Recommendation of an ideal mixed fluid preparation to be used as partial parenteral nutrition in surgical Neonatal Intensive Care Unit

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ABSTRACT

Background: This study was conducted to assess the role of Partial Parenteral Nutrition (PPN) and a specially prepared “mixed fluid formula” used as PPN in sick surgical neonates.

Methods: This single institution based Randomised Control Trial was performed in Surgical NICU of a tertiary care Centre. Surgical neonates who required bowel rest for >3 days like Esophageal Atresia (22), Duodenal Atresia (38), Jejuno-ileal Atresia (50), Necrotising Enterocolitis (29) and others (11), were chosen. As a CONTROL population half (75) neonates were allowed maintenance fluid only (Isolyte P) and rest (75) were given a combination of maintenance fluid (Isolyte P) and PPN (specially prepared mixed fluid). This mixed fluid each 100 ml was prepared with 65ml Isolyte P, 15 ml 25% Dextrose, 10 ml Normal Saline, 7 ml Astymin 3, 2 ml Multivitamin and 1 ml Injection KCl. Fluid was continued till enteral feeding was established.

Results: Neonates according to their body weight were divided in three groups <1 kg (50), 1-2.5 kg (71) and >2.5 kg (29) and their post-operative outcome was assessed as Clinical Positive/Negative and Laboratory Positive/Negative. Results were separately assessed in 3 body weight groups under “Control” and “Study” which showed both Clinical and Biochemical improvement in “Study group”.

Conclusions: The composition of mixed fluid, its nutritional value, calorie supplementation, compatible osmolarity for peripheral venous administration and most importantly its easy and cost-effective preparation were assessed thoroughly and we recommend this “mixed fluid” preparation as a very useful PPN for sick surgical neonates.

Keywords: Calorie requirement, Osmolarity, Partial parenteral nutrition, Post-operative IV fluid, Surgical neonate

INTRODUCTION

Sick surgical neonates and neonates with medical co-morbidities and Low Birth weight are very delicate and require intensive care and observation. Surgical outcome in Neonates and infants depend on various factors - preoperative (hydration, nutrition); operative (skill, suture materials etc.) and post-operative (fluid and electrolyte balance, antibiotics and infection control and nutrition).

Among these, it has been observed since last decade, importance is given on Nutrition and fluid electrolyte balance. Early initiation of Enteral feeding (EN) begets better result but in some Gastro Intestinal surgeries prolong intestinal rest is needed thus requires Parenteral Nutritional (PN) support.

Normal neonatal physiology is different from adults. All babies are born with an excess of Total Body Water (TBW), mainly Extra Cellular Fluid (ECF). Adults have 60% water (20% ECF, 40% ICF) whereas Term neonates have 75% water (40% ECF, 35% ICF) and Preterm neonates have more water (23 weeks: 90% ;60% ECF, 30% ICF). High water content provides a large volume
of distribution for water soluble medications which has great anaesthetic and post-operative implication.\textsuperscript{8}

After birth, there is efflux of fluid from ICF to ECF - these floods the neonatal kidneys eventually resulting in a salt and water diuresis by 48-72 hours which is commonly known as Physiological weight loss in newborn. But the neuroendocrine stress response due to surgery or medical illness results in substantially increased secretion of anti-diuretic hormone (ADH) that will result in retention of free water. A physiologically more appropriate approach during these circumstances is to use a solution with a 'close to physiological' concentration of sodium (120-140 mmol/litre) combined with the administration of a reduced infusion volume compared with the normal situation (50-70% of normal infusion rate).\textsuperscript{9,10}

Sick newborns premature and under-weights (LBW, VLBW) usually have increased caloric and protein requirements. Along with-it sick neonates after surgery lack glycogen stores. So, hypoglycemia is more commonly encountered. It causes brain damage. Again, hyperglycemia causes Osmotic diuresis resulting in dehydration and electrolyte imbalance. So, the optimum concentration of Dextrose in maintenance fluid is very important.\textsuperscript{11-13}

The common and prime composition of an ideal PN includes Protein, Carbohydrate, Fat, Vitamin, Minerals and Electrolytes which should fulfill caloric requirement and osmolarity for peripheral administration.\textsuperscript{11-18} Keeping all these in mind and for the nutritional supplementation of Sick neonates we are using a mixed preparation of “fluid formula” for this sick newborn and sick surgical neonates, LBW, VLBW who need a long term (>3 days) parenteral therapy in the Neonatal surgery unit.

Authors commonly use this preparation for patients where oro -enteral nutrition is contraindicated for >3 days and where intestine needs rest for prolonged period thus require long term parenteral nutrition. They are

- Esophageal Atresia (and/or Tracheo Esophageal Fistula),
- Duodenal Atresia,
- Jejuno Ileal atresia,
- Necrotising Enterocolitis (and/or perforation)
- Meconium ileus with jejunostomy or ileostomy,
- Short bowel syndrome due to resection of long length of bowel (Volvulus, Gangrene),
- Other upper gastro intestinal surgeries requiring long term parenteral therapy.

METHODS

Study population was conducted in the Surgical NICU (Neonatal Intensive Care Unit) of Paediatric Surgery Department in a Tertiary Care Hospital during January 2018 to February 2020.

Total 150 sick neonates were included in the study. 75 were under “STUDY” group and 75 under “CONTROL” group. A Randomised Control Study was conducted with randomisation of patient selection among all Surgical Sick Neonate. Out of that 150 patients 29 weighted >2.5 kg, 50 patients <1kg and rest (79) 1-2.5kg.

**Administered fluid amount**

Administered fluid amount varies according to body weight (Table 1).

**Table 1: Fluid requirements for sick neonates**\textsuperscript{13}

| Days | <1 kg | 1-2.5 kg | >2.5 kg |
|------|-------|----------|---------|
| 1    | 100*  | 80       | 60      |
| 2    | 120   | 100      | 80      |
| 3    | 140   | 120      | 100     |
| 4 and onward | 150 | 140 | 120-150 |

*fluid requirement in ml/kg/day

**Administered type of fluid**

In this Randomised control study we randomly selected patients for two groups (Table 2).

**Table 2: Administered type of fluid.**

| Study group | Control group |
|-------------|---------------|
| 50% Maintenance fluid (Isolyte P) + 50% PPN (Mixed Fluid) | Maintenance fluid only (Isolyte P) |

Maintenance fluid was used Isolyte-P and PPN was mixed fluid preparation

**PPN composition and preparation**

This PPN preparation contains 6 components in 100 ml fluid

- Isolyte P 65 ml
- Normal Saline 10 ml
- 25% Dextrose 15 ml
- Astymin 3 7 ml
- Multivitamine 2 ml
- Injectin KCl 1 ml

This PPN “mixed fluid” is prepared in NICU with maintaining complete asepsis. Authors have taken all precaution to avoid bacterial contamination during preparation of mixed fluid.

**Inclusion criteria**

Authors used this preparation for patients who require long term (>3days) Parenteral Nutrition (PN) for intestinal rest. For the purpose of study, they were broadly divided in 5 groups.
Esophageal Atresia and TEF (EA)
Duodenal Atresia (DA)
Jejuno ileal atresia (JIA)
Necrotising Enterocolitis (NEC) and/or perforation
Others

Meconium ileus with jejunostomy or ileostomy,
Short bowel syndrome due to resection of long length of bowel (Volvulus, Gangrene),
Other upper gastrointestinal surgeries requiring long term parenteral therapy.

Exclusion criteria

- Other congenital abdominal wall defects like Gastroschisis etc were not included in the study.
- Few neonates required Total Parenteral Nutrition (TPN) where enteral feeding was not possible due to very high output Stoma.
- Neonate whose parents were not willing to undergo study were also excluded.

Duration of fluid therapy

After starting PPN monitoring was done on Clinical, Biochemical, Hematological and sepsis screening criteria till initiation and establishment of full enteral feeding. The amount of fluid was decreased gradually with increase of oral/enteral feeding.

Outcome assessment

For the purpose of Study and its outcome we focused both on Subjective and Objective responses. Assessment for “POSITIVE” and “NEGATIVE” response was calculated based on few criteria. They were

Clinical (5)

- SEPSIS
- General Condition (Cry/Reflex/Activity)
- Weight Gain
- Bowel movement (IPS/NG tube suction/Stool)
- Wound status (dehiscence/anastomosis)

Laboratory (5)

- Sepsis screen
- Hemoglobin
- Electrolytes
- Blood glucose
- LFT (Albumin, Total protein) and pre-albumin

Assessment of outcome was graded as

- “Clinical positive” (CP) if No Sepsis with any other 2 clinical improvement
- “Clinical negative” (CN) if Sepsis with any other 2 clinical deterioration
- “laboratory positive” (LP) if Sepsis screen negative with any 2 normal laboratory value
- “laboratory negative” (LN) if Sepsis screen positive with any 2 abnormal laboratory value

RESULTS

In this Study authors used Intravenous Fluid as postoperative parental nutrition in total 150 patients. 75 of them were in Control Group who received maintenance fluid only and other 75 were in Study group who received additional “Mixed Fluid” as Parenteral Nutrition. Patients of both the groups were chosen randomly.

Among these 150 patients, babies with body weight of <1, 1-2.5 and > 2.5 kg are 24, 36 and 15 in Study group and 26, 35 and 14 in Control group respectively.

Average duration of fluid therapy in Control group is 5.6 days (minimum 4 days and maximum 10 days) where as in Study group 4.9 days (minimum 4 days and maximum 9 days).

Clinical response

Authors monitored the clinical response in all 150 patients and for statistical calculation we categorised them into “Clinical Positive” and “Clinical Negative” according to 5 criteria.

Sepsis

In postoperative period during fluid therapy total 37 patients had features of Septicaemia which were treated conservatively according to blood culture sensitivity report. 23 were under “Control group” and 14 under “Study group”. Despite common belief of increased chance of infection in “Mixed fluid” our study shows a marked difference in outcome probably due to over cautious preparation of fluid in NICU under strict asepsis control. Authors also emphasised our outcome assessment of both clinical and laboratory parameters based in “Sepsis” and “Sepsis screening” negativity.

General condition

General condition of neonate in terms of Cry, Reflex and Activity there were no difference in both groups. In Study and Control Group it is 36 and 32 respectively.

Weight gain

Weight gain during fluid therapy in “Study group” is significantly high (37) compared to “Control group” (19).

Though in majority of cases actual weight gain could not be assessed, in measurable cases average weight gain was noted 15-20 gm/day.
It is also a well-known fact that in postoperative period weight gain depends on different factors like Birth weight, prematurity, other co-morbidities, loss of fluid in Stoma and other third space loss etc.

**Bowel movement**

Bowel movement was established in almost all post-operative patients except 4 who had post-operative paralytic ileus and was treated conservatively (correction of electrolytes) and most importantly all were under “Control group”. Study group had no electrolyte abnormality causing paralytic ileus.

**Anaestomotic leak**

Anaestomotic leak was seen in 6 patients - 5 in “Control group” and 1 in “Study group”. All were treated conservatively. Wound dehiscence was seen in 14 patients among them study group had only 3.

According to above 5 criteria and for the purpose of statistical analysis we marked “Clinical Positive” to a neonate without Sepsis with any 2 positive clinical criteria and “Clinical Negative” to a baby with Sepsis with any 2 negative clinical criteria.

In this study we found “Clinical Positive” 61 and 37 in “Study” and “Control” group respectively.

**Laboratory response**

Laboratory values were again assessed and divided into “Laboratory Positive” and “Laboratory Negative” based on 5 criteria. In our study “Laboratory Positive” and “Laboratory Negative” outcome seen in Study group 61 and 14 respectively.

**Sepsis**

Sepsis screen was positive in 27 patients in “Control group” and 14 in “Study group”.

**Haemoglobin**

Haemoglobin level was normal in most of the patients. Only 8 had anaemia- 4 in each “Study” and “Control group”.

**Electrolyte and serum calcium**

Electrolyte and Serum Calcium abnormality was found in 20 patients of “Control group” and much less in “Study group” (only 4).

**Hypoglycemia**

Hypoglycemia was seen in 21 neonates with Maintenance fluid and only 6 in neonates having “Mixed Fluid”.

**Liver function test (LFT) and albumin**

Liver Function Test (LFT) and Albumin was normal in most of “Study Group” neonates. Only 3 had abnormality compared to 10 in “Control group”.

In 75 “Control Group” neonates Esophageal Atresia (EA) was 10, Duodenal Atresia (DA) 20, Jejuno Ileal Atresia (JIA) 25, Necrotising Enterocolitis (NEC) 15 and Other 5 (Table 3).

### Table 3: Control group.

| Disease | Response | Clinical | Biochemical |
|---------|----------|----------|-------------|
|         | <1kg     | 1-2.5kg  | >2.5kg      | <1kg     | 1-2.5kg  | >2.5kg |
| DA (20) | Positive | 2        | 5           | 3        | 2        | 5      | 3 |
|         | Negative | 3        | 5           | 2        | 3        | 5      | 2 |
|         | Total    | 5        | 10          | 5        | 5        | 10     | 5 |
| EA (10) | Positive | 1        | 2           | 1        | 1        | 2      | 1 |
|         | Negative | 3        | 2           | 1        | 3        | 2      | 1 |
|         | Total    | 4        | 4           | 2        | 4        | 4      | 2 |
| JIA (25) | Positive | 4        | 6           | 3        | 3        | 6      | 3 |
|         | Negative | 6        | 5           | 1        | 7        | 5      | 1 |
|         | Total    | 10       | 11          | 4        | 10       | 11     | 4 |
| NEC (15) | Positive | 2        | 4           | 1        | 2        | 5      | 1 |
|         | Negative | 3        | 4           | 1        | 3        | 3      | 1 |
|         | Total    | 5        | 8           | 2        | 5        | 8      | 2 |
| Others (5) | Positive | 1        | 1           | 1        | 1        | 1      | 1 |
|          | Negative | 1        | 1           | 0        | 1        | 1      | 0 |
|          | Total    | 2        | 2           | 1        | 2        | 2      | 1 |
Table 4: Study group.

| Disease | Response | Clinical | Biochemical |
|---------|----------|----------|-------------|
|         |          | <1kg     | 1-2.5kg     | >2.5kg       | <1kg  | 1-2.5kg | >2.5kg |
| DA (18) | Positive | 3        | 8           | 5            | 3     | 8       | 5      |
|         | Negative | 1        | 1           | 0            | 1     | 1       | 0      |
|         | Total    | 4        | 9           | 5            | 4     | 9       | 5      |
| EA (12) | Positive | 2        | 5           | 2            | 2     | 5       | 2      |
|         | Negative | 2        | 1           | 0            | 2     | 1       | 0      |
|         | Total    | 4        | 6           | 2            | 4     | 6       | 2      |
| JIA (25)| Positive | 6        | 10          | 4            | 6     | 10      | 4      |
|         | Negative | 2        | 2           | 1            | 2     | 2       | 1      |
|         | Total    | 8        | 12          | 5            | 8     | 12      | 5      |
| NEC (14)| Positive | 4        | 6           | 2            | 4     | 6       | 2      |
|         | Negative | 2        | 0           | 0            | 2     | 0       | 0      |
|         | Total    | 6        | 6           | 2            | 6     | 6       | 2      |
| Others (6)| Positive | 1       | 2           | 1            | 1     | 2       | 1      |
|          | Negative | 1        | 1           | 0            | 1     | 1       | 0      |
|          | Total    | 2        | 3           | 1            | 2     | 3       | 1      |

In 75 “Study Group” neonates Esophageal Atresia (EA) was 12, Duodenal Atresia (DA) 18, Jejuno Ileal Atresia (JIA) 25, Necrotising Enterocolitis (NEC) 14 and Other 6 (Table 4).

Among all EA patients “Clinical positivity” increased in increasing body weight- 50%, 83.3% and 100% in neonates with body weight <1, 1-2.5 and >2.5 kg respectively. In “Control group” the ratio is much lower 25%, 50% and 50% respectively.

For neonates with DA, JIA and NEC the results are again better in “Study Group” and improved with increased body weight as depicted in Table 2 and 3. Even the laboratory outcome is corroborating with the clinical values.

Another important observation is that in Extremely Low Birth Weight (ELBW) babies (BW <1 kg) the outcome improves with the use of “Mixed Fluid”. For LBW babies with EA, DA, JIA and NEC “Clinical Positivity” was 25, 40, 40 and 40% respectively in “Control Group” which found to be 50, 75, 75 and 66.67% in “Study Group”.

DISCUSSION

Parenteral nutrition (TPN or PPN) is the intravenous infusion of all nutrients necessary for metabolic requirements and growth.11

In this Study we used “Mixed Fluid preparation” as PPN in Sick Surgical Neonates who required bowel rest for >3days like neonates with EA, DA, JIA, NEC and other condition with short bowel syndrome.

Earlier introduction and more aggressive advancement of TPN is safe and effective, even in the smallest and most immature infants. Premature infants tolerate PN from day 1 of post-natal life.

Thus, it is important to start PN within the first 24 hours of life in the smaller preterm infants <1000 grams birth weight.12,14-18

In this Study authors categorically monitored the outcome of babies with different body weight groups and noted an improved outcome even in Extremely Low Birth Weight Babies. The results support effectiveness of our PN preparation.

Table 5: Isolyte P composition.

| Isolyte P Composition | Individual amounts |
|-----------------------|--------------------|
| Component             | Amounts            |
| Dextrose anhydrous 5gm| Na⁺ 23meq/l        |
| Sodium Chloride 0.13gm| K⁺ 20meq/l         |
| Sodium Acetate 0.32gm | Mg²⁺ 3meq/l        |
| Di basic potassium phosphate 0.026gm | Cl⁻ 22meq/l |
| Magnesium chloride 0.031gm | Acetate 24meq/l |
| Phosphate             | 3 meq/l            |
| Total cations         | 46                 |
| Total anions          | 43                 |
| Calorie               | 170 Kcal/l         |
| Osmolarity...         | 366mOsm/l          |
| pH                    | 5.0(4.0-6.0)       |
The goal of TPN is to provide sufficient nutrients to prevent negative energy and nitrogen balance and to support normal growth rates without increased significant morbidity.12,14-18

Good clinical outcome as measured by “Clinical positivity” is a reliable indicator of effectiveness of a good Parenteral Nutrition formula (TPN or PPN) and in “Study group” it is higher.

**Table 6: Astymin 3 composition.**

| Composition of astymin 321 |  |
|---------------------------|---|
| Essential amino acid      | 13.84 gm |
| Total nitrogen content    | 2.62 gm |
| Protein content (high biologic value) | 16.38 gm |
| Total amino acid          | 18.24 gm |
| Energy content            | 105 Calorie. |
| Osmolarity                 | 1000 mOsmol/L |

This preparation 100 ml TPN contain:

- Isolyte-P 65ml
- 25%dextrose 15ml
- Normal saline (0.9%) 10ml
- Astymine-3 7ml
- MVI 2ml
- KCL 1ml

Individual composition of available components like Isolyte P (Table 5), Astymin 3 (Table 6), Multivitamine Injection (Paediatric) (Table 7), 25% Dextrose Solution (Table 8), Normal saline (0.9%) (Table 9), Injection KCL (Table 10) are discussed and total calorie value of the Mixed fluid is calculated (Table 11).

**Table 7: Multivitamine injection (paediatric) composition.**

| Multivitamine injection (paediatric) composition22 |  |
|---------------------------------------------------|---|
| Fat soluble vitamins*:                             | Water soluble vitamins**: |
| Vitamin A  2300 USP units                         | Riboflavin       1.4 mg |
| Vitamin D  400 USP units                          | Thiamine         1.2 mg |
| Vitamin E 7 mg equals 7 USP units                 | Vitamin B6       1.0 mg |
| *with 30% Propylene glycol and 2% Gentisic acid ethanalamide as stabilizers and preservatives Sodium hydroxide for pH adjustment; 1.6% Polysorbate 80; 0.028% polysorbate 20; 0.0002% butylated hydroxyl toluene; 0.0005% butylated hydroxyanisone |  |
| Vitamin C                                         | 80 mg |
| Vitamin B12                                       | 1 mg |
| Folic acid                                        | 140 mcg |
| Dexampanthenol                                    | 5.0 mg |
| Nicin                                             | 17 mg |
| Biotin                                            | 20 mcg |
| **Fat soluble vitamins are water stabilised with Polysorbate 80. |  |

Vitamin K - 200 mcg (Not included in the solution, separately given through injection).

**Table 8: 25% Dextrose solution composition.**

| 25% Dextrose solution composition23 |  |
|------------------------------------|---|
| 1 ml solution contain              | 250 mg Dextrose |
| Each ml solution gives energy      | 0.85 Kcal (@3.4 Kcal/gm) |
| Osmolarity                         | 1390 mOsmol/L |
| pH                                 | 4.5 (3.2 - 6.5) |

The essential components of parental nutrition are - Fluid, Carbohydrate, Amino Acid, Lipids, Electrolytes, Vitamins and Trace minerals and the Goal is to provide adequate energy (calorie).14-18

This fluid composition (PPN) yields 30 Kcal energy per 100 ml mixed fluid which is lower than the recommended TPN calorie value of 90-110 Kcal/kg/day. Low calorie yielded from this PPN formula is as per requirement for short Pre- and post-operative period till oral feed is resumed to tide over the crisis period.14-18

To avoid Re-feeding syndrome which is fatal in sick babies, we prefer to offer them low Calorie and Low Amino acid Formula.15,17

Though Lipids prevent essential fatty acid deficiency, provide energy substrates and improve delivery of fat-soluble vitamins, it is noted that LBW infants may have immature mechanisms for fat metabolism. Also, some conditions inhibit lipid clearance e.g. infection, stress, malnutrition. Moreover, Lipid component increases fluid osmolality which is unfavourable for a peripheral intravenous line. Lastly this lipid emulsion is a good...
culture medium for bacterial overgrowth causing septicaemia.

Lastly, neonatal requirement of essential fatty acid is low (0.5-1mg/kg/day) so lipid component is excluded in this study.14,18 The recommended values of Carbohydrate, Amino acid, Electrolytes, Minerals and Vitamin are close to the composition’s individual values as well as a complete fluid with adequate adjustment of osmolarity.

Authors can compare daily requirement of nutrients for Surgical Neonate and amount supplied by the “Mixed fluid” preparation as Partial Parenteral Nutrition (PPN) from Table 13.

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Table 11: Calorie calculation of mixed fluid.20-25

| Component     | Amount (ml) | Osmolarity (mOsmol/L) |
|---------------|-------------|-----------------------|
| Isolyte P     | 65          | 3.25                  |
| Normal saline (0.9%) | 10    | 1.54                  |
| 25% Dextrose  | 15          | 3.75                  |
| Astymin 3**   | 7           | 0.9                   |
| 10% KCL       | 1           | -                     |
| Multivitamine injection | 2    | -                     |
| Injection KCL | 1           | -                     |
| Total         | 100         | 7.0                   |

The major benefit of this fluid is that the preparation is very easy and cost-effective in comparison to commercially available TPN.

In Indian scenario this preparation may be useful keeping in mind its cost benefit ratio. Though the preparation of mixed fluid within the Ward atmosphere without laminar flow carries the risk of infection we have taken all precaution to avoid bacterial contamination during preparation of mixed fluid.

Authors have formulated the composition in 100 ml solution so that it can be easily calculated by multiplication or fraction of fluid requirement (60-100ml/kg/day). This study clearly showed the difference in outcome (clinical and laboratory) in sick surgical neonate which is better in Study group compared to Control group as explained earlier. Authors deviate in the amount of the different composition of mixture in specific situations like very low birth weight baby and other abdominal wall defects like Gastroschisis (excluded in this study). Further study with this “mixed fluid” preparation is required for comparison of outcome with commercially available TPN and also its role in other congenital anterior abdominal wall defects like Gastroschisis etc. Again, emphasising on its best part that it can be easily prepared in the NICU, we recommend this fluid for the sick surgical neonat.

Table 12: Osmolarity calculation.20-25

| Component                      | Amount (ml) | Osmolarity (mOsmol/L) |
|-------------------------------|-------------|-----------------------|
| Isolyte P                     | 65          | 3.25                  |
| Normal saline (0.9%)          | 10          | 1.54                  |
| 25% Dextrose                  | 15          | 3.75                  |
| Astymin 3**                   | 7           | 0.9                   |
| 10% KCL                       | 1           | -                     |
| Multivitamine injection       | 2           | -                     |
| Injection KCL                 | 1           | -                     |
| Total                         | 100         | 7.0                   |

Table 13: Daily requirement of components and comparison with our PPN.14-18

| Component     | Normal Daily Requirement | Amount present in PPN | Remarks                     |
|---------------|--------------------------|-----------------------|-----------------------------|
| Carbohydrate  | 1.5-20 gm (Rate of infusion 1-2 mg/kg/min to 15 mg/kg/min) | 7 gm (energy 3.4 Kcal/gm) | Adequate                    |
| Amino acid    | 0.5-1 gm/kg              | 0.9 gm                | Adequate                    |
| Lipid         | 0.5-1 gm/kg              | Nil                   | Osmolarity is maintained for peripheral vein administration |
| Sodium        | 2-3 meq                  | 3.03 meq              | Adequate                    |
CONCLUSION

Surgical outcome in recent times, especially in sick surgical neonates and very low birth weight babies, depends upon Nutrition both enteral and parenteral. As a part of parenteral nutrition our “mixed fluid” preparation is scientific, easy to prepare, components comprise of recommended daily requirements, supply adequate calorie requirement, osmolarity is compatible for peripheral veins and lastly cost effective. So, authors recommend use of this “mixed fluid” preparation for sick surgical neonates where parenteral nutrition is required.

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