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Case Report

Comparison of Three Types of Crystalloids for Choice in Early Fluid Resuscitation of Polytrauma Patients Admitted to Emergency Room

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Abstract

Introduction: The Intravenous fluids that are commonly used for early resuscitation in trauma patients are Isotonic saline and Ringer lactate. A new Intravenous fluid, Plasmalyte has been recently introduced for fluid resuscitation in trauma patients. In our study we compare the effects of commonly used Intravenous fluids such as Plasmalyte, Ringer lactate and Isotonic saline in traumatic patients

Material and Methods: AGE of 18-60 years of either gender admitted to emergency room for resuscitation with HR >120/ minute and Revised Trauma Score of 7-8(4 when weighing factor included). Three fluids Normal saline, Ringer lactate and Plasmalyte in150 adult trauma patients given and then blood, acid base parameters compared and then statistically analysed.

Discussion: Interventional comparative study comparing Normal saline, Ringer lactate and Plasmalyte in150 adult trauma patients of either gender admitted in emergency room in order to find out type of fluid used for fluid resuscitation, has any impact on acid -base balance, blood lactate level, biochemical parameters like blood urea, serum creatinine, serum electrolytes and hemodynamical parameters like Heart rate,spo2 and Revised trauma score.

Conclusion: The trauma patients resuscitated with Plasmalyte was found to have stable and normal acid base status, biochemical parameters and serum electrolyte levels.

Keywords: Crystalloids; Early Fluid Resuscitation; Polytrauma Patients; Emergency Room

Introduction

Trauma is associated with high morbidity and mortality and it is one of the common causes of death in young [1]. Trauma pose a global health problem and account for 10% global health burden. Among the injured patients, the major cause of morbidity and mortality in trauma patients is due to complications like uncontrolled hemorrhage which results in imbalance between systemic oxygen delivery and oxygen consumption [1,2]. Blood loss also leads to hemodynamic instability, coagulopathy, decreased tissue perfusion and cellular hypoxia [3].

Initial response to hemorrhage takes place on the macrocirculatory level which is mediated by neuroendocrine system. Decreased arterial blood pressure leads to vasoconstriction of regional beds and release of catecholamines which maintains blood flow to the heart, kidney and brain at the expense of other tissues [3]. This inflammatory response becomes a disease process independent of its own origin which results in development of multiorgan failure, a systemic inflammatory process that leads to dysfunction of different organs and causes high incidence of mortality. Hence Intravenous fluids are the most essential part of early resuscitation in the management of trauma patients as they increase intravascular volume, increase cardiac output and enhance organ perfusion in patients with hypovolemia. They also provide adequate oxygen perfusion and oxygen delivery to the tissue compromised by the physiological consequence of trauma [3].

Fluid resuscitation of trauma patients has been an ongoing challenge repeatedly reviewed and debated. The resuscitation strategies are based on the type of fluid, volume, rate and the time of fluid administration. The recommendations for type of fluids ranges from the use of crystalloids, colloids, packed red blood cells, whole blood and clotting factors. International guidelines recommend restrictive volume replacement approach with slower rates of infusion of fluids to achieve target blood pressure until bleeding is controlled. A large volume of crystalloid administration is not recommended as it results in decreased hematocrit, decreased coagulation capability, electrolyte imbalance, direct immune suppression and premature reperfusion [4]. The best fluid available doesn't always equate to the best fluid for patient. For example, Isotonic crystalloids are commonly used for initial fluid resuscitation in any trauma patients as they are readily available, non-allergenic, noninfectious, efficacious in restoring total body fluid, they are easy to administer and they also mix well with infused medications but they lack oxygen carrying capacity and coagulation capability and they have less intravascular half -life similarly colloids (including starch solutions and albumin) have advantage of readily availability, easy storage and they also increase intravascular volume more rapidly than crystalloids but they lack oxygen carrying capacity and also causes adverse effect on kidney function hence achieving a balance in the type of fluid and the volume that should be administered to different trauma patients is always a challenge [3].

The Intravenous fluids that are commonly used for early resuscitation in trauma patients are Isotonic saline and Ringer lactate.3 A new Intravenous fluid, Plasmalyte has been recently introduced for fluid resuscitation in trauma patients [2].

Isotonic saline is widely used as a resuscitation fluid and remains the fluid of choice for patients with brain injury, diabetic acidosis, hyponatremia and metabolic alkalosis. However, there is concern regarding high chloride load in these fluids and potential contribution towards acidosis and renal injury as it contains 154mmol/L Na+ and Cl - with pH of 5.0 and Osmolarity of 308 mOsm/L. The risk of hyperchloremic metabolic acidosis and its negative consequences are present [5].

Ringer lactate is a balanced salt solution which closely resemble human plasma and have lower sodium and chloride content with addition of lactate as buffer (130mmol/L Na+ and 109mmol/L Cl-, 4 mmol/L Potassium,1.5 mmol/L Calcium, 28mmol/L lactate, pH of 6.5 and Osmolarity of 272mOsm/L) [6]. Being more physiological in nature, it is being used more frequently and has been proved to be less harmful than Isotonic saline [7]. However, there is risk of hyperkalemia, lactate accumulation and exacerbation of cerebral edema in brain injured patients when infused in large quantity [8].

Plasmalyte is an Intravenous fluid which has composition very similar to plasma and it has acetate and gluconate as buffer. The composition is 140mmol/L Na+, 98mmol/L Cl-, 5mmol/L Potassium, 27 mmol/L Acetate, 23 mmol/L Gluconate, Osmolarity of 296mOsm/L of pH 7.4 making the fluid physiologically balanced with Plasma [2]. The presence of acetate and gluconate provides additional buffer action by undergoing complete metabolism into bicarbonate, carbon dioxide and water hence data from adult studies supports the use of Plasmalyte for resuscitation and maintenance fluids in preference to Isotonic saline and Ringer lactate [2,9].

The response to Intravenous fluid resuscitation is assessed using physiological markers of improvement such as Pulse rate, Heart rate, Systolic and Diastolic blood pressure and SpO2. The improvement in physiological markers is similar with all three fluids [4] (Isotonic saline, Ringer lactate and Plasmalyte) but the changes in biochemical parameters are significantly different in all the three fluids and it depends upon chemical composition of each crystalloid [4,6,7].

Crystalloids are the initial resuscitative fluid used in any trauma patients as they are inexpensive, easy to store, readily available, non- infectious, non-allergic, mix well with any medication to be administer, can easily warm to body temperature and very effective in expanding volume when used for fluid resuscitation. The major disadvantage of crystalloids are they lack oxygen carrying capacity, coagulation capability and they have small molecules i.e. size less than 1nm which allows easy penetration through endothelium to extravascular spaces hence they have less intravascular half-life [2,8].

Colloids are grouped into natural (starch or human albumin), semisynthetic and synthetic (dextrans, gelatin etc). They are said be increase intravascular volume expansion rapidly and they have molecule size of 1nm -100nm hence their intravascular half - life is more .Like crystalloids, colloids have similar adverse effect like lack oxygen carrying capacity and coagulation capability. The SAFE (Saline Versus Albumin Fluid Evaluation) study compared Normal saline and 4% albumin in traumatic brain injury patients showed equal efficacy clinically. Amount fluid required for resuscitation was less in 4% albumin group compare to normal saline but the traumatic brain injury patients receiving albumin 4% had higher mortality compare to patients receiving normal saline. Another multicentric randomized controlled study conducted by John A Myburgh., *et al*, in 7000 patients admitted to intensive care unit receiving either 6% hydroxyethyl starch or normal saline showed no difference in 90-day mortality between patients receiving 6% HES or saline but the patients who received HES 6% had adverse kidney function and they were treated with renal replacement therapy. By seeing findings in above studies,it showed that colloids also have adverse effects like causing allergic reactions, kidney dysfunctions, coagulation abnormalities and even mortality Hence crystalloids are preferred for initial fluid resuscitation in any clinical situation compare to colloids [10].

Most commonly used fluids for resuscitation

- 0.9% Normal saline
- Ringer lactate
- Plasmalyte

Many studies are available in literature comparing Isotonic saline and Ringer lactate for purpose of fluid resuscitation both in adults and children with variable and significant changes in biochemical parameters like Association of fall in pH and increased Serum chloride levels with Isotonic saline and lactate accumulation observed with Ringer lactate [7,11]. Plasmalyte is more likely to be associated with least changes in biochemical parameters as its composition is similar to plasma [3,9]. but there is a paucity in literature comparing Plasmalyte either with Isotonic saline or Ringer lactate for fluid resuscitation. Hence in our study, we propose to compare Plasmalyte with Isotonic Saline and Ringer Lactate for early fluid resuscitation of adult patients with acute traumatic injury in Resuscitation zone in terms of changes in biochemical parameters and hemodynamic changes.

Materials and Methods

The proposed study was carried out in the Department of Anaesthesia and Intensive care at tertiary care center, after obtaining clearance from Institute Ethical Committee and informed written consent from participants.

Type of study

Prospective randomized interventional comparative study.

Duration of study

18 months.

Sample size

As there was no study available comparing Isotonic saline and Ringer lactate with Plasmalyte for resuscitation or maintenance Hence we took below study as reference for sample size. A study conducted by Jason B young., *et al*, comparing hemodynamic and biochemical markers in 46 evaluable subjects with penetrating injuries, Injury severity score 23 ± 16, Systolic blood pressure < 90 and operation within 60 mins using Normal saline and Plasmalyte A for initial resuscitation showed that change in base excess, arterial pH and sodium bicarbonate in normal saline group was 4.4 ± 3.9 mmol/L, 7.37 ± 0.07 and 22 ± 4 mEq/L respectively and in Plasma-Lyte A was 7.5 ± 4.7 mmol/L, 7.41 ± 0.06 and 26 ± 3 mEq/L respectively.

- **Block Randomization**: Block Randomization with Sealed envelope system: - In this, Iprepared fifteen randomly generated treatment allocations within sealed opaque envelopes assigning NS, RL and PL in 5 envelopes each, where NS represents normal saline group, RL represents Ringer lactate group and PL represents Plasmalyte Group. after patients gave consent to enter into trial an envelope was opened and the patients were then offered the allocated group. In this technique, patients were randomized in a series of blocks of fifteen.
- **Patient selection:** Patients in the age group of 18-60 years of either gender were randomly assigned into three groups of 50 patients each.
- **Group NS:** (n = 50) received resuscitation with Isotonic Saline. Group RL: (n = 50) received resuscitation with Ringer lactate. Group PL: (n = 50) received resuscitation with Plasmalyte.

Inclusion criteria

AGE of 18-60 years of either gender admitted to emergency room for resuscitation with HR >120/minute and Revised Trauma Score of 7-8(4 when weighing factor included).

Exclusion criteria

Pregnancy.

Known cases of chronic renal disease and liver disease. Patients with abnormal coagulation profile.

Patients having on going blood loss.

Patient resuscitation

- All patients with traumatic injury on arrival at Resuscitation zone were transferred to the bed immediately.
- Monitoring devices such as ECG, NIBP, SpO2 were attached and baseline readings were recorded and Revised Trauma Score scoring were done. Oxygen therapy was started.
- All the patients were assessed and managed as per ATLS protocol and Institutional guidelines.
- A wide bore Intravenous cannula were placed in the upper limb of the patient and blood sample were drawn for baseline investigations.
- Fluid resuscitation with appropriate fluid under study was performed as early as possible.
- The end point of resuscitation was continued till the Heart rate of 90bpm achieved and Revised Trauma Score > 4.
- The time duration at which the end point is achieved and the total amount of fluid required for achieving end point of resuscitation were recorded.

Study parameters

Biochemical parameters

- pH and base status.
- Serum bicarbonate.
- Serum electrolyte- Na+, K+, Cl-. Serum lactate.
- Blood urea and creatinine.

Hemodynamic parameters

- Heart Rate.
- Revised Trauma Score (GCS, SBP and Respiratory rate). SpO2.
- These parameters were noted before resuscitation, After one Hour, at Completion of end point of resuscitation, and 6 hours,12 and 24 hours post resuscitation.

Blood sampling-timings

- Before the start of resuscitation.
- After one Hour.
- Completion of end point of resuscitation.
- 6 hours post resuscitation.
- 12 hours post resuscitation.
- 24 hrs after resuscitation.

Results

In our study, 150 adult trauma patients admitted in Emergency room were randomized into three group with 50 in each group as group NS, group RL and group PL. A Prospective Randomized Interventional comparative study done to compare Normal saline, Ringer lactate and Plasmalyte in 150 adult trauma patients of either gender admitted in emergency room in order to find out the correct fluid for fluid resuscitation and its impact on acid -base balance, blood lactate levels, biochemical parameters like blood urea, serum creatinine and serum electrolyte levels hemodynamic parameters like Heart rate, SpO2 and Revised trauma score. All three groups received fluids until resuscitation goals were achieved (HR < 90 bpm and RTS > 8). The type of fluid used for resuscitation or maintenance in intensive care settings and perioperative period have been extensively studied in adult patients while there is paucity of literature regarding studies for the choice of fluid used for early fluid resuscitation in trauma patients.

Haemodynamic parameters

Heart rate

The heart rate changes in individual groups revealed that In NS Group, the baseline Heart Rate (BPM) was 135.16 ± 11.78 before resuscitation which showed progressive decrease following resuscitation to a stable and minimum value of 83.26 ± 7.94 at 24 Hours Post-Resuscitation. This change was statistically significant (p = < 0.001).

Similarly, in RL Group, the pre-resuscitation Heart Rate (BPM) was 133.24 ± 10.70 which showed progressive decrease Post resuscitation, to a stable and minimum value of 82.08 ± 9.18 at the 24 Hours Post-Resuscitation. These changes were statistically significant (p = < 0.001).

Plasmalyte group also showed that the baseline pre-resuscitation Heart Rate (BPM) was 139.67 ± 10.55 which showed progressive decrease Post- resuscitation, to a minimum and stable value of 81.33 ± 9.14 at the 24 Hours Post-Resuscitation timepoint. This change was statistically significant (p = < 0.001).

Revised trauma score

We analyzed the Revised Trauma Score in each individual group to find out the scoring pattern in each group. Revised trauma Score correlate with survival and mortality. We found that in each study group, that is, NS, RL or Plasmalyte group, the scoring pattern was similar. The mean baseline RTS was between 7-8, indicating that the hemodynamic status is sub optimal and presence of severe trauma. Immediate resuscitation is recommended.

Following resuscitation the mean RTS (NS = 7.04 ± 0.20,RL = 7.14 ± 0.35, PLA = 7.10 ± 0.30) increased progressively during resuscitation (NS = 8 ± 0.28,RL = 8 ± 0.35, PLA = 7.98 ± 0.25) immediate Post-Resuscitation,(NS = 8.29 ± 0.50,RL = 8.56 ± 0.50, PLA = 8.62 ± 0.49), 6 Hours Post-Resuscitation(NS = 8.82 ± 0.52,RL = 8.96 ± 0.40, PLA = 9.00 ± 0.40) and 12 Hours PoResuscitation (NS = 9.10 ± 0.67,RL = 9.40 ± 0.67, PLA = 9.42 ± 0.57) to NS = 9.80 ± 0.57, RL = 9.96 ± 0.60, PLA = 9.84 ± 0.51 at the 24 Hours Post-Resuscitation . These changes in RTS were found to be statistically significant ($p = < 0.001$).

SpO_2

The changes oxygen saturation was observed in each NS, RL and Plasmalyte group during the entire period of study. This revealed interesting findings. The spo2 showed a progressive and a statistically significant increase throughout the period under study in NS group (99.56 ± 0.88), RL group(,RL = 99.54 ± 0.97) and Plasmalyte group(PLA = 99.61 ± 0.85).

Comparison of three groups, Normal Saline group vs Plasmalyte group, Normal saline group vs Ringer Lactate group and Ringer lactate vs Plasmalyte showed progressive fall in pH value in Normal saline group compare to Plasmalyte ($p < 0.001$) and Ringer lactate group($p < 0.001$). These findings reveal that among three fluids i.e. NS, RL and Plasmalyte, NS showed a higher and progressive fall in the pH values may be due to high chloride content and lack of buffer. The high chloride content in plasma causes intracellular shift of bicarbonate which result in Metabolic acidosis [12]. Following results were obtained.

Hemodynamic parameters	Study Group								
	NS			RL			Plasmalyte		
	Heart Rate (BPM) Mean (SD)	RTS Mean (SD)	SpO2 (%) Mean (SD)	Heart Rate (BPM) Mean (SD)	RTS Mean (SD)	SpO2 (%) Mean (SD)	Heart Rate (BPM) Mean (SD)	RTS Mean (SD)	SpO2 (%) Mean (SD)
Baseline	135.16 (11.78)	7.04 (0.20)	94.94 (6.33)	133.24 (10.70)	7.14 (0.35)	93.00 (12.90)	139.67 (10.55)	7.10 (0.30)	96.71 (3.26)
During Resuscitation	110.98 (9.97)	8.00 (0.28)	99.12 (1.26)	110.98 (8.37)	8.00 (0.35)	98.92 (1.61)	115.39 (10.15)	7.98 (0.25)	99.41 (0.70)
Immediately post-resuscitation	88.76 (1.41)	8.29 (0.50)	99.86 (0.45)	88.54 (2.57)	8.56 (0.50)	99.72 (0.61)	88.08 (2.37)	8.62 (0.49)	99.84 (0.42)
6 Hours Post-Resuscitation	84.32 (7.70)	8.82 (0.52)	99.54 (1.05)	84.70 (8.09)	8.96 (0.40)	99.42 (1.26)	82.31 (7.32)	9.00 (0.40)	99.51 (1.75)
12 Hours Post-Resuscitation	84.16 (7.89)	9.10 (0.67)	99.54 (0.97)	83.20 (8.65)	9.40 (0.67)	99.56 (0.97)	81.45 (7.75)	9.42 (0.57)	99.71 (0.61)
24 Hours Post-Resuscitation	83.26 (7.94)	9.80 (0.57)	99.56 (0.88)	82.08 (9.18)	9.96 (0.60)	99.54 (0.97)	81.33 (9.14)	9.84 (0.51)	99.61 (0.85)

Table 1: Comparison of hemodynamic parameters in study groups.

BPM: Beats Per Minute; SD: Standard Devaition; RL: Ringer Lactate; NS: Normal Saline

Acid balance parameters

pH

The pH changes in individual groups revealed that In NS Study Group, the mean baseline pH value was 7.38 ± 0.05 which showed progressive fall during resuscitation (7.34 ± 0.03), immediately post resuscitation(7.34 ± 0.05), 6hrs post resuscitation(7.30 ± 0.04) and 12 hrs post resuscitation(7.29 ± 0.04) to a minimum value of 7.28 ± 0.04 at the 24 Hours Post-Resuscitation timepoint. This change was statistically significant ($p = < 0.001$).

In Study Group: RL, the mean baseline pH was 7.36 ± 0.05 which unlike Normal saline group showed normal values and comparable throughout the study ($p = 0.504$).

In Study Group: Plasmalyte, the mean baseline pH was 7.38 ± 0.08 which unlike Normal saline group showed normal values and comparable throughout the study ($p = 0.358$).

Acid -base parameters	Study Group								
	NS			RL			Plasmalyte		
	pH Mean (SD)	Base Excess (mmol/L) Mean (SD)	S. Bicarbonate (mmol/L) Mean (SD)	pH Mean (SD)	Base Excess (mmol/L) Mean (SD)	S. Bicarbonate (mmol/L) Mean (SD)	pH Mean (SD)	Base Excess (mmol/L) Mean (SD)	S. Bicarbonate (mmol/L) Mean (SD)
Baseline	7.38 (0.05)	-1.80 (1.48)	22.49 (1.39)	7.36 (0.05)	-2.33 (1.63)	21.63 (1.91)	7.38 (0.08)	-2.18 (1.11)	21.77 (1.09)
During Resuscitation	7.34 (0.03)	-2.44 (1.52)	21.28 (1.43)	7.36 (0.04)	-2.26 (1.44)	21.70 (1.64)	7.39 (0.08)	-1.83 (1.02)	21.93 (1.11)
Immediately Post-Resuscitation	7.34 (0.05)	-2.56 (1.46)	21.30 (1.27)	7.36 (0.04)	-2.28 (1.59)	21.61 (1.78)	7.39 (0.04)	-1.68 (0.96)	21.91 (1.02)
6 Hours Post-Resuscitation	7.30 (0.04)	-4.07 (5.53)	20.27 (1.52)	7.36 (0.03)	-2.19 (1.33)	21.61 (1.60)	7.39 (0.04)	-1.50 (0.73)	22.33 (1.34)
12 Hours Post-Resuscitation	7.29 (0.04)	-3.94 (1.43)	19.46 (1.35)	7.36 (0.03)	-2.25 (1.42)	21.45 (1.56)	7.39 (0.04)	-1.18 (0.78)	22.47 (0.97)
24 Hours Post-Resuscitation	7.28 (0.04)	4.27 (1.31)	22.49 (1.54)	7.37 (0.03)	-2.13 (1.61)	21.57 (2.12)	7.38 (0.06)	-0.99 (084.)	22.67 (1.02)

Table 2: Comparison of acid base parameters.

NS: Normal Saline; RL: Ringer Lactate; SD: Standard Deviation

Acid base parameters	Study Group								
	NS			RL			Plasmalyte		
	S. Lactate (mmol/L) Mean (SD)	S. Urea (mg/dl) Mean (SD)	S. Creatinine (mg/dL) Mean (SD)	S. Lactate (mmol/L) Mean (SD)	S. Urea (mg/dl) Mean (SD)	S. Creatinine (mg/dL) Mean (SD)	S. Lactate (mmol/L) Mean (SD)	S. Urea (mg/dl) Mean (SD)	S. Creatinine (mg/dL) Mean (SD)
Baseline	2.58 (0.59)	22.44 (4.13)	0.67 (0.14)	2.39 (0.40)	23.18 (2.98)	0.67 (0.10)	2.36 (0.30)	23.22 (3.15)	0.70 (0.08)
During Resuscitation	1.60 (0.57)	23.04 (3.98)	0.66 (0.12)	1.60 (0.38)	23.22 (2.99)	0.64 (0.10)	1.45 (0.24)	23.56 (3.26)	0.66 (0.08)
Immediately Post-Resuscitation	1.46 (0.56)	23.16 (3.71)	0.66 (0.11)	1.57 (0.33)	23.40 (3.89)	0.66 (0.11)	1.27 (0.21)	23.67 (3.38)	0.63 (0.08)
6 Hours Post-Resuscitation	1.18 (0.48)	22.90 (3.63)	0.65 (0.11)	1.49 (0.43)	22.88 (3.86)	0.66 (0.10)	1.08 (0.17)	23.78 (3.38)	0.64 (0.06)
12 Hours Post-Resuscitation	1.10 (0.48)	23.06 (3.44)	0.66 (0.11)	1.49 (0.49)	23.06 (3.63)	0.67 (0.10)	0.96 (0.16)	24.04 (3.74)	0.62 (0.07)
24 Hours Post-Resuscitation	1.02 (0.47)	23.06 (3.98)	0.68 (0.14)	1.49 (0.51)	3.88 (3.51)	0.66 (0.10)	0.89 (0.14)	23.88 (3.77)	0.60 (0.05)

Table 3: Comaprison of acid base parameters.

BPM: Beats Per Minute; SD: Standard Devaition; RL: Ringer Lactate; NS: Normal Saline

Base Excess

In NS Study Group: the mean baseline Base Excess (mmol/L) was -1.80 ± 1.48 which showed progressive fall from immediately post resuscitation (-2.44 ± 1.52), 6 hrs post resuscitation (-2.56 ± 1.52) and 12 hrs post resuscitation (-3.94 ± 1.43) to a minimum of -4.27 ± 1.31 at the 24 Hours Post-Resuscitation timepoint. This change was statistically significant (p = < 0.001).

In RL Study Group, the mean baseline Base Excess (mmol/L) was -2.33 ± 1.63 which unlike Normal saline showed no significant change and was comparable throughout the study (p = 0.985).

In Plasmalyte Study Group, the mean baseline Base Excess (mmol/L) was -2.18 ± 1.11 which showed progressive rise from 6 hrs post resuscitation (-1.50 ± 0.73) and 12 hrs post resuscitation (-1.18 ± 0.78) to a maximum of -0.99 ± 0.84 at the 24 Hours Post-Resuscitation timepoint. This change was statistically significant (p = < 0.001).

Serum bicarbonate

In NS Study Group, the mean baseline S. Bicarbonate (mmol/L) was 22.49 ± 1.39 which showed progressive fall during resuscitation, immediately post resuscitation (21.30 ± 1.27), 6 hours post resuscitation (20.27 ± 1.52) and 12 hrs post resuscitation timepoint (19.46 ± 1.35) to a minimum of 19.01 ± 1.54 at the 24 Hours Post-Resuscitation timepoint. This change was statistically significant (p = < 0.001). In RL Study Group, the baseline mean S. Bicarbonate (mmol/L) was 21.63 ± 1.91 and was comparable throughout the study period (p = 0.882).

In Study Group: Plasmalyte, the baseline mean S. Bicarbonate (mmol/L) was 21.77 ± 1.09 which showed progressive rise from 12 hrs post resuscitation to a maximum of 22.67 ± 1.02 at the 24 Hours Post-Resuscitation timepoint. This change was statistically significant (p = < 0.001). ELECTROLYTES

Serum sodium

In NS Study Group, the mean baseline S. Sodium (mEq/L) was 137.02 ± 3.80 which showed progressive rise during resuscitation (139.20 ± 3.52), immediately post resuscitation (139.88 ± 4.41), 6 hrs post resuscitation(141.34 ± 3.41),12 hrs post resuscitation (141.70 ± 3.44) to maximum of (142.86 ± 3.60) at the 24 Hours Post-Resuscitation timepoint. This change was statistically significant (p = < 0.001).

In RL Study Group, the mean baseline S. Sodium (mEq/L) was 137.98 ± 4.29 which showed progressive fall during resuscitation (137.50 ± 3.44), immediately post resuscitation (136.86 ± 3.42), 6 hrs post resuscitation (136.04 ± 3.73) to minimum of 135.54 ± 4.84 at the 12 Hours Post-Resuscitation timepoint, and then showed mild increase 135.62 ± 4.47 at the 24Hours Post-Resuscitation timepoint. This change was statistically significant (p = < 0.001).

In Plasmalyte Study Group, the mean baseline S. Sodium (mEq/L) was 138.88 ± 3.28 which were normal and comparable throughout the study period.

Potassium

- In NS Study Group, the mean S. Potassium (mEq/L) was 3.63 ± 0.40 which remain within normal limits and comparable at during resuscitation (3.63 ± 0.37), Immediately Post-Resuscitation timepoint (3.63 ± 0.35),6 hrs post resuscitation (3.64 ± 0.32),12 hrs post resuscitation (3.66 ± 0.34) and then it increased to 3.71 ± 0.33 at the 24 Hours Post-Resuscitation timepoint. This change was statistically significant (p = 0.049).
- In RL Study Group, the mean baseline S. Potassium (mEq/L) was 3.75 ± 0.41 and remain within normal limits throughout study period and comparable throughout the study period. (p = 1.000).
- In Study Group: Plasmalyte, the baseline mean S. Potassium (mEq/L) was 3.73 ± 0.28 which remain within normal limits throughout study period and comparable throughout the study period. (p = 0.468).

Chloride

In NS Study Group, the mean baseline S. Chloride (mEq/L) was 108.40 ± 4.41 showed progressive rise during resuscitation (111.02 ± 3,65), immediately post resuscitation (112.10 ± 4.63) and 6 hrs post resuscitation (113.94 ± 4.42) to a maximum of 115.02 ± 4.42 at the 12 Hours Post-Resuscitation timepoint, and then mild fall to 114.04 ± 6.75 at the 24 Hours Post-Resuscitation timepoint. This change was statistically significant (p = < 0.001). In RL Study Group, the mean baseline S. Chloride (mEq/L) was 108.24 ± 6.03 which remain within normal limit and comparable throughout the study period (p = 0.976).

In Plasmalyte Study Group, the mean S. Chloride (mEq/L) increased from a minimum of 108.43 ± 3.46 which remain within normal limit and comparable throughout the study period (p = 0.624).

Serum urea levels

- In NS Study Group, the mean baseline S. Urea (mg/dL) was 22.44 ± 4.13 and stayed within normal limits throughout the study period ($p = 0.454$).
- In RL Study Group, the mean baseline S. Urea (mg/dL) was 23.18 ± 2.98 and stayed within normal limits throughout the study period ($p = 0.206$).
- In Study Group: Plasmalyte, the mean baseline S. Urea (mg/dL) was 23.22 ± 3.15 and stayed within normal limits throughout the study period ($p = 0.589$).

Serum creatinine

- In NS Study Group, the baseline mean S. Creatinine (mg/dL) was 0.67 ± 0.14 and stayed within normal limits throughout the study period ($P = 0.684$).
- In RL Study Group, the baseline mean S. Creatinine (mg/dL) was 0.67 ± 0.10 and stayed within normal limits throughout the study period ($p = 0.10$).
- In Plasmalyte Study Group, the baseline mean S. Creatinine (mg/dL) was 0.70 ± 0.08 showed progressive fall from baseline values during resuscitation (0.66 ± 0.08), immediately post resuscitation(0.63 ± 0.08),6 hrs post resuscitation (0.64 ± 0.06),12 hrs resuscitation(0.62 ± 0.07) to minimum of 0.60 ± 0.05 at the 24 Hours Post-Resuscitation . This change was statistically significant ($p = < 0.001$).

Discussion

In our study, 150 adult trauma patients admitted in Emergency room were randomized into three group with 50 in each group as group NS, group RL and group PL. A Prospective Randomized Interventional comparative study done to compare Normal saline, Ringer lactate and Plasmalyte in 150 adult trauma patients of either gender admitted in emergency room in order to find out the correct fluid for fluid resuscitation and its impact on acid -base balance, blood lactate levels, biochemical parameters like blood urea, serum creatinine and serum electrolyte levels hemodynamic parameters like Heart rate, SpO2 and Revised trauma score. All three groups received fluids until resuscitation goals were achieved (HR < 90 bpm and RTS > 8). Demographic profile, Hemodynamical parameters and biochemical parameters were subjected to statistical analysis.The type of fluid used for resuscitation or maintenance in intensive care settings and perioperative period have been extensively studied in adult patients while there is paucity of literature regarding studies for the choice of fluid used for early fluid resuscitation in trauma patients. We analyzed the changes Heart rate, Revised Trauma Score and SpO2 in each individual groups during the period of study followed by comparing groups in the manner such as Normal saline VS Plasmalyte, Normal saline VS Ringer lactate and Plasmalyte VS Ringer lactate.

Hemodynamic parameters

Heart rate

All the three fluids, NS, RL and Plasmalyte are successful in reversing tachycardia after resuscitation and lead to stabilization of heart rate post-resuscitation. When the heart rate changes were compared among the three groups, it revealed that all three fluids lead to a progressive statistically significant but comparable fall in heart rate throughout the period of resuscitation ($p = 0.643$,$p = 0.878$,$p = 0.973$ respectively) and stabilize the heart rate at the end of the period of study. The tachycardia observed in all patients in our study is corroborated by the review article [9]. Which reveals that the initial response to blood loss is reflex tachycardia as a result of sympathetic efferent activity and vagal inhibition and Intravenous fluid therapy with either crystalloids or colloids is an important step for correcting hypovolemia is a well known and is an important aspect of trauma resuscitation [12]. A randomized control trial conducted in 66 patients undergoing spinal surgery comparing hemodynamic parameters, biochemical parameters, serum electrolytes, pH and ICU lengths between patients receiving either Normal saline or ringer lactate showed no difference in hemodynamic parameters, hospital or icu stay but there was increase in serum chloride and sodium levels in patient receiving normal saline. This above study showed same results as our study i.e there was no difference in hemodynamic parameters in between study group.

Revised trauma score

All three crystalloids were able to increase the RTS and were able to bring hemodynamic stability. Also an improving score correlated with good prognosis. Comparison of NS VS Plasmalyte revealed that Plasmalyte infusion resulted in overall faster increase in RTS compared to that of NS. This increase in RTS were found to be statistically significant at immediate post resuscitation period ($p = 0.005$), at 6 hours post resuscitation ($p = 0.127$) and 12 hours post resuscitation ($p = 0.046$) indicating a better and faster improvement in RTS. On comparing NS group with that of RL group, we found that RL infusion resulted in a better Revised Trauma Score during the study period compared to NS group. Also, the scores were statistically significant in the immediate post resuscitation period ($p = 0.033$). However, comparison of RL group and plasmalyte group showed that both resulted in comparable rise in RTS throughout the period of study.

A descriptive cross-sectional study done on 200 patients with different trauma mechanism to analyse gender, age, day of week, mechanism of injury, type of transportation, Revised Trauma Score, hospitalization time and mortality in patients with penetrating trauma to the abdomen and chest(G1), blunt trauma to the abdomen(G2) and chest, and traumatic brain injury(G3) shown that the mean age was significantly lower in G1 than in the other groups ($p < 0.001$). Most (40%) of the visits occurred on weekends. The hospital stay was significantly higher in G1 compared with the other groups ($p < 0.01$). Regarding mortality, there were 12%, 1.35% and 3.95% of deaths in G1, G2 and G3, respectively. The median Revised Trauma Score among the deaths was 5.49, 7.84 and 1.16, respectively, for the three groups [11]. By above study, we understand that the Revised Trauma Score is a very important and valuable scoring technique to predict the mortality and morbidity in traumatic injury patients. In our study, we found that early and adequate fluid resuscitation with crystalloids improve the Revised Trauma Score and reduce the morbidity and Mortality in patients admitted to emergency room. Unfortunately, there is paucity of research studies comparing different crystalloids used for early fluid resuscitation and its effect on RTS in patients with traumatic injury.

SpO_2

The changes oxygen saturation was observed in each NS, RL and Plasmalyte group during the entire period of study. This revealed interesting findings. The spo2 showed a progressive and a statistically significant increase throughout the period under study in NS group (99.56 ± 0.88), RL group(,RL = 99.54 ± 0.97) and Plasmalyte group(PLA = 99.61 ± 0.85). This is probably due to improvement observed in tissue oxygenation following a successful fluid resuscitation.

Comparison of three groups, Normal Saline group vs Plasmalyte group, Normal saline group vs Ringer Lactate group and Ringer lactate vs Plasmalyte, revealed that the mean SpO2 (%) changes observed were comparable in all the three groups.($p < 0.001$) during all times till the end of study. Thus, all the three crystalloids are effective in improving tissue oxygenation in equal measure.

A randomized control trial conducted in 66 patients undergoing spinal surgery comparing hemodynamical parameters, biochemical parameters, serum electrolytes, pH, hospital and ICU lengths between patients receiving either Normal saline or ringer lactate showed no difference in hemodynamic parameters, hospital or icu stay but there was increase in serum chloride and sodium levels in patient receiving normal saline [11]. This above study showed same results as our study i.e there was no difference in hemodynamic parameters in between study group.

ACID BALANCE PARAMETERS

pH

The pH changes in individual groups revealed that In NS Study Group, the mean baseline pH value was 7.38 ± 0.05 which showed progressive fall during resuscitation(7.34 ± 0.03), immediately post resuscitation(7.34 ± 0.05), 6hrs post resuscitation(7.30 ± 0.04) and 12 hrs post resuscitation(7.29 ± 0.04) to a minimum value of 7.28 ± 0.04 at the 24 Hours Post-Resuscitation timepoint. This change was statistically significant ($p = < 0.001$).

Comparison of three groups, Normal Saline group vs Plasmalyte group, Normal saline group vs Ringer Lactate group and Ringer lactate vs Plasmalyte showed progressive fall in pH value in Normal saline group compare to Plasmalyte ($p < 0.001$) and Ringer lactate group($p < 0.001$). These findings reveal that among three fluids i.e NS, RL and Plasmalyte, NS showed a higher and progressive fall in the pH values may be due to high chloride content and lack of buffer . The high chloride content in plasma causes intracellular shift of bicarbonate which result in Metabolic acidosis [12].

A study conducted comparing the serum osmolality, serum sodium, blood glucose, pH in 20 adult volunteers by infusing fluid at a rate of 50 ml/kg over one hour and biochemical analysis were done one hour prior to infusion (T1), immediately after infusion (T2), one hour after infusion (T3) using RL and normal saline. Participants in RL group showed statistically significant decrease in serum osmolality at T2 which returned to normal at T3 and participants receiving normal saline had a significant decrease in pH at T2 and it remained same in T3. They also revealed that the decrease in the serum osmolality and return to normal with RL group is due to ADH. With the large infusion with RL, serum osmolality decreases which is sensed by the osmoreceptors in hypothalamus and inhibits ADH release hence diuresis occurs and osmolality returns to normal. They also elucidated that acidemia with normal saline was due to hyperchloremia and it is explained by Stewart's approach [4].

An observational study conducted in 31920 patients undergoing abdominal surgery by comparing postoperative complications in hospital mortality and resource utilization after abdominal surgery by using normal saline or plasmalyte for fluid therapy on the day of surgery showed patients who received plasmalyte had lower rate of in hospital mortality ($p < 0.001$)and major complications including renal failure requiring dialysis($p < 0.001$), post operative infection ($p < 0.006$), blood transfusion ($p < 0.001$), electrolyte disturbance ($p < 0.046$) acidosis investigations (p < o.001) and intervention compared to the patients who received normal saline.

The above two studies results were in agreement with our study results in which the patients receiving Normal saline infusion showing statistically significant fall in pH compare to Ringer lactate and Plasmalyte group.

Base excess

Comparison of three groups, Normal Saline group vs Plasmalyte group, Normal saline group vs Ringer Lactate group and Ringer lactate vs Plasmalyte showed progressive and a greater fall in basal excess value in Normal saline group in comparison to Plasmalyte ($p < 0.001$) and Ringer lactate group($p < 0.001$). The reason behind the decrease in base excess is Normal saline group is due to hyperchloremic acidosis and the reason behind increase in base excess in plasmalyte group is due to presence of physiological buffer like acetate and gluconat [12]. A study conducted comparing hemodynamic and biochemical markers in 46 evaluable subjects with penetrating injuries, Injury severity score 23 ± 16, Systolic blood pressure < 90 and operation within 60 mins using Normal saline and Plasmalyte A for initial resuscitation concluded that mean improvement in basal excess from 0 to 24hrs was significantly greater with Plasmalyte A than saline difference 3.1 and serum chloride was lower with Plasmalyte A than with Normal saline.

Another study conducted and was a randomized control trial in 18 trauma patients comparing pH, basal excess and electrolyte abnormalities receiving normal saline or plasmalyte for fluid resuscitation showed more acidemia (mean pH = 7.31) and basal excess was - 5.3mmol/L in normal saline group at 6hrs post resuscitation compared to plasmalyte group (mean pH -7.39) and basal excess was 0.6 in plasmalyte group at 6hrs post resuscitation. There was significant increase in chloride level in normal saline group (serum chloride -113 mEq/L) compared to plasmalyte group (serum chloride 105 mEq/L) at 6hr of post resuscitation.

The above two studies results echoed findings of our study results. The patients who received Normal saline showed statistically significant fall in basal excess compared to Ringer lactate and Plasmalyte group. Plasmalyte group showed significant rise in basal excess compare to Ringer lactate revealing greater buffering potential.

Serum bicarbonate

Comparison of three groups, Normal Saline group vs Plasmalyte group, Normal saline group vs Ringer Lactate group and Ringer lactate vs Plasmalyte showed progressive and significant fall in serum bicarbonate value in Normal saline group compared to Plasmalyte ($p < 0.001$) and Ringer lactate group($p < 0.001$),Statistically significant rise in serum bicarbonate level in Plasmalyte group compared to Ringer lactate group seen in 6 hrs post resuscitation and 12 hrs post resuscitation ($p = 0.005$) serum bicarbonate levels were comparable between the two groups ($p = 0.076$) at 24 hours. As mentioned above the reason of decreased Serum bicarbonate level in Normal saline group is due to hyperchloremia which causes intracellular movement of bicarbonate resulting in a fall in Serum bicarbonate level. The increase in Serum bicarbonate level in Plasmalyte group can be attributed to the presence of physiological buffers like acetate and gluconate which are converted to bicarbonate.

A randomized control trial conducted in 30 patients undergoing major hepatobiliary or pancreatic surgery comparing preoperative and postoperative acid base status of patients receiving either normal saline or plasmalyte intraoperatively for fluid replacement showed increased in serum chloride concentration ($p < 0.01$), decreased serum bicarbonate levels ($p < 0.01$), and an increased base deficit ($p < 0.01$) in intraoperative period in patients receiving normal saline compared to patient receiving plasmalyte [2].

In Study Group: Plasmalyte, the baseline mean S. Bicarbonate (mmol/L) was 21.77 ± 1.09 which showed progressive rise from 12 hrs post resuscitation to a maximum of 22.67 ± 1.02 at the 24 Hours Post-Resuscitation timepoint. This change was statistically significant (p = < 0.001).

Lactate

Comparison of three groups, Normal Saline group vs Plasmalyte group, Normal saline group vs Ringer Lactate group and Ringer lactate vs Plasmalyte showed progressive rise in serum Lactate value in Ringer lactate group compared to Plasmalyte ($p < 0.001$) and Normal saline group($p < 0.001$). Initially rise in lactate level in all three groups shows that they were in hypovolemic shock, after adequate resuscitation, the lactate levels were decreased in all three groups initially but after 6 hrs of resuscitation, lactate levels were continued to decrease in Normal saline and Plasmalyte group but in Ringer lactate group mild rise in seen . The increase in serum lactate level in Ringer lactate group probably due to the presence of lactate (29 mEq/L) in the fluid leading to accumulation of lactate where as Plasmalyte and Normal saline do not contain lactate. Thus one can infer that infusion of large amount of RL may be associated with rise in serum lactate levels.

A multicenter randomized double blind control study conducted in 60 patients undergoing major hepatic resection comparing effect of plasmalyte and Hartman's solution on biochemical parameters that is basal excess in immediate post operative period and changes in blood hematological parameters showed no significant difference in base excess in between the group ($p = 0.17$) in immediate postoperative period, In postoperative period, it is seen that the patient receiving Hartmann's solution had more hyperchloremia ($p = 0.01$) and hyperlactatemia ($p = 0.02$) compare to patients receiving plasmalyte. It was also seen that the patients receiving plasmalyte had more serum magnesium levels ($p < 0.001$) and lower ionized calcium levels ($p < 0.001$) compared to patients receiving Hartmann's solution. There were no significant differences in pH, bicarbonate, albumin and phosphate levels. PT and aPTT levels were significantly lower in the patients who received plasmalyte. A randomized controlled study conducted in 104 patients undergoing hepatectomy for liver transplant by comparing lactate and liver function test after receiving fluids which contains lactate like Hartman solutions or non-lactate containing solutions like plasmalyte showed the patients who received plasmalyte had lower lactate levels ($p = 0.005$), lower bilirubin concentrations ($p < 0.001$), shorter prothrombin time ($p = 0.009$), and higher albumin levels compared to the Hartman's solution in immediate post operative period and there was no significant difference of albumin, bilirubin levels or prothrombin time on post operative day 5 in between the groups. There were also no significant difference of complications or hospital stay in between the groups [13].

Our study showed similar findings as the above two studies results. The patients receiving Ringer lactate showing statistically significant rise in serum lactate levels compared to Normal saline and Plasmalyte group.

Serum sodium

Comparison of three groups, Normal Saline group vs Plasmalyte group, Normal saline group vs Ringer Lactate group and Ringer lactate vs Plasmalyte showed progressive rise in serum Sodium value in normal saline group compare to Plasmalyte ($p < 0.001$) and Ringer lactate group ($p < 0.001$).It was also seen that there was mild fall in Serum Sodium levels in Ringer lactate group compared to plasmalyte group ($p = 0.001$) . The increase in serum Sodium level in Normal saline group probably due to high sodium content in the fluid whereas Ringer lactate group showed mild fall in the serum Sodium level is due to low Sodium content in the fluid.

A study conducted Comparing Plasmalyte VS 0.9% Normal saline for intra operative fluid replacement in abdominal surgeries and its effect on arterial pH, Serum bicarbonate,base deficit, serum electrolytes, 24 hrs urine output and length of hospital stay after surgery was performed in 60 patients who belongs to ASA 1 and 2 of either sex, between age group 20 to 65 years of age . they received either intravenous Plasmalyte or 0.9 %Normal saline during surgery at rate 15 ml/kg/hr. Arterial blood gas and serum electrolytes were measured preoperatively, immediate postoperatively,24 hrs after the surgery. They found that there was a decrease in pH in the NS group ($p < 0.001$). They concluded that Plasmalyte maintained a better acid base, electrolyte profile in the immediate postoperative period [14].

Another double blinded randomized control study conducted comparing biochemical parameters in 66 patients undergoing abdominal aortic aneurysm surgery receiving either Normal saline or Ringer lactate showed rise in serum sodium, chloride levels and decrease in pH seen in patients receiving Normal saline compare patient receiving Ringer lactate [15].

The above studies results were same as our study results. The patients infused with Normal saline showing statistically significant rise in serum Sodium level compare to ringer lactate and Plasmalyte group. Therefore, infusion of Normal Saline in large amount is associated with risk of hypernatremia.

Serum potassium

(NS 3.63 ± 0.40,RL = 3.75 ± 0.41,PLA = 3.73 ± 0.28) to 6 hrs post resuscitation (NS = 3.64 ± 0.32, RL = 3.75 ± 0.33, PLA = 3.76 ± 0.33) then serum Potassium values are comparable between the two groups in 12 hrs post resuscitation (NS = 3.66 ± 0.34,RL = 3.75 ± 0.34,PLA = 3.72 ± 0.30) and 24 hrs post resuscitation (NS = 3.71 ± 0.33, RL = 3.76 ± 0.38, PLA = 3.77 ± 0.32) ($p = 0.103$). This is due to slight rise in Serum Potassium levels in Normal saline group which is due to metabolic acidosis which cause shift of potassium from intracellular space to extracellular space.

A prospective randomized control study conducted in 150 patients of end stage renal disease undergoing cadaveric renal transplantation comparing incidence of hyperkalemia and metabolic acidosis and kidney function receiving normal saline or chloride restricted acetate buffered crystalloids showed the incidence of hyperkalemia differed by less than 17 percentage between groups ($p = 0.56$),incidence of metabolic acidosis and hyperchloremia was less in the patients receiving the buffered acetate containing crystalloids compare to normal saline ($p < 0.001$) and significantly more patients in the normal saline group required administration of catecholamines for circulatory support ($p = 0.03$) [16]. The above study showed same results as our study.

Serum chloride

Comparison of three groups, Normal Saline group vs Plasmalyte group, Normal saline group vs Ringer Lactate group and Ringer lactate vs Plasmalyte showed Statistically significant rise in serum Chloride levels seen in Normal saline group compared to Plasmalyte group ($p < 0.001$) and Normal saline group ($p < 0.001$) throughout the study and mild fall in serum chloride seen in the Ringer lactate group compared to Plasmalyte group throughout the study ($p = 0.022$). The increase in serum chloride level in Normal saline group probably due to high chloride content in the fluid whereas Ringer lactate group showed mild fall in the serum chloride level is due to low chloride content in the fluid.

A blinded randomized control trial conducted in 60 patients undergoing living donor kidney transplantation comparing acid base balance measured by stewart and basal excess methods after receiving either plasmalyte or normal saline showed significant lower values of pH, basal excess, and effective strong ion difference in the post reperfusion periods in the normal saline group ($p < 0.05$) compare to plasmalyte, hyperchloremic metabolic acidosis seen in the normal saline group ($p < 0.05$) and no difference between the groups in early postoperative graft function ($p = 0.3$) [17].

A retrospective study comparing comparing plasma biochemistry, hemodynamic and glycemic control in 23 diabetic ketoacidosis patients admitted in intensive care units by using plasmalyte or normal saline for fluid resuscitation over the first 12hrs in this patient showed the patients who resuscitated with plasmalyte showed less chloremia and a more rapid recovery in metabolic acidosis than who received normal saline ($p < 0.05$),and it also observed that the patients resuscitated with plasmalyte showed improved hemodynamic parameters including mean arterial pressure at 2-4 hrs. and cumulative urine output at 4-6 hrs. compared to normal saline group ($p < 0.05$), and no difference in glycemic control or length of stay in icu [18].

The above two studies results were similar as our study results. The patients receiving Normal saline showing statistically significant rise in serum chloride level compared to ringer lactate and Plasmalyte group.

Biochemical parameters

Serum urea levels

Comparison of three groups, Normal Saline group vs Plasmalyte group, Normal saline group vs Ringer Lactate group and Ringer lactate vs Plasmalyte, revealed that the mean Serum Urea were within normal limits and comparable in all the three groups during all times till the end of study.

A double blind, cluster randomized double crossover trial conducted in 2278 patients admitted in 4 intensive care units, the primary aim of study was to determine the effects of Plasmalyte compared to normal saline on renal complication (acute kidney injury) showed no difference in the incidence of acute kidney injury($p = 0.77$) and no difference in mortality ($p = 0.40$) [19].

Even through there are no studies available comparing serum urea levels following resuscitation with various crystalloids but serum urea is the direct indicator of a renal function hence we can say that above study results were same as ours.

Serum creatinine

Comparison of three groups, Normal Saline group vs Plasmalyte group, Normal saline group vs Ringer Lactate group and Ringer lactate vs Plasmalyte showed Serum Creatinine levels were comparable between three groups up to 6 hours of post resuscitation (NS = 0.65 ± 0.11,RL = 0.66 ± 0.10.PL = 0.64 ± 0.06) but the serum creatinine levels showed decrease in serum creatinine levels in Plasmalyte group as compared to Normal saline and Ringer lactate till the end of study period. (NS-p = 0.68 ± 0.12, RL-p = 0.66 ± 0.10, PL-p = 0.60 ± 0.05) respectively.

A study conducted in 1533 patients admitted in intensive care units comparing acute kidney injury incidence in critically ill patients after administration of chloride restrictive fluids (plasmalyte and Ringer lactate) or high chloride containing fluids like normal saline showed the incidence of acute kidney injury was more with critically ill patients who received normal saline compared to critically ill patients who received chloride restrictive fluids like plasmalyte and ringer lactate. But there was no difference in hospital mortality, hospital stay or ICU length of stay between the groups [20].

A randomized control double blind cross over study conducted comparing renal blood flow velocity and renal cortical tissue perfusion in 12 healthy volunteers after receiving two-liter infusion of normal saline or plasmalyte, showed, decrease in mean renal artery flow velocity, renal cortical tissue perfusion, hyperchloremic and metabolic acidosis in volunteers receiving normal Saline, this above finding not seen in plasmalyte group [21]. There are paucity in literature about comparing serum creatinine levels following resuscitation with various crystalloids. It is safe to presume that fluid resuscitation in general improves perfusion of kidney and results in adequate urine output.

Trauma is associated with high morbidity and mortality and it is one of the common causes of death in young patients.1 Among the injured patients, the major cause of morbidity and mortality in trauma patients is due to complications like uncontrolled hemorrhage which results in imbalance between systemic oxygen delivery and oxygen consumption [1,2]. Blood loss also leads to hemodynamic instability, coagulopathy, decreased tissue perfusion and cellular hypoxia. Hence Intravenous fluids are the most essential part of early resuscitation in the management of trauma patients as they increase intravascular volume, increase cardiac output and enhances organ perfusion in patients with hypovolemia. They also provide adequate oxygen perfusion and oxygen delivery to the tissue compromised by the physiological consequence of trauma. This Prospective Randomized Interventional comparative study comparing Normal saline, Ringer lactate and Plasmalyte in 150 adult trauma patients of either gender admitted in emergency room in order to find out type of fluid used for fluid resuscitation, has any impact on acid -base balance, blood lactate level, biochemical parameters like blood urea, serum creatinine, serum electrolytes and hemodynamical parameters like Heart rate, spo2 and Revised trauma score.

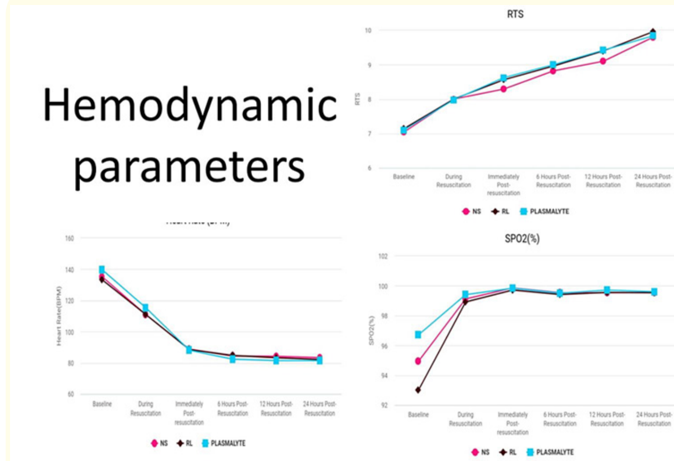

Figure 1: Hemodynamic Parameters.

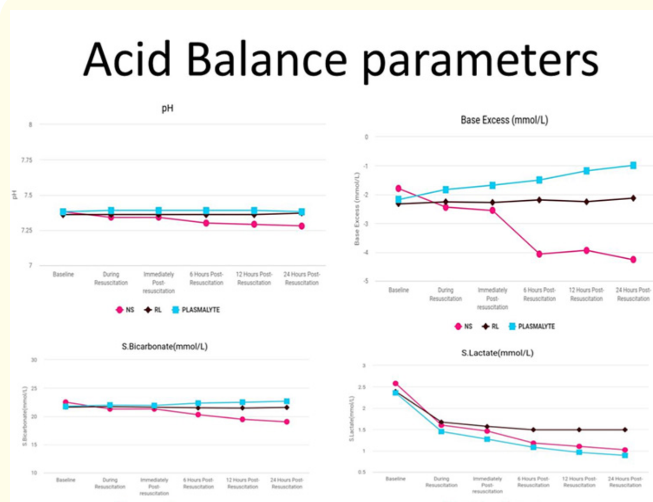

Figure 2: Acid base parameters.

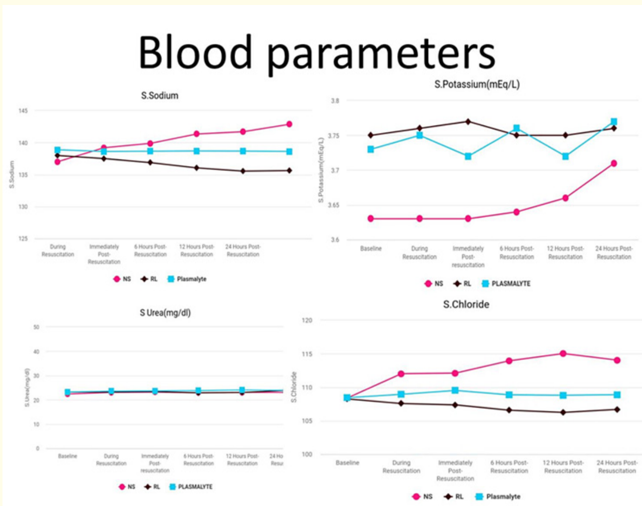

Figure 3: Blood parameters

Conclusions

The trauma patients resuscitated with Plasmalyte was found to have stable and normal acid base status, biochemical parameters and serum electrolyte levels. The trauma patients resuscitated with Ringer lactate was found to have hyperlactatemia and mild fall in serum sodium levels. The trauma patients resuscitated with Normal saline had hyperchloremic metabolic acidosis, fall in Basal excess and increased serum Sodium level.

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