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A comparative study of postoperative acidemia after intraoperative administration of balanced crystalloid (Plasma-lyte A®) versus 0.9% sodium chloride in gastrointestinal surgery

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ABSTRACT

Background: The administration of intravenous fluids is one of the most common and universal interventions in medicine. Fluid therapy is the most challenging and debated aspect of perioperative care. Plasma-lyte A® Injection (multiple electrolytes injection, type 1, USP) is indicated as a source of water and electrolytes or as an alkalinizing agent. 0.9% sodium chloride is an isotonic crystalloid solution having a sodium concentration higher is useful in replacing fluid and electrolyte loss. **Aims and Objectives:** The study was designed to compare the effects of intraoperative administration of balanced crystalloid solution (Plasma-Lyte A®) and 0.9% NaCl on acid-base balance in the post-operative period in patients undergoing gastrointestinal surgery. **Materials and Methods:** Eighty consenting patients of ASA-I and ASA-II who underwent Gastrointestinal surgery were at first randomly allocated to 2 groups. One group received Plasma-Lyte A® as the sole crystalloid and the other group received 0.9% sodium chloride. **Results:** Serum Na^+ conc. of the groups were comparable and no difference was shown at the time of induction, but postoperatively at 12 h, there was a significant increase in group 2. There was no significant difference in serum K^+ concentration in both the groups except at 6 h postoperatively when there was an increase in K^+ concentration in group 1. Serum Cl^- concentration was having no significant difference at the time of induction and 1 h intraoperative, but postoperatively at 1, 6, and 12 h the Cl^- concentration significantly increased in group 2. HCO_3^- concentration of the two groups had no difference between them throughout the study period. The pH of patients in both the groups showed no statistically significant difference during the entire procedure ($P > 0.05$). A significant decrease in pH observed in 0.9% sodium chloride group in comparison to Plasma-Lyte® group when the duration of surgery increased to more than 120 min. **Conclusion:** Both plasma-lyte A and 0.9% sodium chloride can be used safely as intravenous infusion fluid without altering pH status and blood electrolyte concentration in patients undergoing gastrointestinal surgery.

Key words: Normal saline; Plasma-lyte A; Serum electrolyte; Acid-base status; Crystaloids

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INTRODUCTION

Fluid therapy is the most challenging and debated aspect of perioperative care. During major surgery with blood loss and fluid shifts, maintenance of normovolemia and hemodynamic stability is an important task for anesthesiologists.[1] The primary aim of perioperative fluid administration is to restore normal intravascular volume and improve microcirculatory flow for ensuring adequate tissue oxygenation. The choice of intravenous fluid during

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surgery is often arbitrary and a variety of crystalloid solutions with widely differing compositions is used. Crystalloid solutions, satisfying basic fluid requirements and compensating for insensible losses are commonly used in large volumes to support circulation during periods of large fluid shifts.[2]

0.9% sodium chloride (normal saline) solution is commonly used as it is isotonic with plasma and has little effect on serum osmolality. Despite the recognition of causing hyperchloremic metabolic acidosis,[3] it remains the most commonly used intravenous solution in the perioperative period. Solutions containing physiologic levels of chloride and buffer often called "balanced solutions" (e.g., Ringer's acetate, Ringer's lactate, and other multiple electrolyte solutions) are widely available but are used less frequently than 0.9% saline.[4,5] This study was carried out to examine the effects of intraoperative administration of balanced salt solution namely Plasma-Lyte A® (multiple electrolytes injection type I USP, Baxter, Gurgaon, India.) and 0.9% sodium chloride on acid-base and biochemical status in patients undergoing gastrointestinal surgery.

Aims and objectives

To find the effects of intraoperative administration of balanced salt solution PlasmaLyte A and 0.9% sodium chloride on acid-base and biochemical status in patients undergoing gastrointestinal surgery.

MATERIALS AND METHODS

A prospective comparative study using eighty patients of either sex, ASA I & II, age 18–60 years and weight 40–70 kg undergoing elective gastrointestinal surgery were enrolled for the study after obtaining ethical committee approval. Using power analysis and considering an effect size of 5, 40 patients were enrolled in each group considering alpha error at 5% and power at 90%. Patients receiving diuretic therapy, pre-operative bowel washout, with pre-operative abnormal electrolyte, or undergoing major abdominal surgeries for traumatic injuries were excluded from the study. Patients were randomized by using sealed envelopes to receive either balanced crystalloid solution (Plasma-Lyte A®) or 0.9% NaCl during and after the operation. In group 1, balanced crystalloid solution (Plasma-Lyte A®), and in group 2, 0.9% sodium chloride solution was infused as per fluid replacement guidelines intra-operatively and postoperatively (40 patients in each group). The patients with >20% blood loss received blood transfusions.

Intraoperative monitoring including continuous electrocardiogram, intermittent/continuous arterial blood pressure (non-invasive/intra-arterial), heart rate, oxygen saturation, and end-tidal carbon dioxide was done in all patients, and the values were recorded every 15 min. Intraoperative crystalloid infusion volumes, urinary output, blood loss, and blood transfusion volumes were recorded hourly. Electrolytes (Na^+, K^+) and arterial blood gases were measured after induction of anesthesia, every hour intraoperatively and at the 1st, 6th, and 12th h postoperatively. The same solutions were infused @ 2.0 mL/kg/h till oral intake was allowed postoperatively.

Statistical analysis

Categorical variables were expressed as a number of patients and percentage of patients and compared across the groups using Pearson's Chi-square test for Independence of attributes/Fisher's exact test as appropriate. Continuous variables are expressed as Mean±Standard deviation and compared across the 2 groups using Mann–Whitney U test. The statistical software SPSS version 20 was used for the analysis. An alpha level of 5% was taken, i.e. if $P<0.05$, it was considered statsitically significant.

RESULTS

The groups were comparable with respect to age, sex, weight, ASA grade, and duration of surgery as the P-value in each case was <0.05.

Intraoperatively, 1640±918.69 mL and postoperatively 1491.25±140.46 mL fluid was transfused in group 1 whereas intraoperatively 1813.75±930.88 mL and postoperatively 1487.5±143.56 mL fluid was transfused in group 2. Intraoperative blood was transfused in three patients in group 1 and two patients in group 2. There was no significant difference in both groups as $P>0.05$.

Serum Na^+ conc. of both the groups were comparable and no difference was shown at the time of induction, at 1 h intraoperatively, postoperatively at 1 h, and at 6 h. ($P>0.05$), but postoperatively at 12 h there was a significant difference in serum Na^+ between the two groups ($P<0.05$). Serum K^+ conc. of both the groups were comparable and no difference was shown at the time of induction, at 1 h intraoperatively, postoperatively at 1 h, and at 12 h. ($P>0.05$), but postoperatively at 6 h there was a significant difference in serum K^+ between these two groups ($P<0.05$). No difference in Serum Cl^- conc. of both the groups at the time of induction and at 1 h intraoperatively ($P>0.05$), but postoperatively at 1, 6, and 12 h there was a significant difference in serum Cl^- between these two groups ($P<0.05$). No difference

in BEecf of both the groups at the time of induction, at 1 h intraoperatively and postoperatively at 1 and 6 h (P>0.05), but postoperatively at 12 h there was a significant difference in BEecf between these two groups (P<0.05). No difference in pO_2 level of both the groups at the time of induction, at 1 h intraoperatively and postoperatively at 1 and 6 h (P>0.05), but postoperatively at 12 h there was a significant difference in pO_2 level between these two groups (P<0.05). The arterial PCO_2, SPO_2, and pH between the two groups were comparable and no statistically significant difference was observed during the entire procedure (P>0.05). No difference in Serum HCO_3^- conc. of both the groups at the time of induction, at 1 h intraoperatively and postoperatively at 1, 6, and 12 h (P>0.05).

DISCUSSION

There were no significant differences between the two groups in respect of age, sex distribution, weight and duration of surgery as per Table 1, intraoperative and postoperative volume of fluid administered as per Table 2. Preoperative biochemical and acid-base profiles were also comparable. There were no statistically significant differences with respect to age, sex distribution and weight between the two groups.

Table 3 shows the mean serum Na^+ level measured at induction, 1 h intraoperative and 1 h, 6 h and 12 h postoperative. The mean serum Na^+ at the beginning was not statistically significant (P >0.05) and the following three results (at 1 h intraoperative, 1 h postoperative, and 6 h postoperative) also showed no significant difference (P>0.05). However, postoperatively after 12 h significant difference in serum Na^+ was found in the two groups.

Serum K^+ concentration of both groups was comparable and no difference was shown at the time of induction, at 1 h intraoperatively, postoperatively at 1 h, and at 12 h. (P>0.05). However, postoperatively at 6 h mean K^+ concentration in group 1 was 3.75 mmol/L whereas in group 2 it was 3.59 mmol/L which was a significant difference in serum K^+ between these two groups (P <0.05).

Hadimioglu et al.,[6] in their study concluded that no groups experienced significant changes in serum potassium during the surgery. Chua et al.,[7] (2012) concluded that patients with diabetic ketoacidosis resuscitated with Plasma-Lyte had lower Potassium levels at 6–12 h than 0.9% sodium chloride group. McFarlane and Lee[8] found no significant changes in plasma sodium or potassium or blood lactate concentrations in either group.

Serum Cl^- concentration measured at intervals same as Na^+, K^+ concentration. The mean serum Cl- conc. at the time of induction, were 104.8 mmol/L for group 1 and 104.88 mmol/L for group 2 was not significant as P=0.558. Mean serum Cl^- concentration at 1 h intraoperatively also showed no significant difference. However, the mean serum concentration of Cl^- postoperatively at 1 h, 6 h and 12 h was 102.43 mmol/L, 102.43 mmol/L, and 102.68mmol/L, respectively, for group 1 and 106.3 mmol/L, 106.38 mmol/L, and 107.58 mmol/L, respectively, for group 2. These results were statistically significant (P<0.05). McFarlane and Lee[8] also found

Table 1: Demographic data

Demographic Data	Group I Mean±SD	Group II Mean±SD	P-value	Significance
Age (years)	46.48±13.76	50.3±10.43	0.315	Not significant
Sex				
Female	21 (52.5%)	24 (60%)	0.885	Not significant
Male	19 (47.5%)	16 (40%)		
Weight	58.85±9.55	59.63±10.02	0.531	Not significant
ASA				
I	14 (35%)	8 (20%)	0.133	Not significant
II	26 (65%)	32 (80%)		
Duration of surgery (Min)	126±60.51	129.13±71.34	0.626	Not significant

SD: Standard deviation

Table 2: Perioperative fluid and blood transfusion volume in milliliter

Volume Transfused	Group I (Mean±SD)	Group II (Mean±SD)	P-value	Significance
Intraoperative fluid volume (mL)	1640±918.69	1813.75±930.88	0.371	Not significant
Postoperative fluid volume (mL)	1491.25±140.46	1487.5±143.56	0.652	Not significant
Blood transfusion volume (mL)		43±154.5	0.630	Not significant

SD: Standard deviation

Table 3: Serum electrolyte concentration in the perioperative period

Serum Electrolyte	Group I (Mean±SD)	Group II (Mean±SD)	P-value
Serum sodium			
At induction	136.8±3.21	136.1±3.75	0.268
Intraoperative 1 h	137.28±3.64	136.08±3.39	0.165
Postoperative 1 h	136.33±3.67	135.78±4.07	0.273
Postoperative 6 h	135.8±4	136.83±3.81	0.315
Postoperative 12 h	135.03±3.95	137.43±4.35	0.028
Serum potassium			
At induction	3.73±0.42	3.66±0.42	0.479
Intra operative 1 h	3.71±0.37	3.69±0.41	0.791
Post-operative 1 h	3.71±0.31	3.64±0.33	0.301
Post-operative 6 h	3.75±0.38	3.59±0.33	0.044
Post-operative 12 h	3.74±0.34	3.6±0.31	0.069
Serum Chloride			
At Induction	104.8±3.58	104.88±5.51	0.558
Intra operative 1 h	103.48±3.42	103.68±4.39	1.000
Post-operative 1 h	102.43±2.8	106.3±5.34	<0.001
Post-operative 6 h	102.43±3.46	106.38±4.17	<0.001
Post-operative 12 h	102.68±4.35	107.58±4.92	<0.001
Serum Bicarbonate			
At induction	23.9±2.61	24.44±3.14	0.519
Intraoperative 1 h	23.79±2.25	23.7±3.49	0.992
Post-operative 1 h	23.88±2.35	23.34±3.05	0.476
Post-operative 6 h	23.87±2.48	24.03±2.89	0.935
Post-operative 12 h	24.51±2.29	23.59±2.53	0.088
Base excess in the extracellular fluid			
At induction	0.49±2.78	0.73±3.38	0.773
Intraoperative 1 h	−0.26±2.7	−0.77±3.5	0.416
Post-operative 1 h	−0.19±2.51	−0.76±2.87	0.225
Post-operative 6 h	−0.04±2.39	−0.21±2.97	0.567
Post-operative 12 h	0.63±2.45	−0.79±2.93	0.020
PO_2 in the arterial blood			
At induction	238.9±123.18	287.14±129.12	0.067
Intraoperative 1 h	283.49±82.79	287.11±95.59	0.954
Post-operative 1 h	103.72±12.08	103.36±13.78	0.630
Post-operative 6 h	95.37±10.04	94.48±6.6	0.173
Post-operative 12 h	91.08±10.64	88.37±8.52	0.041
Pa CO_2 in the Arterial blood			
At induction	34.07±4.67	36.13±6.31	0.144
Intraoperative 1 h	35.92±4.76	35.91±5.6	0.920
Post-operative 1 h	37.46±4.53	37.07±5.9	0.851
Post-operative 6 h	37.06±4.2	37.62±5	0.348
Post-operative 12 h	37.6±3.43	37.05±4.5	0.821
SpO_2			
At induction	99.84±0.34	99.86±0.25	0.759
Intraoperative 1 h	99.92±0.17	99.86±0.26	0.244
Post-operative 1 h	97.13±1.85	96.94±1.52	0.285
Post-operative 6 h	95.57±1.45	95.61±1.65	0.939
Post-operative 12 h	95.1±1.37	94.96±1.48	0.283
Arterial pH			
At induction	7.46±0.04	7.45±0.05	0.312
Intraoperative 1 h	7.44±0.04	7.43±0.06	0.394
Post-operative 1 h	7.42±0.04	7.42±0.05	0.769
Post-operative 6 h	7.43±0.03	7.42±0.04	0.312
Post-operative 12 h	7.43±0.03	7.42±0.04	0.213

that the patients receiving 0.9% sodium chloride had significantly increased chloride concentrations (P<0.01), compared to those receiving plasmalyte 148. Hadimioglu et al.,[6] similarly found that only the saline group had a significant elevation in serum chloride levels during surgery (104.2±3.2–125.4±3.7 mM/L). Chloride levels in these patients continued to be significantly elevated until post-operative day 3. Roquilly et al.,[9] found that copraemia was

higher in the saline group than in the balanced group (mean difference =4.8 mmol/L (1.9–7.6); P=0.002. Hofmann-Kiefer et al.,[10] showed a significant difference in serum Cl^- concentration between patients who received lactate- and acetate-based balanced salt solutions.

No significant difference in serum HCO_3^- conc. was found in both the groups at the time of induction, at 1 h intraoperatively and postoperatively at 1, 6, and 12 h (P>0.05). Although Hadimioglu et al.,[6] and Hasman et al.,[11] found that a maximum decrease in HCO_3^- concentration occurred in 0.9% sodium chloride group and the least changes were seen with Plasmalyte A. In our study, at the start of the operation, the mean HCO_3^- level of group 1 was 23.9 mmol/L and group 2 was 24.44 mmol/L. However, 12 h postoperatively, the mean HCO_3^- level was 24.51 mmol/L in group 1 and 23.59 mmol/L in group 2. It was seen that there was a gradual decline of HCO_3^- level in group 2 which was not statistically significant.

In case of base excess, there was no significant difference between the groups at the time of induction, but postoperatively at 12 h, there was a significant difference in base excess in the extracellular fluid (BEecf) P<0.05. The mean BEecf in group 1 changed from 0.49 mmol/L to 0.63 mmol/L from induction to 12 h postoperative whereas mean BEecf in group 2 changed from 0.73 mmol/L to −0.79 mmol/L from induction to 12 h postoperative. A similar result was found in the study of Hadimioglu et al.,[6] who found a significant fall in base excess only in the saline group, from 0.4 to −4.9.

The mean pO_2 level of group 1 was 238.9, 283.49, 103.72, 95.37, and 91.08 mmHg at the time of induction, at 1 h intraoperatively, postoperatively at 1 h, 6 h and 12 h respectively. On the other hand, the mean pO_2 level of group 2 was 287.14, 287.11, 103.36, 94.48, and 88.37 mm Hg at the same time. The results were not significant (P>0.05) at the time of induction, at 1 h intraoperatively and postoperatively at 1 h and 6 h. However, there was a significant difference in oxygenation between these 2 groups at 12 h postoperatively.

Mean arterial pCO_2 of group 1 and group 2 at different times during intraoperative and postoperative periods of operation was compared and no statistically significant difference was observed during the entire procedure (P>0.05). There was a gradual increase in the pCO_2 level in both the groups, similar to the study of Hadimioglu et al.[6]

The mean perioperative Oxygen saturation (SpO_2) from induction up to 12 h postoperatively was comparable in both the groups and no significant difference was found as P>0.05. This result was similar to the study conducted by Modi et al.,[12] and Mcfarlane and Lee.[8]

In our study, the initial mean pH of the two groups was 7.46 and 7.45, respectively. There was no significant difference between the two groups (P=0.312). At 1 h intraoperative and postoperatively at 1, 6 and 12 h also no statistically significant difference in pH was observed (P>0.05). The mean pH in group 1 changed from initial 7.46 to 7.43 at the end of the study, whereas the mean pH in group 2 changed from initial 7.45 to 7.42 at the end of the study. From the above data, it could be said that, although in both the groups, the pH decreased there was no statistically significant difference. But when we compared the pH values of the two groups in perioperative period where the duration of surgery >120min there was a significant difference between two groups. The mean pH in group 1 changed from initial 7.46 to 7.43 at the end of the study, whereas the mean pH in group 2 changed from initial 7.44 to 7.39 at the end of study. From the above data, it could be said that in case of surgery >120 min duration, the pH was gradually decreased but it was more and statistically significant in 0.9% sodium chloride group than Plasma-Lyte A® although acidosis was not present in either group. This result was similar to the study conducted by Hasman et al.,[11] and Hadimioglu et al.[6] Three patients from group 1 and two patients from group 2 required intra-operative blood transfusion. In our study, there were no serious adverse effects in any of the patients who received either 0.9% sodium chloride or Plasma-Lyte A®.

Ninety patients participated in the study conducted by Hasman et al.,[11] and were randomized to 0.9% sodium chloride (30 patients), lactated Ringer's (30 patients), and Plasmalyte (30 patients) groups. All pH values were in the physiological range (7.35–7.45) throughout the study. However, in the 0.9% sodium chloride group, there was a significant tendency to decrease the pH values to 7.40, 7.37, and 7.36 at 0, 1, and 2 h, respectively. They concluded that 0.9% sodium chloride can affect acidosis which might be significant in patients who have underlying metabolic disturbances. Roquilly et al.,[9] also found that the pH was lower in the 0.9% sodium chloride group than in the balanced group (mean difference=−0.03 [−0.05–−0.01]; P=0.004). Hadimioglu et al.,[6] showed that there was a statistically significant decrease in pH (7.44±0.50–7.36±0.05), in patients receiving 0.9% sodium chloride during surgery but no patients developed acidosis despite the hyperchloremia. pH did not change significantly in the other two groups receiving lactated Ringer's or Plasmalyte. The development of acidosis is a consequence of central filling volumes, the composition of plasma and extracellular fluids, as well as the rate and composition of fluid losses.[13] The short duration of surgery in their patients and low

blood loss also likely contributed to the relatively stable pH during surgery which is similar to our study.

Smith et al.,[14] performed a single center, double-blind RCT comparing 0.9% saline with Plasma- Lyte A® in critically ill trauma patients and found that patients receiving 0.9% saline had significantly lower serum chloride and bicarbonate concentration. Young et al.,[15] in a single center, double-blind RCT comparing 0.9% saline with Plasma-Lyte A® in patient presenting to the emergency department with severe acute trauma found that patients receiving 0.9% saline had an increase in serum chloride concentration and decrease in serum pH without significant differences in mortality, hospital length of stay, blood transfusion requirements. Mahler et al.,[16] in a single center, double-blind RCT comparing either 0.9% saline with Plasma-Lyte A® in patients presenting to ED with diabetic ketoacidosis showed patients receiving 0.9% saline had significantly higher serum chloride and lower bicarbonate concentration.

Limitations of the study

The sample size could have been bigger. The evaluation of the electrolytes could have been done at a frequent interval.

CONCLUSION

It can be concluded from this study that both Plasma-lyte A® and 0.9% sodium chloride can be used safely during gastrointestinal surgery as the sole crystalloid. However, the chance of developing hyperchloremic metabolic acidosis is more with 0.9% sodium chloride than Plasma-Lyte A® in prolonged surgery (>120 min).

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REFERENCES

1. Tølløfsrud S, Elgjo GI, Prough DS, Williams CA, Traber DL and Kramer GC. The dynamics of vascular volume and fluid shifts of lactated Ringer's solution and hypertonic-saline-dextran solutions infused in normovolemic sheep. Anesth Analg. 2001;93(4):823-831.
https://doi.org/10.1097/00000539-200110000-00005
2. Olthof CG, de Vries JP, de Vries PM, Kouw PM, Donker AJ and de Lange JJ. The influence of Ringer's lactate and gelatin infusion on the internal fluid balance of healthy volunteers measured by a non-invasive conductivity technique. Eur J Anaesthesiol. 1993;10(6):397-402.
3. Scheingraber S, Rehm M, Sehmisch C and Finsterer U. Rapid saline infusion produces hyperchloremic acidosis in patients undergoing gynecologic surgery. Anesthesiology. 1999;90(5):1265-1270.
https://doi.org/10.1097/00000542-199905000-00007
4. Powell-Tuck J, Gosling P, Lobo DN, Allison SP, Carlson GL, Gore M, et al. Summary of the British consensus guidelines on intravenous fluid therapy for adult surgical patients (GIFTASUP)-for comment. J Intensive Care Soc. 2013;10(1):13-15.
https://doi.org/10.1177/175114370901000105
5. Stephens R and Mythen M. Optimizing intraoperative fluid therapy. Curr Opin Anaesthesiol. 2003;16(4):385-392.
https://doi.org/10.1097/01.aco.0000084478.59960.76
6. Hadimioglu N, Saadawy I, Saglam T, Ertug Z and Dinckan A. The effect of different crystalloid solutions on acid-base balance and early kidney function after kidney transplantation. Anesth Analg. 2008;107(1):264-269.
https://doi.org/10.1213/ane.0b013e3181732d64
7. Chua HR, Venkatesh B, Stachowski E, Schneider AG, Perkins K, Ladanyi S, et al. Plasma-lyte 148 vs 0.9% saline for fluid resuscitation in diabetic ketoacidosis. J Crit Care. 2012;27(2):138-145.
https://doi.org/10.1016/j.jcrc.2012.01.007
8. McFarlane C and Lee A. A comparison of plasmalyte 148 and 0.9% saline for intra-operative fluid replacement. Anaesthesia. 1994;49(9):779-781.
https://doi.org/10.1111/j.1365-2044.1994.tb04450.x
9. Roquilly A, Loutrel O, Cinotti R, Rosenczweig E, Flet L, Mahe PJ, et al. Balanced versus chloride-rich solutions for fluid resuscitation in brain-injured patients: A randomised double-blind pilot study. Crit Care. 2013;17(2):R77.
https://doi.org/10.1186/cc12686
10. Hofmann-Kiefer KF, Chappell D, Kammerer T, Jacob M, Paptistella M, Conzen P, et al. Influence of an acetate-and a lactate-based balanced infusion solution on acid base physiology and hemodynamics: An observational pilot study. Eur J Med Res. 2012;17(1):21.
https://doi.org/10.1186/2047-783X-17-21
11. Hasman H, Cinar O, Uzun A, Cevik E, Jay L and Comert B. A randomized clinical trial comparing the effect of rapidly infused crystalloids on acid-base status in dehydrated patients in the emergency department. Int J Med Sci. 2012;9(1):59-64.
https://doi.org/10.7150/ijms.9.59
12. Modi MP, Vora KS, Parikh GP and Shah VR. A comparative study of impact of infusion of Ringer's Lactate solution versus normal saline on acid-base balance and serum electrolytes during live related renal transplantation. Saudi J Kidney Dis Transpl. 2012;23(1):135-137.
13. Prough DS and White RT. Acidosis associated with perioperative saline administration: Dilution or delusion? Anesthesiology. 2000;93(5):1167-1169.
https://doi.org/10.1097/00000542-200011000-00005
14. Smith CA, Gosselin RC, Utter GH, Galante JM, Young JB, Scherer LA, et al. Does saline resuscitation affect mechanisms of coagulopathy in critically ill trauma patients? An exploratory analysis. Blood Coagul Fibrinolysis. 2015;26(3):250-254.
https://doi.org/10.1097/MBC.0000000000000154
15. Young JB, Utter GH, Schermer CR, Galante JM, Phan HH, Yang Y, et al. Saline versus plasma-lyte a in initial resuscitation of trauma patients: A randomized trial. Ann Surg. 2014;259(2):255-262.
https://doi.org/10.1097/SLA.0b013e318295feba
16. Mahler SA, Conrad SA, Wang H and Arnold TC. Resuscitation with balanced electrolyte solution prevents hyperchloremic metabolic acidosis in patients with diabetic ketoacidosis. Am J Emerg Med. 2011;29(6):670-674.
https://doi.org/10.1016/j.ajem.2010.02.004

Authors Contribution:
LND- Literature survey, preparation of the manuscript, implementation of the study protocol, data collection; **JP-** Concept, design, clinical protocol, manuscript editing, and revision. **SJ-** Manuscript writing, statistical analysis, and interpretation. **HD-** Literature survey and preparation of tables, manuscript revision, and editing. **PCS-** Design of study, ethical approval, data collection. **DB-** Manuscript preparation, literature review, protocol preparation, implementation of the study.

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