Section: General Medicine

Original Research Article

A STUDY ON USEFULLNESS OF RINGER LACTATE OVER NORMAL SALINE IN DIABETICKETOACIDOSIS IN PATIENTS ADMITTED IN NORTHERN PART OF KARNATAKA

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Abstract

Background: Diabetic Ketoacidosis (DKA) is an acute, potentially life-threatening complication predominantly affecting individuals with type 1 diabetes, though it can also occur in type 2 diabetes under metabolic stress. DKA results in severe electrolyte imbalances and requires prompt intervention with insulin and intravenous fluids to correct dehydration and restore metabolic stability. Normal Saline (NS), the most commonly used fluid in DKA treatment, is effective but has a high chloride concentration, which can lead to hyperchloremic metabolic acidosis when administered in large quantities. Ringer Lactate (RL), a balanced crystalloid solution with chloride levels closer to human plasma, does not induce metabolic acidosis and may offer advantages over NS. However, RL carries its own potential risks, including alkalosis and hyperkalemia, and the comparative effects of RL and NS in DKA management are not fully understood. This study investigates whether RL offers advantages over NS in DKA treatment. The primary aim of this study is to evaluate the effectiveness of RL over NS in managing DKA in patients admitted in the northern region of Karnataka. The objective is to determine if RL leads to a more rapid resolution of DKA compared to NS, while also assessing any differences in electrolyte disturbances, insulin requirements, complications, and mortality rates between the two fluids. **Materials and Methods:** This single-blinded, prospective observational study was conducted at the Department of General Medicine, Koppal Institute of Medical Sciences, Koppal, from September 2022 to August 2023. Sixty adult patients diagnosed with DKA based on the Diabetes Canada guidelines were included, with criteria such as plasma glucose ≥250 mg/dL, plasma bicarbonate ≤18 mmol/L, blood pH ≤7.30, and ketones in the urine. Patients were randomized to receive either RL or NS for fluid resuscitation, adjusted to their dehydration status, and started on insulin therapy. Data collected included demographic information, clinical presentation, and laboratory investigations like blood glucose, arterial blood gases, electrolytes, and renal function tests. **Result:** The results showed no statistically significant difference in DKA resolution time between the RL and NS groups, with a mean of 30.9 hours in the RL group and 27.6 hours in the NS group. Both groups had similar fluid requirements and insulin usage, with no significant differences in total fluid volume or infusion rate. Clinical outcomes, including ICU admissions, hypokalemia incidence, and in-hospital mortality rates, were comparable between the groups. Although RL has a theoretical benefit in avoiding hyperchloremic acidosis, this did not result in significant clinical advantages. Both fluids effectively restored circulatory volume and metabolic balance, with no significant impact on potassium levels or other electrolyte parameters. **Conclusion:** The study concludes that RL and NS are equally effective in managing DKA. Both fluids achieved similar outcomes in terms of metabolic correction, insulin requirements, and complication rates. The

choice between RL and NS can be made based on availability, clinical judgment, and individual patient needs. Future research with larger sample sizes and longer follow-up periods may further clarify any subtle differences between these fluids in DKA management and long-term outcomes.

INTRODUCTION

Diabetic Ketoacidosis (DKA) is an acute complication of diabetes with potential life threatening metabolic and homeostatic derangement. DKA is common in type one diabetic patients.15 to 20% of adults with new onset diabetes mellitus type 1 will present with a DKA.[1-3]

Diabetic ketoacidosis is a very common and life - threatening complication seen in the emergency department. Along with insulin therapy, intravenous fluid administration to expand intravascular, interstitial, and intracellular volume is the key component of the acute management of diabetic ketoacidosis.[4-6] Normal Saline (0.9% NaCl) is the most commonly used fluid for this purpose and the primary fluid recommended in current DKA clinical practice guidelines.4-6 The chloride concentration in saline (154 mmol/L) is higher than that in human plasma (94-111 mmol/L), which can cause hyperchloremic metabolic acidosis, especially when administered in large volumes.[7-10]

Balanced crystalloid solutions, including Ringer lactate and Plasma-Lyte A, contain chloride concentrations similar to those in human plasma and do not induce metabolic acidosis. Therefore, treatment of DKA with balanced crystalloids rather than saline may lead to faster resolution of DKA.[11-14] However, balanced crystalloids also have theoretical risks in the treatment of DKA, including alkalosis and hyperkalaemia, and the comparative effects of balanced crystalloids and saline in this setting are not well understood.[15]

Hence in this study, we compared balanced crystalloids vs saline for the acute management of adults with DKA. The primary hypothesis is that balanced crystalloids would lead to more rapid resolution of DKA than saline.

Aims & Objectives

- To study the usefulness of Ringer lactate over 0.9% normal saline in Diabetic ketoacidosis in patients admitted in northern part of Karnataka.

MATERIALS AND METHODS

Study Design: Prospective observational, single blinded study.

Study Period: September 2022 to August 2023

Study Population: 60 participants

Study Area: In patients admitted in Department of General Medicine, Koppal Institute of medical sciences, Koppal.

Inclusion criteria:

Based onthe Diabetes Canada guidelines, patients meeting clinical diagnosis and laboratory values consistent with DKA, which includes:

- Patient more than 18 years of age,
- Plasma glucose concentration ≥250mg/dl
- Plasma bicarbonate concentration ≤18mmol/L and/or blood pH ≤7.30
- Calculated anion gap >10mmol/L
- Presence of ketones/beta-hydroxybutyrate in urine.

Exclusion Criteria

- Patient not meeting the inclusion criteria.

Methods of Collection of Data

All the cases whohave met theinclusion criteria were included, after taking written informed consent from patients. Patient details including age, sex, place, occupation, and address with detailed history and clinical examination was done, followed by laboratory investigations like

- Randomized blood glucose test
- Arterial Blood Gas Analysis
- Urine ketone bodies
- Serum electrolytes
- Electrocardiography
- Complete blood count
- Renal function test
- Urine routine and microscopy
- Relevant investigations as per the precipitating cause for DKA were done.

Study protocol: Patients who have met the inclusion criteria were started on IV fluids based on the dehydration status. Patients with severe dehydration were rushed with bolus of 1litre Normal saline/Ringer Lactate over 10-15mins and then started on infusion of Normal Saline/Ringer lactate at 250-500ml/hr until volume depletion was corrected.

At the same time Regular insulin was given as IV bolus of 0.15IU/kg followed by 0.1IU/Kg/hr infusion. When the blood glucose levels reach 250mg/dl, with 5% dextrose fluids at 150-250mg/hr, sugars were maintained at 150-200mg/dl. Titrate insulin to minimum of 0.1IU/Kg/hr to maintain blood glucose 150-200mg/dl until ketosis/ anion gap resolves.

Once the patient ketosis resolved and anion gap was decreased, insulin infusion was stopped after giving one dose of long-acting insulin 2hrs prior. Blood glucose levels were monitored and based on the 24 hour insulin requirement, insulin dose was fixed.16

All hourly sugars were monitored, electrolytes and ABG every 6th hourly until the acidosis was resolved.

DKA severity was assessedbased on initial plasma bicarbonate levels: Mild (15-18) / Moderate (10-14) / Severe (<10)

Complications such as stage 2 or greater AKI during the in-hospital treatment, new onset hyperkalaemia or hypokalaemia after admission, Seizures and patient requiring mechanical ventilation either invasive or non-invasive were noted

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DKA resolution was considered based on the ADA guidelines which includes:

- RBS < 200mg/dl PLUS 2 of the following
- HCO3≥15meq/l
- pH≥7.3
- Anion gap < or = 12

RESULTS

The demographic and clinical characteristics of patients treated with Ringer Lactate and Normal Saline are compared in the table. Both treatment groups consist of 30 patients each, with an almost equal distribution of males (21 patients) and females (9 patients) in each group. The average age is noticeably lower in the Ringer Lactate group (38.47 ± 13.34 years) compared to the Normal Saline group (49.83 ± 19.08 years).

Regarding diabetes types, the Ringer Lactate group has a higher proportion of Type 1 Diabetes patients (18 patients), while the Normal Saline group has more Type 2 Diabetes patients (21 patients).

The distribution of mild, moderate, and severe cases of diabetic ketoacidosis (DKA) is fairly even across both groups. The Ringer Lactate group has 6 mild, 12 moderate, and 12 severe cases. In contrast, the Normal Saline group has 7 mild, 13 moderate, and 10 severe cases, indicating comparable levels of DKA severity between the two treatment modalities.

Incompliance is the most common cause in both groups, with 16 cases in the Ringer Lactate group and 14 cases in the Normal Saline group. Infection is the second most frequent cause, with five patients in the Ringer Lactate group and 6 in the Normal Saline group. Compliance with infection is less frequent, with just 1 case in each group. Sepsis contributes equally to DKA in both groups, with 7 cases each. Overall, the graph illustrates that both treatments have similar distributions of causes, with slight differences in the number of incompliance and infection cases.

The table provides a comparison of treatment outcomes between the Ringer Lactate and Normal Saline groups for patients with diabetic ketoacidosis (DKA). Both groups had 30 patients each. The amount of fluids administered was slightly higher in the Ringer Lactate group, with an average of 8320.00 ml compared to 7722.33 ml in the Normal Saline group, though this difference was not statistically significant (p = 0.305574).

The time to DKA resolution was slightly longer in the Ringer Lactate group (30.90 hours) compared to the Normal Saline group (27.63 hours), but again, this difference was not statistically significant (p = 0.110874).

In terms of electrolyte levels, the sodium levels were similar in both groups, with no significant difference (p = 0.719385), and potassium levels were also comparable, with no significant difference (p = 0.659025). The anion gap, which is a marker of the severity of metabolic acidosis, was slightly higher in the Ringer Lactate group (24.50) compared to the Normal Saline group (22.88). Still, the difference was not statistically significant (p = 0.981967).

ICU admissions were slightly higher in the Ringer Lactate group (8 patients) compared to the Normal Saline group (6 patients), and in-hospital deaths were also higher in the Ringer Lactate group (7 patients) compared to the Normal Saline group (4 patients). However, the statistical significance for these outcomes was not calculated in the provided data. Overall, the two groups had no significant differences in treatment outcomes, suggesting that both treatment strategies yielded similar results.

The average DKA resolution time was slightly longer in the Ringer Lactate group, with a mean of 30.90 hours, compared to 27.63 hours in the Normal Saline group. Although there is a difference of a few hours, the standard deviation in both groups is relatively large (16.27 for Ringer Lactate and 16.72 for Normal Saline), indicating considerable variability in how quickly patients resolved their DKA within each group. This overlap in the variation suggests that the difference in time to resolution between the two treatments may not be clinically significant.

[Table 3] compares the clinical and laboratory parameters between the Ringer Lactate (CASE) and Normal Saline (CONTROL) groups. The HbA1c levels, which indicate long-term blood glucose control, were similar between the two groups, with a mean value of 10.51 ± 2.19 in the Ringer Lactate group and 10.00 ± 1.74 in the Normal Saline group. The p-value of 0.591118 suggests that this difference is not statistically significant.

Creatinine levels, which reflect kidney function, were slightly lower in the Ringer Lactate group at 1.50 ± 0.70 compared to 1.66 ± 0.73 in the Normal Saline group. However, the p-value of 0.157530 indicates that this difference is not statistically significant. Similarly, the urea levels were slightly higher in the Normal Saline group (41.87 ± 15.69) than in the Ringer Lactate group (35.97 ± 13.07). While the difference in urea levels is approaching statistical significance, with a p-value of 0.059822, it still falls short of the conventional threshold for significance.

The Glasgow Coma Scale (GCS), used to assess a patient's level of consciousness, showed very similar scores between the two groups, with 12.07 ± 2.30 in the Ringer Lactate group and 12.43 ± 2.18 in the Normal Saline group. The p-value of 0.715098 confirms that this difference is not statistically significant.

Regarding pH levels, which are indicative of acid-base balance in the body, the two groups had nearly identical values: 7.19 ± 0.14 in the Ringer Lactate group and 7.22 ± 0.13 in the Normal Saline group. The p-value of 0.217202 again shows no significant difference between the groups. Lastly, bicarbonate levels, which help indicate metabolic acidosis, were slightly lower in the Ringer Lactate group at 10.70 ± 5.13 compared to 12.56 ± 5.13 in the Normal Saline group, but the p-value of 0.266655 suggests that this difference is not significant. Overall, the table

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demonstrates that there are no significant clinical or laboratory differences between the two treatment groups in these key parameters.

[Table 4] provides a comparison of insulin usage and blood glucose control between patients treated with Ringer Lactate and Normal Saline. The mean amount of insulin infused was higher in the Ringer Lactate group, with an average of 105.03 ± 75.32 IU, compared to 87.07 ± 62.52 IU in the Normal Saline group. However, the p-value of 0.352 indicates that this difference is not statistically significant, suggesting that the insulin usage was comparable between the two groups.

The time to stop insulin infusion was also slightly longer in the Ringer Lactate group, averaging 33.70 ± 16.82 hours compared to 30.00 ± 17.30 hours in the Normal Saline group. Again, the difference was not statistically significant, as reflected by the p-value of 0.274, indicating that both treatments had a similar duration of insulin therapy.

In terms of blood glucose levels at admission, the Ringer Lactate group had a slightly higher mean blood glucose level (395.96 ± 76.65 mg/dl) compared to the Normal Saline group (375.96 ± 85.39 mg/dl). However, with a p-value of 0.501, this difference is not significant, suggesting that both groups presented with similar levels of hyperglycemia at the time of admission. Overall, the table indicates that there were no significant differences in insulin usage, time to stop insulin infusion, or blood glucose control between the Ringer Lactate and Normal Saline groups.

The average time to stop insulin infusion was slightly longer for the Ringer Lactate group, with a mean of 33.70 hours, compared to 30.00 hours for the Normal Saline group. The error bars, representing the standard deviation, indicate considerable variability within both groups, with the standard deviations being 16.82 hours for Ringer Lactate and 17.30 hours for Normal Saline. This overlap suggests that the difference in the time to stop insulin infusion between the two groups may not be clinically significant. Overall, both treatment groups show similar durations for insulin infusion.

[Table 5] compares the complications and outcomes between the Ringer Lactate and Normal Saline treatment groups. Hypokalemia (low potassium levels) was slightly higher in the Ringer Lactate group, with 2 cases, while no cases were reported in the Normal Saline group. The p-value of 0.467 suggests that this difference is not statistically significant.

Regarding patients who required ventilation, 3 cases were observed in the Ringer Lactate group and 2 cases in the Normal Saline group, with a p-value of 0.534, indicating no significant difference between the two groups in this outcome. When looking at the number of cured patients, 22 patients in the Ringer Lactate group were cured compared to 24 in the Normal Saline group. The p-value of 0.219 shows that this difference is not statistically significant, meaning both treatments had comparable recovery outcomes.

Finally, the number of deaths was slightly higher in the Ringer Lactate group (7 deaths) compared to the Normal Saline group (4 deaths), with a p-value of 0.329, again indicating no statistically significant difference between the two groups. Overall, the table shows that both treatment groups experienced similar rates of complications and outcomes, with no statistically significant differences observed.

[Table 6] compares detailed fluid administration between the Ringer Lactate and Normal Saline groups. The fluid infusion rate, in Ringer Lactate group had a slightly higher mean rate of 346.67 ml/hr, compared to 321.76 ml/hr for the Normal Saline group. The p-value of 0.429 shows that this difference is not statistically significant, implying that the rate at which fluids were administered was similar between the two treatment groups.

The total fluid volume administered during treatment was the same as the initial bolus amount for both groups, with 8320.00 ml for the Ringer Lactate group and 7722.33 ml for the Normal Saline group. The p-value of 0.512 indicates no significant difference in the overall amount of fluid administered between the two groups. Overall, the table suggests that fluid administration practices were quite similar between patients treated with Ringer Lactate and Normal Saline, with no significant differences in bolus volume, infusion rate, or total fluid volume.

Table 1: Demographic and Clinical Characteristics of Patients.

Variable	Ringer Lactate	Normal Saline
Total Patients	30	30
Age (Mean ± SD)	38.47 ± 13.34	49.83 ± 19.08
Male	21	21
Female	9	9
Type 1 Diabetes	18	9
Type 2 Diabetes	12	21
Severity of DKA		
Mild DKA	6	7
Moderate DKA	12	13
Severe DKA	12	10

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Table 2: Comparison of Treatment Groups.

Variable	Ringer Lactate	Normal Saline	p-value
Number of Patients	30	30	
Amount of Fluids Used (ml)	8320.00 ± 3839.43	7722.33 ± 4288.80	0.305574
Time for DKA Resolution (hours)	30.90 ± 16.27	27.63 ± 16.72	0.110874
Sodium Levels (Mean ± SD)	129.57 ± 5.02	130.43 ± 5.32	0.719385
Potassium Levels (Mean ± SD)	3.25 ± 0.57	3.47 ± 0.73	0.659025
Anion Gap (Mean ± SD)	24.50 ± 6.60	22.88 ± 6.53	0.981967
ICU Admission	8	6	
In-Hospital Death	7	4	

Table 3: Comparison of Clinical and Laboratory Parameters

Variable	CASE Mean ± SD	CONTROL Mean ± SD	p-value
HbA1C	10.51 ± 2.19	10.00 ± 1.74	0.591118
Creatinine	1.50 ± 0.70	1.66 ± 0.73	0.157530
UREA	35.97 ± 13.07	41.87 ± 15.69	0.059822
GCS	12.07 ± 2.30	12.43 ± 2.18	0.715098
Ph	7.19 ± 0.14	7.22 ± 0.13	0.217202
Bicarb	10.70 ± 5.13	12.56 ± 5.13	0.266655

Table 4: Insulin Usage and Blood Glucose Control.

Variable	Ringer Lactate	Normal Saline	p-value
Insulin Infusion Used (IU) (Mean ± SD)	105.03 ± 75.32	87.07 ± 62.52	0.352
Time to Stop Insulin Infusion (hours) (Mean ± SD)	33.70 ± 16.82	30.00 ± 17.30	0.274
Blood Glucose at admission (mg/dl) (Mean ± SD)	395.96 ± 76.65	375.96 ± 85.39	0.501

Table 5: Complications and Outcomes.

Complications/Outcomes	Ringer Lactate	Normal Saline	p-value
Hypokalemia	2	0	0.467
Ventilated	3	2	0.534
Cured	22	24	0.219
Death	7	4	0.329

Table 6: Detailed Fluid Administration.

Variable	Ringer Lactate	Normal Saline	p-value
Infusion Rate (ml/hr)	346.67 ± 159.98	321.76 ± 178.70	0.429
Total Fluid Volume (ml)	8320.00 ± 3839.43	7722.33 ± 4288.80	0.512

DISCUSSION

This study aimed to compare the clinical outcomes and laboratory parameters of patients with diabetic ketoacidosis (DKA) treated with Ringer Lactate and Normal Saline. Our findings suggest that both treatment groups exhibited comparable clinical outcomes in terms of insulin usage, time to DKA resolution, fluid administration, and major complications. These results align with prior studies that evaluated fluid resuscitation in DKA management, affirming the effectiveness of both solutions in stabilizing patients and correcting metabolic derangements.

The time to DKA resolution was slightly longer in the Ringer Lactate group, with a mean of 30.90 hours compared to 27.63 hours in the Normal Saline group. However, the difference was not statistically significant, suggesting that both solutions are similarly effective in resolving acidosis and restoring normal metabolic function. This finding is consistent with previous studies, which have indicated that lactated Ringer's solution can be safely used in DKA patients without a significant delay in acidosis resolution compared to saline.[16,17]

Fluid resuscitation is a cornerstone of DKA management, and both groups received similar amounts of total fluid volume and subsequent infusion rates. The initial bolus was slightly higher in the Ringer Lactate group (8320.00 ml) compared to the Normal Saline group (7722.33 ml), but the difference was not statistically significant. These results are in line with the existing literature, which highlights that the type of fluid used does not significantly affect the total volume required for resuscitation.[17] Both Ringer Lactate and Normal Saline have been shown to be effective in restoring circulatory volume and improving renal perfusion during DKA management.[18,19]

The clinical outcomes, including the rate of hypokalemia, ventilation requirement, cure rate, and mortality, were also similar between the two groups. Hypokalemia occurred slightly more frequently in the Ringer Lactate group (2 cases) than in the Normal Saline group (0 cases), though the difference was not statistically significant. This may be explained by the lower sodium content in Ringer Lactate, which could potentially lead to more potassium loss during correction of acidosis(ringer lactate-2). However, previous studies have reported that both solutions generally provide adequate electrolyte balance during DKA treatment.[20,21]

The study also evaluated insulin usage and blood glucose control, finding no significant differences

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between the groups. Patients in the Ringer Lactate group required slightly more insulin (105.03 IU) compared to the Normal Saline group (87.07 IU), but this difference was not statistically significant. Similarly, blood glucose at admission and the time to stop insulin infusion were comparable between the two groups. This supports previous evidence that the choice of fluid does not have a substantial impact on insulin sensitivity or glucose management during DKA treatment.[22]

The overall mortality rate was slightly higher in the Ringer Lactate group (7 deaths) compared to the Normal Saline group (4 deaths), though this difference was not statistically significant. While this finding might raise some concerns, the numbers are small, and further studies with larger sample sizes would be necessary to draw definitive conclusions. Previous research has shown no significant difference in mortality between patients treated with different fluids in DKA.[23-25]

CONCLUSION

In summary, the results of this study suggest that Ringer Lactate and Normal Saline are equally effective in managing patients with DKA. Both fluids provided similar outcomes in terms of metabolic correction, insulin requirement, fluid administration, and complication rates. Given the lack of significant differences, clinicians may choose either solution based on clinical judgment, patient-specific factors, or resource availability. Future studies with larger populations and longer follow-up periods may help clarify whether there are any subtle differences in long-term outcomes between the two treatment modalities.

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