Review Article

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Fluid Therapy in Gastrointestinal Surgeries

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Abstract

Gastrointestinal surgery is a major physiological insult to the body accounting for significant fluid and electrolyte disturbances. Therefore a judicious peri-operative fluid therapy needs to be considered in such cases to overcome the risks associated with organ hypo- or hyperperfusion. By large, two main fluid therapy regimens- liberal and restricted-have been proposed for gastrointestinal surgeries by various study groups, each having merits and demerits of its own. Goal directed therapy (GDT), a new term coined, emphasises on use of fluid therapy only when clearly indicated and also recommends that functional haemodynamic parameters should be assessed to judge fluid responsiveness and avoid unnecessary fluid loading. Several trials such as the Albios, the Cristal and the Cochrane meta-analyses were taken up in varied clinical scenarios as to conclude which of the two, crystalloid or colloid, have shown beneficial effect on the outcome of the patient. Monitoring of the hemodynamic parameters plays a vital role in assuring adequate global perfusion without any inadvertent fluid overload. However a peri-operative fluid plan should be personalised for each case based on patient status, surgical risk, selection of hemodynamic monitoring based upon patient and surgical risk, and anaesthesiologists' needs. The contents of this article is largely taken from websites such as google scholar and pubmed, and related scholarly journals and research articles. Textbooks such as Miller's Anaesthesia, Current Diagnosis and Treatment of Paediatrics (McGraw Hill) and Textbook of Paediatric Surgery (Elsevier Saunders) were also referred to.

Keywords: Gastrointestinal Surgery; Fluid; Liberal; Restricted.

Introduction

G I Surgery is a major physiological insult to the body with significant morbidity and mortality. It leads to serious fluid and electrolyte disturbance accounting for poor outcome and recovery of the patient. Thereby, a judicious peri-operative fluid management plays a vital role in such cases. It not only maintains or restores effective circulating blood volume during the immediate peri-operative period but also ensures adequate organ perfusion while avoiding the risks associated with either organ hypo- or hyperperfusion [1]. However, it has remained a debated topic with large difference in individual and institutional protocols. Currently taught and practiced methods rely upon body weight per unit time and magnitude of surgical trauma.

Why is Fluid Therapy Significant in GI Surgery?

1. To combat the increased sympathetic stimulation leading to tachycardia, vasoconstriction and stress.
2. Hypovolemia during major surgery leads to increased aldosterone secretion which subsequently decreases the post operative requirement of sodium for few hours.

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3. Post operative pain and stress results in increased ADH secretion transiently, leading to decreased urine output and less maintenance fluid requirement in the first few hours.
4. Fluid deficit due to overnight fasting needs to be considered.
5. Pre –existing hypovolemia needs to be corrected prior to onset of surgery.
6. Special consideration is needed in patients with electrolytes and acid-base imbalance.
7. Considerable third space loss occurs during major surgical procedures.

Physiological Basis of Fluid Therapy

It is the first line support to combat the decreased circulatory blood volume following induction of anaesthesia and surgical trauma. Peri operative hypovolemia usually seen in patients posted for GI surgery is largely due to pre-operative fasting, hypertonic bowel preparation, effect of anaesthetic agents, positive pressure ventilation and loss from surgical site. Fluid therapy is aimed to achieve specific hemodynamic goals such as : adequate blood volume, cardiac output, sustained perfusion pressure, adequate oxygen delivery. Fluid infusions directly increase vascular volume, subsequently and usually improve global and regional perfusion and blood pressures if the heart is preload-responsive, and often improve oxygen delivery and tissue oxygenation. However, these changes are profoundly influenced by the cardiac and peripheral vascular status [2].

Liberal Vs Restrictive Fluid Therapy

Fluid management continues to be a daily challenge in anaesthesia practice. The impact of the two intraoperative fluid regimens –RESTRICTIVE AND LIBERAL- on postoperative outcome were studied in various patients undergoing elective gastrointestinal surgeries. In the restrictive group, patients received fluid at the rate of 4ml/kg/hr whereas in the other group, fluid was given at the rate of 10ml/kg/hr. Restrictive fluid therapy improves outcome in GI surgery where titrated and has become the standard of choice. Associated complications are less resulting in decreased hospital stay. Serum albumin and hematocrit is also maintained in the initial postoperative period [3].

Liberal fluid therapy leads to pulmonary, cardiac, gastrointestinal and renal dysfunction due to fluid overload. Current fluid therapy in major surgery causes a weight increase of 3–6kg [4-6].

Intravenous fluid overload during or after surgery has been shown to decrease muscular oxygen tension and delay recovery of gastrointestinal function. Furthermore, postoperative weight gain and intraoperative fluid overload have been associated with poor survival and complications. Fluid overload may cause general edema, impeding tissue healing and cardiopulmonary function.

A different school of thought, however, recommends the liberal fluid administration advocating that it helps in maintaining adequate blood flow to the kidneys thus protecting it from any injury and subsequent shut-down.

In yet another study, epidural anaesthesia with local anaesthetics wss used in gastro-intestinal surgery and liberal fluid was instituted to combat the resulting hypotension. Neither any delay in return of gastrointestinal transit nor any anastomotic leak was seen as per the study [7].

Goal Directed Therapy (GDT)

GDT focuses attention on the type of surgery being performed and the impact of the following outcomes: 1) the type of fluid being administered; 2) the timing of fluid administration; 3) the rate of fluid administration; 4) the total amount of fluid administered; and 5) the best measures to both optimize and individualize perioperative fluid therapy [8]. It emphasises on use of fluid therapy only when clearly indicated and also recommends that functional haemodynamic parameters should be assessed to judge fluid responsiveness and avoid unnecessary fluid loading.

Preoperative Fluid Shifting

Fluid shifting out of the vasculature primarily depends on the body temperature. Below 30°C, a significant decrease of plasma volume, accompanied by a decrease in central venous pressure, and an increase in pulmonary and systemic vascular resistance, and hematocrit is seen [9]. However, between 33°C and 37°C, no significant dependence on body temperature is observed. This causes a deficit of 3-6 litres in the sensible perioperative fluid balance. It causes not only intraoperative but postoperative problems as well. The peak of fluid shifting is maximum at 5 hours after trauma and persists for up to 72 hours, depending on the location of the operation site and the duration of surgery [10].

Perioperative weight gain, being the most reliable marker of fluid storage outside the circulatory space, is strongly related to patient mortality. A gain of less than 10% body weight shows mortality of 10%, whereas the mortality increased to 32% in case of 20% weight gain, and a mortality rate of 100% in case of weight gain of more than 20%.

Composition of Fluid Therapy

Three categories basically constitutes fluid therapy - crystalloids, colloids and blood. Each has unique and characteristic role in fluid therapy.

Crystalloids are electrolyte solutions which are best used to replace extracellular volume losses from perspiration, respiration, and urine output. Although crystalloids increase vascular volume and may improve haemodynamics, the effectiveness is transient and less than colloid solutions. Crystalloids can be classified by their composition and osmolality. *Colloids* are solutions of macromolecular solutes that exert a colloid osmotic pressure across the microvascular tissue barrier and retain fluid in the intravascular bed. Colloids efficiently increase vascular volume, preload, cardiac output, and tissue perfusion in volume responsive patients. Many of the GDT trials that have shown improved outcomes employ the use of iterative infusions (small volume boluses) of colloid [11].

Several trials were taken up in varied clinical scenarios as to conclude which of the two, crystalloid or colloid, have shown beneficial effect on the outcome of the patient. Few of such important trials are as mentioned :

1. Cristal Trial
2. Albios Trial
3. Cochrane Meta –Analyses

Cristal Trial

This trial compared the fluid resuscitation with colloids vs crystalloids on mortality in ICU patients with hypovolemic shock. Results showed no difference in 28 day mortality but 90 days mortality was significantly reduced in patients treated with colloids [12].

Albios Trial

This study compared fluid resuscitation with 20% albumin and crystalloid vs crystalloid alone in patients with sepsis. Results showed higher mean arterial pressure observed for 7 days in the colloid group. However 28 days and 90 days mortality was similar in both the groups [13].

Cochrane Meta-Analyses

It concluded that there is no evidence that resuscitation with colloids instead of crystalloids, reduces the risk of death in patients with trauma, burns or following surgery [14].

Following the trials, certain generalized recommendations were made, such as [15]:

- Crystalloids for routine surgery of short duration.
- GDT containing colloid and balanced salt solutions in major surgery.
- In US, a black box warning for the use of starch solution exists.
- Careful consideration in patient with known renal dysfunction and sepsis prior to administering starch solution.
- Perioperative fluid plan should be developed by each individual department and health system.

Monitoring

Perioperative assessment of changes in blood volume is difficult and requires evaluation of several clinical and physiologic events that accompany major surgery [16]. In patients with normal cardiac rhythm, the parameters which act as a tool to guide fluid therapy are:- systolic blood pressure, pulse pressure, stroke volume, plethysmographic waveform variation (pulse oximetry). An anesthesiologist may also consider assessing global perfusion by measuring base deficit, lactate, and central and mixed venous oxygen saturation to clarify the impact of selected interventions. Other parameters which may be beneficial in avoiding overload are central venous pressure, pulmonary artery pressure and pulmonary capillary wedge pressure. The use of esophageal Doppler monitoring (EDM) has been advocated by many studies and shows association with improved end organ perfusion. However, it use and implication in cases on daily basis remains controversial and has not been recommended [17].

Pre Operative Fluid Plan should be based on-

1. Patient status (health, age, physiology and comorbidities).

2. Surgical risk (procedure, approach and surgical expertise).
3. Selection of hemodynamic monitoring based upon patient and surgical risk, and anaesthesiologists' needs.

It can be broadly discussed under:

1. Preoperative
2. Intra operative
3. Postoperative

Pre Operative Fluid Therapy generally aims at correction of hypovolemia, anaemia and other disorders like electrolyte imbalance. Hypovolemia jeoparadises oxygen transport, increasing the risk of tissue hypoxia and development of organ failure. It is compensated by increase in vascular resistance and heart rate.

The volume used for preoperative optimization is guided as : Mild dehydration = 4% body weight fluid deficit

Moderate dehydration =6-8% body weight

Severe dehydration =10% body weight

Normal saline and ringer's lactate are commonly used. Improvement in blood pressure and urine output, and lack of tachycardia and orthostatic hypotension points towards optimal preoperative resuscitation.

Correction of anaemia preoperatively is important to establish hemodynamic stability, proper tissue oxygenation, to cope up with possible operative blood loss, adequate recovery and healing. Packed red blood cells is always preferred to correct anaemia as it avoids fluid overload.

Correction of other factors such as hypokalemia in patients posted for GI surgery that is mainly due to vomiting, nasogastric aspiration, ureteroenterostomies, potassium free IV fluids. Patients are at high risk of developing cardiac arrhthmias intraoperatively, respiratory difficulty after extubation and paralytic ileus postoperatively.

Intra Operative Fluid Therapy

It aims to combat the deficit due to loss of blood, fluid depletion (intra-operative fluid loss and maintenance requirment), third space losses, evaporative loss from viscera and wound, hypoxia, vasodilatory effect of anaesthetic agents or neuroaxial blockade. Ringer's lactate is the most commonly used IV fluid in GI surgery to replace intra operative fluid loss.Isotonic saline is used when RL is contraindicated or when large volume needs to be replaced. In paediatric patients, Isolyte P is preferred solution as it avoids sodium overload. It contains high potassium and should be avoided in oliguric patients. Additionally, newborns should be given 10% dextrose to avoid hypoglycemia.

How Much Fluid to Give?

In adult patients, with no fluid deficit, amount of intraoperative fluid can be roughly estimated as:

1. Correction of fluid deficit due to starvation (2 ml/kg/hr).
2. Maintenance requirement for period of surgery (duration of surgery * 2ml/kg/hr).
3. Loss due to hemorrhage and visceral evaporation.
4. Loss due to tissue dissection (third space loss)

Third Space Loss

Internal redistribution of ECF due to sequestration of fluid in body is called third space loss. It decreases the circulating blood volume and produces hypotension and shock. It is usually seen in massive ascites, crush injuries, acute intestinal obstruction, peritonitis, acute pancreatitis, postoperative swelling of bowel wall and mesentery.

Third space loss can be roughly estimated as:

Least trauma	nil
Minimal trauma	4 ml/kg/hr
Moderate trauma	6 ml/kg/hr
Severe trauma	10 ml/kg/hr

The Quadrant Scheme is used for calculating third space loss in children. This scheme called for an additional one fourth of the maintenance volume for each quadrant of the abdominal cavity involved in the surgical procedure [18].

Maximun Allowable Blood Loss

It is the amount of blood loss that does not require blood transfusion.It is calculated as

MABL=(starting hct of pt.–25) × Estimated blood volume starting hct of pt.

Post Operative Fluid Therapy

It depends on clinical judgement of patient's status.

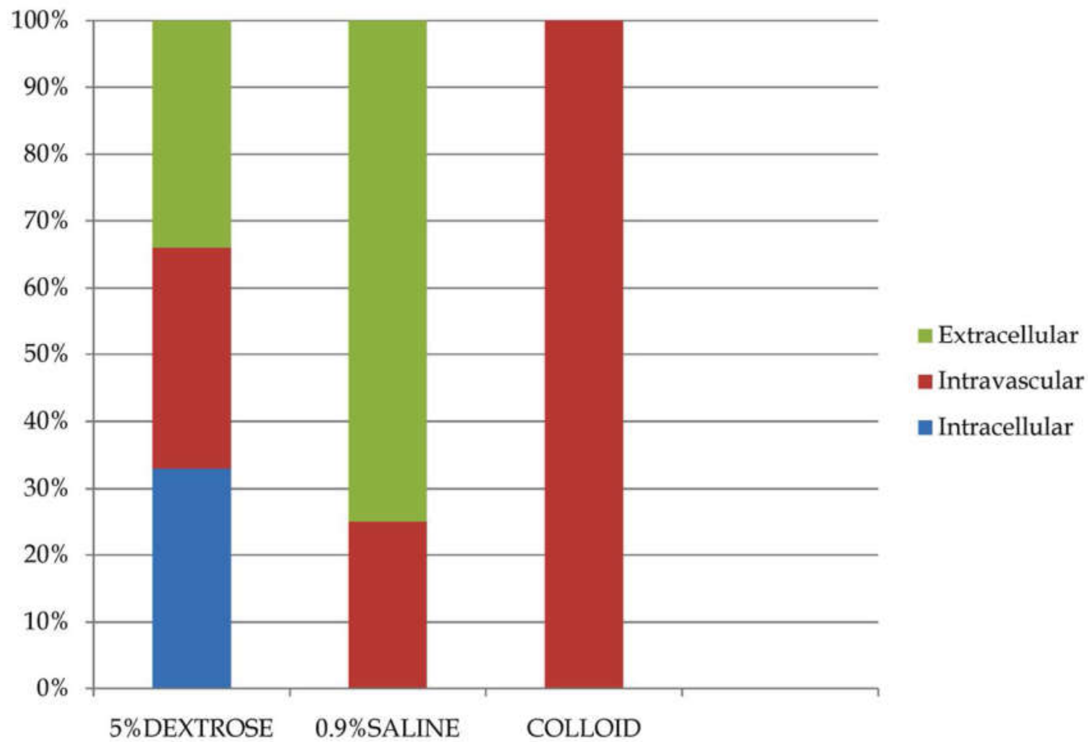

Fig . 1: Distribution of infused fluid in total body water (TBW)

One should aim at maintaining:

- Blood pressure > 100/70 mmHg
- Pulse rate < 120/min
- Urine output >0.5 ml/kg/hr

Patients undergoing short procedure without much gut handling , requires only maintenane fluid, can resume to oral intake after 4-5 hrs. However in major surgeries such as intestinal resection with anastomosis or colostomy, postoperative fluid is continued for few days.

Considerations for Prescribing Post Operative Intravenous Fluid in Paediatric Population [19,20]:

- Age, weight, vitals, hydration status and urine output.
- Pre operative diagnosis, nature of surgery and blood loss.
- Nature and volume of fluid and blood replaced intra operatively.
- Drain output, nasogastric aspiration and fluid loss from suture site.
- Renal status, associated illness (HTN, DM, IHD), electrolyte and acid base imbalance,
- Insensible loss due to atmospheric temperature and hyperventilation.

Maintenance of Fluid and Electrolyte Balance in Intra-Uterine Life:

It is essential for normal cell and organ function during intrauterine development and throughout extrauterine life.

Intrauterine life: early gestation- water 94%, 2/3 extracellular; full term- water 75% 1/2 intracellular; premature – state of total water excess. Extracellular compartment expansion compared to their full term counterpart.

Changes during labour

Increased arterial pressure in response to circulating catecholamine, vasopressin and cortisol hormones influences capillary membrane resulting in shift of fluid from intracellular compartment to the interstitium. Hence less fluid is available for filtration. It serves as a source of volume support for newborn until maternal milk production becomes adequate. Intracellular and extracellular fluid becomes close to adult level after one year of age.

Regulation of body water

Plasma osmolarity which is the concentration of solute particle in plasma remains almost constant at 285-295 mmosm/kg of water regardless of the day to day fluctuation in solute and water intake.

The Basic Plan of Management:

1. Estimation of fluid and electrolyte deficit.
2. Replacement of losses.
3. Maintenance of fluid.
4. Monitoring the adequacy of therapy.

Estimation of Fluid and Electrolyte Deficit

A body water deficit can be estimated on the basis of degree of dehydration.

A. History: Maternal hydration

Drug administration

B.Physical Examination:

a. Birth Weight- Twice Daily.

Term infant loses 10% of body weight

Preterm infant loses 15% of body weight

b. Skin- Turgor, Tension of AF

- Moistness of mucosal membrane
- Peripheral or periorbital edema.

c. CVS- tachycardia- ECG depletion and delayed capillary refill time.

- Hepatomegaly.

Laboratory Investigation

- Serum and plasma osmolality.
- Urine specific gravity
- Urine output <1 ml/kg/hr
- Fe Na excretion = Urine sodium × urine creatinine × 100

Plasma sodium × plasma creatinine

< 1% - full term neonate

<3 % -preterm neonate

Replacement of Losses

- Mandatory loss (urine ,stool)
- Insensible loss through skin and respiratory tract (20 ml/ky/day)

Factors affecting insensible water loss

- Increased respiratory rate, skin injury, congenital malformation (gastroschisis, omphalocele)
- Increased body temperature (30% per °C)
- Decreased ambient humidity
- Increased motor activity.
- Increased phototherapy by 50%.

Maintenance of Fluid

Guideline for fluid therapy:

Birth weight	day 1	day 2	day 3	day 4
1.0-1.5 kg	80	95	110	120
> 1.5 kg	40	75	90	105

(ml/kg body weight)

For Older Children

Upto 10 kg – 100 ml/kg

10 -20 kg -50ml/kg

>20 kg -20 ml/kg

Monitoring of Effectiveness of Fluid Therapy:

Increase the IV fluid if –

a. Weight loss >3% per day
b. Increased serum sodium>145 meq/L
c. Increased specific gravity>1.020
d. Decreased urine output(<1ml/kg/hr)
e. Osmolality >400m osm/L

Decrease the IV fluid if –a) weight loss < 1% per day

b. Decreased serum sodium in presence of weight gain <130meq /L
c. Decreased urine specific gravity <1.005
d. Increased urine output (3ml/kg/hr)

Which Fluid? How Much? How Fast?

The type and quantity of fluid to be given and its rate of administration is governed by a simple rule.

1. The composition and volume of the fluid given should be similar to that which it is replacing.
2. The rate of administration should equal the rate of loss (ongoing loss plus maintenance fluid plus a rapid replacement of any pre-existing deficit).

Absolute fluid deficit – actual fluid loss

Relative fluid deficit – increased intravascular capacitance or septic shock

Choice of Fluid:

D10 – for the first two days

D25 and Isolyte P (1:4) –from third day onwards.

Most physiological fluid is Ringer's Lactate (RL).

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