol/L (approximately 7.1 %). These values represent differences between group means rather than the mean of paired individual changes.

On postoperative day 3, 42 of 75 patients (56.0%) had sodium concentrations within the laboratory reference range, 45 (60.0%) had potassium concentrations within the normal range, and 51 (68.0%) had chloride concentrations within the normal range. The available data did not permit further differentiation between hyponatremia and hypernatremia, hypokalemia and hyperkalemia, or hypochloremia and hyperchloremia at each time point.

This study showed that early postoperative changes in serum electrolytes among patients with colorectal cancer who underwent ileostomy were most apparent for sodium and chloride levels. Both exhibited

statistically significant overall differences from the preoperative period to postoperative day 3, whereas potassium did not. These findings characterize electrolyte dynamics during the immediate postoperative period, when patients continue to experience physiological changes associated with surgery, fluid therapy, gastrointestinal adaptation, and altered intake. Accordingly, the results should be interpreted as temporal patterns following ileostomy rather than as evidence that ileostomy was the sole cause of the observed electrolyte changes.

The observed sodium and chloride patterns were physiologically relevant to the study. The colon plays an important role in the absorption of water and electrolytes, particularly, sodium and chloride. When intestinal contents are diverted through an ileostomy, the colonic contribution to absorption is reduced, whereas the ileal fluid continues to contain substantial amounts of water and electrolytes. This may increase susceptibility to fluid and sodium loss, particularly when the stoma output is high and intestinal adaptation remains incomplete. Contemporary reviews of gastrointestinal physiology support this

understanding of colonic absorptive function and the physiological changes that occur after ileostomy (Santucci & Velez, 2024).

Although the mean sodium concentration on postoperative day 3 remained near the lower end of the range commonly encountered in clinical practice, only 56% of patients had sodium concentrations within the laboratory reference range at that time. This finding is relevant because serum sodium concentrations do not necessarily reflect total body sodium stores. Sodium depletion may occur in clinically stable patients with an ileostomy without marked changes in serum sodium. Rud et al. (2023) found that 45% of outpatients with an ileostomy had very low urinary sodium excretion, while some had elevated aldosterone levels, supporting the presence of chronic sodium depletion and a compensatory hormonal response. Serum sodium should therefore not be used as the sole indicator of hydration or sodium adequacy.

The decline in mean chloride concentrations on postoperative day 3 should also be considered alongside the sodium changes. Gastrointestinal fluid losses through an ileostomy may involve both sodium and chloride. However, serum chloride concentrations are also strongly influenced by intravenous fluid composition, vomiting, renal function, and changes in acid-base balance. Because this study lacked data on bicarbonate, magnesium, acid-base status, intravenous fluid volume, and stoma output, the specific mechanisms underlying the chloride changes could not be determined. Therefore, decreases in sodium and chloride should prompt a more comprehensive assessment of fluid and electrolyte balance rather than serve as isolated indicators of stomal losses.

Unlike sodium and chloride, potassium levels did not show any statistically significant temporal change. Potassium homeostasis is influenced by multiple factors, including renal function, insulin, acid-base balance, intake, and potassium distribution between the intracellular and extracellular compartments. Consequently, gastrointestinal potassium losses may not immediately be reflected in mean serum potassium concentrations. On postoperative day 3, only 60% of patients had potassium concentrations within the reference range. However, because the distribution of hypokalemia and hyperkalemia was unavailable

and paired individual-level data could not be examined in greater detail, these findings could not establish the direction of potassium abnormalities in individual patients. The relatively large variability in preoperative potassium concentrations also warranted cautious interpretation.

From a clinical and nutritional perspective, these findings support integrating electrolyte evaluation with hydration assessment in the early postoperative period. Dehydration remains a major complication following ileostomy. A meta-analysis involving more than 82,000 patients found that approximately 20% were readmitted within 30 days of ileostomy creation, with dehydration being among the leading causes (Vogel et al., 2022). Early changes in sodium and chloride levels may therefore contribute to clinical vigilance, although they cannot independently predict dehydration or readmission.

Nutrition care for patients with ileostomy is closely linked to fluid and electrolyte management. Simply recommending increased water intake without considering the fluid composition may be suboptimal for patients with high stoma output. Highly hypotonic fluids may increase sodium loss, whereas highly hyperosmolar products may increase ileostomy output. Quist et al. (2024) showed that oral supplement osmolality influences ileostomy output, whereas Rud et al. (2024) supported the use of oral rehydration solutions designed to enhance fluid and sodium absorption in patients with ileostomy.

More recent evidence supports the role of oral rehydration solutions (ORS) in fluid management following ileostomy. A scoping review by Hoeg et al. (2026) concluded that the available evidence supports the use of ORS to improve hydration and reduce complications following ileostomy, although the intervention protocols varied across studies and had not yet been fully standardized. These findings are relevant to the present study because the observed sodium and chloride changes provide a clinical rationale for incorporating hydration assessment into nutrition care, although neither ORS effectiveness nor dietary interventions were directly evaluated in this study.

In addition to fluid composition, nutrition care should account for individual energy and protein adequacy, food tolerance, food texture, fiber intake, electrolyte losses, and changes in

stoma output. The literature indicates that dietary requirements cannot be standardized across all patients with an ileostomy because stoma characteristics, functional bowel length, adaptation stage, cancer treatment, nutritional status, and gastrointestinal tolerance vary among individuals (Michońska et al., 2023; Mitchell et al., 2021). This principle is particularly relevant to patients with colorectal cancer, whose risk of malnutrition may precede surgery and persist throughout cancer treatment (Muscaritoli et al., 2021).

A multidisciplinary approach also plays an important role in preventing complications post-discharge. Structured programs combining patient education, monitoring of stoma output and fluid balance, post-discharge follow-up, and nutrition consultations have been reported to help reduce readmissions related to dehydration and high-output stomas (Moreno Santamaría et al., 2021; van Loon et al., 2020). A prospective study by Ozata et al. (2024) also found that a prevention program incorporating stoma care, output monitoring, education, fluid and dietary management, and structured follow-up reduced dehydration-related readmission. Predischage ileostomy output is an important indicator of dehydration-related readmission risk. Although these findings do not establish intervention effects in the present study, they reinforce the clinical relevance of monitoring fluid balance, stoma output, electrolytes, and intake when preparing patients for the transition to homecare.

In the perioperative setting, the latest Enhanced Recovery After Surgery (ERAS) recommendations for colorectal surgery also emphasize integrated recovery, including fluid optimization and nutritional support as components of surgical care (Gustafsson et al., 2025). Therefore, the nutritional implication of the present study is that electrolyte and hydration monitoring should be incorporated into a broader framework of nutritional and clinical care; the findings do not establish that a specific nutritional intervention would correct the observed electrolyte changes.

This study had several limitations. Sodium, potassium, and chloride levels were measured at three time points in the same patients, providing insights into electrolyte patterns during the immediate postoperative period. The study also contributed clinical data from an Indonesian

surgical setting, whereas much of the literature on hydration and ileostomy originates from high-income countries. Its focus on patients with colorectal cancer further increased the relevance of the findings to surgical oncology and clinical nutrition fields.

Several limitations should nevertheless be considered. First, the retrospective, single-center design limited generalizability and precluded causal inference. Second, the analysis included only patients with complete electrolyte data at all three time points, introducing the possibility of selection bias associated with the complete-case approach. Third, stoma output volume, ileostomy type, surgical procedure, intravenous fluid composition and volume, oral intake, vomiting, cancer stage, serial renal function measurements, measured nutritional status, magnesium, and bicarbonate were not consistently available. These factors could have influenced electrolyte concentrations and could not be controlled for as potential confounders. Fourth, observation was limited to postoperative day 3, preventing assessment of intestinal adaptation, fluid balance, or electrolyte changes after discharge. Fifth, individual-level data were unavailable during manuscript revision; therefore, pairwise comparisons between time points, effect sizes, confidence intervals, and outlier assessments could not be reanalyzed.

This study showed that the early period following ileostomy in patients with colorectal cancer was characterized by more pronounced changes in sodium and chloride levels than in potassium levels. Although these findings do not establish that ileostomy directly causes the observed changes, they underscore the importance of serial electrolyte and hydration monitoring as part of perioperative care. In clinical practice, electrolyte results should be interpreted alongside stoma output, urine output, renal function, fluid balance, and nutritional assessment to facilitate the early recognition of dehydration risk and electrolyte disturbances.

Conclusion

Early changes in serum electrolyte concentrations, particularly sodium and chloride, were observed in patients with colorectal cancer following ileostomy, whereas

potassium levels remained relatively stable. These findings underscore the importance of serial monitoring of electrolytes and hydration status during the early postoperative period.

In clinical practice, assessment should extend beyond laboratory results to include stoma output, urine output, renal function, fluid balance, food tolerance, and nutritional status. Nutrition care should be integrated with hydration monitoring to prevent dehydration and electrolyte disturbances. Future studies should adopt prospective designs with comprehensive documentation of stoma output, intake, fluid therapy, renal function, and nutritional and electrolyte parameters.

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