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A COMPARITIVE STUDY OF NORMAL SALINE AND MULTIELECTROLYTE SOLUTION IN CRITICAL ILL PATIENTS WITH ACUTE KIDNEY INJURY

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ABSTRACT

Background: In critically ill patients with acute kidney injury, the choice of intravenous fluids can mean the difference between recovery and worsening renal failure. Normal saline despite its widespread use has been linked to hyperchloremia, acidosis, and impaired kidney function. In contrast, multiple electrolyte solutions or balanced electrolytes, may provide a more physiologic alternative , potentially improving renal outcomes and survival. This study compares the effects of NS and MES on mortality and renal function in icu patients with AKI

Objectives: This study aimed to evaluate the impact of NS and MES on renal function and survival in critically ill patients with acute kidney injury, focusing on primary outcomes such as Mortality, and changes in s cr levels(baseline vs peak and trend over time), and secondary outcomes including hemodynamic stability and incidence of hyperchloremia(s.cl level>110)

Methods: This prospective observational cohort study, conducted in a tertiary care ICU including critically ill patients diagnosed with acute kidney injury, 100 patients randomized into two groups: Group A (NS) and Group B (MES)., and the primary outcome was Mortality and renal function assessed via serum creatinine levels. Secondary outcomes included serum chloride, and hemodynamic parameters(MAP) over 7 days.

Results: Both groups had similar baseline characteristics, with a median treatment duration of 6.5 days. The MES group showed significantly lower mortality rate compared to NS group, MES group had a significantly lower creatinine levels indicating better renal function preservation. NS group associated with higher risk of hyperchloremia. MAP , lower MAP at 12 and 24 hours after fluid resuscitation.

Conclusion: Fluid choice in critically ill patients with AKI significantly impacts renal function, hemodynamics and survival outcomes.Both NS and MES are effective in managing critically ill patients, but MES offers advantages in maintaining acid-base stability and a balanced chloride profile. These findings suggest MES may be the preferred option in cases where acidosis or hyperchloremia is a concern. Further research is warranted to explore the long-term clinical implications of these differences.

Keywords: Fluid Resuscitation, Normal Saline, Multielectrolyte Solution, Critically Ill Patients,Hemodynamic Stability, Renal Function

INTRODUCTION

Fluid resuscitation for hypovolaemia is a mainstay of the medical management of critically ill patients, whether as a result of trauma, burns, major surgery or sepsis. The selection and use of resuscitation fluids may affect the outcome of patients.[1,2]Although some studies have suggested that the timing of volume replacement deserves careful consideration, when it comes to selecting the resuscitation fluid, clinicians are faced with a range of options.[3] At one level the choice is between a colloid or crystalloid solution. Colloids are widely used, having been recommended in a number of resuscitation guidelines and intensive care management algorithms.[4]

Crystalloids are low-cost salt solutions (e.g. saline) with small molecules, which can move around easily when injected into the body.Colloids can be man-made (e.g. starches, dextrans, or gelatins), or naturally occurring (e.g. albumin or fresh frozen plasma (FFP)), and have bigger molecules, so stay in the blood for longer before passing to other parts of the body. Colloids are more expensive than crystalloids.[5]

Saline is the most widely used and readily available liquid in clinical practice. Despite being referred to as "normal" saline, it contains a higher chloride concentration and lacks bicarbonate than the plasma.[6]Data suggests that intravenous saline may be associated with hyperchloremic metabolic acidosis, acute kidney injury, and death.[7-10] Crystalloid solutions with electrolyte compositions closer to that of plasma (balanced crystalloids, such as lactated Ringer's solution or Plasma-Lyte A) represent an increasingly used alternative to saline.[11] Several observational studies and a before-and-after trial suggested that the use of balanced crystalloids is associated with lower rates of acute kidney injury, renal-replacement therapy, and death.[12,13]

The comparison of multiple electrolyte solution and normal saline in critically ill patients is still controversial. It is uncertain which is better at reducing mortality, need for blood transfusion or need for renal replacement therapy when given to critically ill people who need fluid replacement. Therefore, we planned to conduct this study to investigate the safety of multiple electrolyte solution and saline among critical ill patients.

AIMS AND OBJECTIVES

The aim of this study is to compare normal saline with multiple balanced electrolyte solutions in critically ill patients undergoing exploratory laparotomy. The primary objectives are to evaluate blood gas levels and hemodynamic stability, while the secondary objectives include assessing organ dysfunction and morbidity by measuring serum creatinine, serum bilirubin, and the P/F ratio.

MATERIALS AND METHODS

This prospective cohort study was conducted in a tertiary care ICU in North India over a duration of 9 months, from July 2023 to March 2024, including data collection, organization, presentation, analysis, and interpretation. A total of 80 patients were enrolled and randomly assigned into two groups: Group A received fluid resuscitation with normal saline, and Group B received fluid resuscitation with a multiple electrolyte solution.

Inclusion criteria: Patients aged 18 years or older undergoing major surgery at our institution are eligible for inclusion. Major surgery is defined as any procedure lasting more than two hours, involving a surgical incision, and requiring at least one night of postoperative stay.

Exclusion criteria: Patients undergoing renal or liver transplantation, those classified as American Society of Anesthesiology Class 5, patients requiring a second operation, and individuals not willing to provide consent are excluded from the study.

Methodology

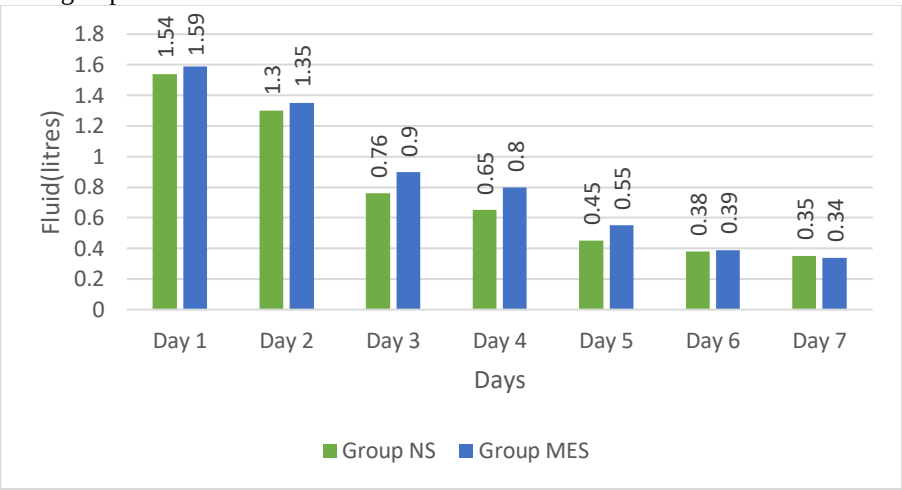
The study was initiated after obtaining ethics committee approval and written informed consent from the patients. Preoperative data, including demographics, detailed medical history, preoperative biochemistry, and comorbidities, were recorded using a predesigned proforma. Intraoperative measurements such as the duration of surgery, surgical urgency, type of surgery, and volume of fluid administered were documented. The primary efficacy outcome was the proportion of patients with changes in renal function, assessed by creatinine concentration during their hospital stay. Other outcome measures, including length of hospital stay and adverse events, were also noted.

RESULTS

A total of 100 patients were randomized, with 50 assigned to the MES group and 50 to the saline group. Both groups had similar baseline characteristics. The average age of the patients was 57.9±11.5 years, with 40% being women, and the median APACHE II score was 18.5 in both groups. Of the total patients, 41.3% were admitted to the ICU directly from the operating room, the majority were on mechanical ventilation, and 45.3% had sepsis. Within 24 hours, both groups received comparable amounts and types of intravenous fluids.

The median treatment duration with the assigned trial fluid was 6.5 days (interquartile range: 3.0–10.0) for both groups. The median volume of trial fluid administered was 3.9 liters (interquartile range: 2.0–6.7) in the MES group and 3.7 liters (interquartile range: 2.0–6.3) in the saline group. Over the first 7 days, there were no significant differences between the

groups in daily mean heart rate, mean arterial pressure, or mean central venous pressure. However, arterial blood pH was significantly higher and serum chloride levels significantly lower in the MES group compared to the saline group (Figs. 2 & 3). Serum creatinine levels (Fig. 1), as well as hemoglobin, lactate, and potassium levels, did not show significant differences between the groups.



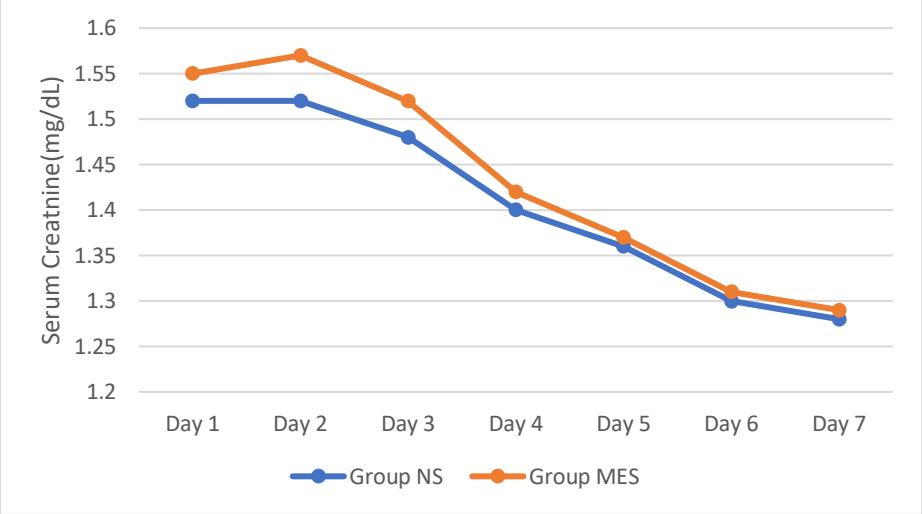


Figure 2: Comparison of Serum Creatinine Levels Over 7 Days in Critical Patients Treated with NS) and MES

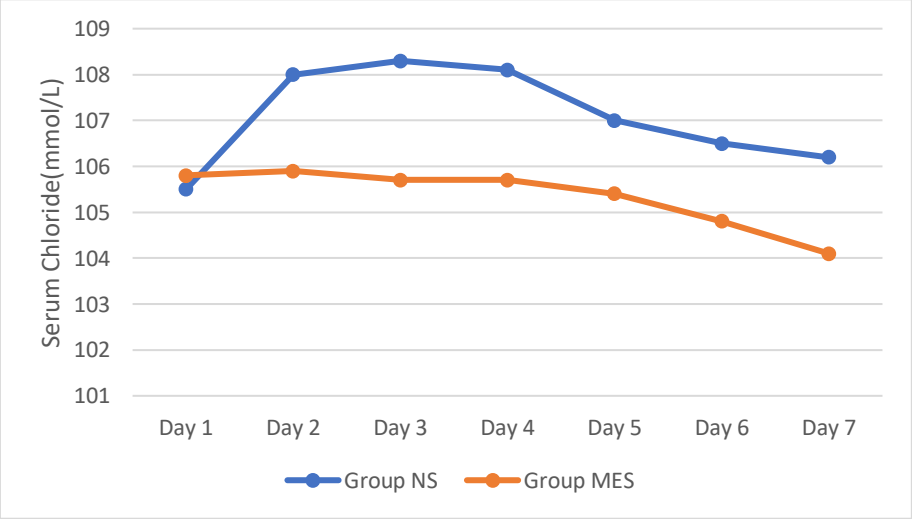


Figure 3: Comparison of Serum Chloride Levels Over 7 Days in Critical Patients Treated with NS & MES

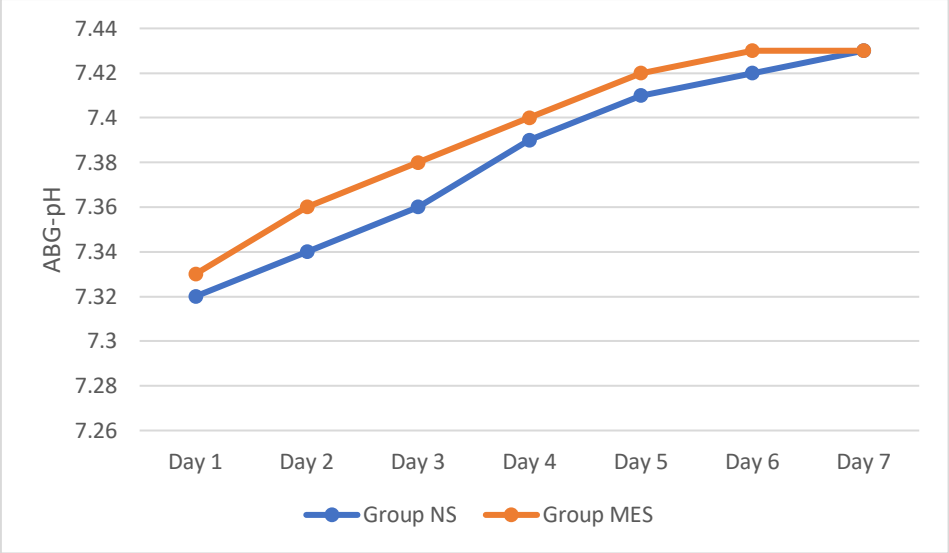


Figure 4: Comparison of ABG-pH Levels Over 7 Days in Critical Patients Treated with NS & MES

DISCUSSION

This study compared the effects of NS and MES in critically ill patients, focusing on fluid management, renal function, acid-base balance, and chloride levels. Both groups exhibited comparable baseline characteristics, including age, gender distribution, and illness severity, as reflected by the APACHE II scores. Over the median treatment duration of 6.5 days, both groups received similar fluid volumes and types, demonstrating effective fluid and renal management. However, MES showed notable advantages in maintaining acid-base balance and chloride levels.

Patients in the MES group had significantly higher arterial blood pH levels throughout the 7-day period, indicating better correction of acidosis compared to NS. This finding aligns with the SMART trial, which reported reduced metabolic acidosis and kidney-related complications with balanced crystalloids.[14] Moreover, the MES group exhibited consistently lower serum chloride levels, suggesting that MES reduces the risk of hyperchloremia, a complication associated with saline use. This observation is consistent with results from the SPLIT trial, which highlighted hyperchloremia-related risks with saline,[15] and a meta-analysis by Raghunathan et al., which demonstrated reduced metabolic acidosis with balanced solutions.[9]

Renal function, measured by serum creatinine levels, improved similarly in both groups by the end of the study period, consistent with findings from the SALT-ED trial, which showed no significant differences in renal outcomes between balanced crystalloids and saline.[16] However, the physiological benefits of MES in maintaining electrolyte and acid-base balance were more evident. Reviews by Myburgh and Mythen[17] and Kellum and Lameire[18] emphasize that hyperchloremia caused by saline can impair renal perfusion and exacerbate acidosis, further supporting the use of MES in critically ill patients.

These findings highlight the potential advantages of MES, particularly in preventing hyperchloremia and maintaining acid-base balance, which are critical for recovery in critically ill patients. Future studies are warranted to evaluate the long-term impact of these findings on morbidity and mortality.

CONCLUSION

In conclusion both NS and MES are effective in fluid management and supporting renal function in critically ill patients. However, MES demonstrates notable advantages, including superior correction of acidosis and maintaining a more stable chloride balance, making it a preferable option in situations where acid-base stability and chloride management are critical. While both solutions achieve comparable long-term outcomes, the enhanced acid-base and electrolyte balance observed with MES suggests its potential to improve patient care in critical settings. Further studies are warranted to explore the broader clinical implications of these findings.

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