Fluid therapy

Preoperative fluid therapy:

Correction of volume changes:

- ECF volume changes are the most common derangements faced in surgical patient.
- Diagnosis is clinical

Causes:

- External fluid loss
- Internal redistribution of ECF as a third space loss
- Usually it is a combination of the above

Treatment

Replacement with a balanced salt solution such a Ringer lactate (when only volume change exists) with frequent clinical follow up of the pulse, blood pressure, and hourly urine volume till stabilization and **reversal** of clinical signs of ECF volume deficit.

Adequate urine output is usually a reliable reference *except with*:

- Mannitol and glucose administration, both result in osmotic diuresis
- Chronic renal disease and developing acute renal damage
- Rapid infusion of salt solutions may transiently expand the intravascular volume

- All of the above 3 present with a misleading high urine output with a shrunken functioning ECF.
- Rate of fluid administration depends on"
    i. *Severity and type of fluid disturbance,*
    ii. *Presence of continuing losses* and
    iii. The *cardiac status.*
- If severe loss start with 2L/h and reduce the rate as the status improves.
- In elderly patients follow a slower and a more careful infusion with closer observation.
- A significant increase in PCV (usually 3) after one unit blood transfusion indicates intravascular volume deficit.
- Prolonged fluid restriction before some investigations or the use of enemas and cathartics for bowel cleaning may cause acute fluid loss that needs to be corrected preoperatively.

Correction of concentration changes

- In case of severe symptomatic hyponatremia or hypernatremia with volume loss, rapid correction of the concentration abnormality is warranted till relief of symptoms. **Then**, the correction is done at a slower rate which is facilitated by reestablishment of renal function. This is done in order to avoid hypervolemia and convulsions and coma respectively.

Sodium concentration changes can be discussed as:

1. **Severe symptomatic hyponatremia with volume loss:** Sodium deficit = decrease in serum sodium below normal X total body water. Half this is given slowly as a hypertonic saline with follow up and correction of the volume loss

2. **Moderate hyponatremia with volume loss. The fluid given as follow**:
    - Normal saline given in the presence of metabolic alkalosis
    - Ringer lactate given in the presence of metabolic acidosis
    - When sodium concentration is corrected the remainder of fluid loss is replaced with Ringer's solution
    - Lactate is converted readily to bicarbonate by the liver after infusion and is used instead of bicarbonate as it is more stable in intravenous fluids during storage.

3. **Hyponatraemia with volume excess**
    - Treated by water restriction
    - If severe symptomatic hyponatremia then small amount of hypertonic salt may be infused till relief of symptoms or; peritoneal dialysis or haemodialysis in case of limited cardiac reserve
4. **Severe symptomatic hypernatremia with volume loss**
    - 5% dextrose *slow* infusion or better with half-strength NaCl or Ringer which are safer.

Correction of composition changes

- Correction of potassium deficits should be started after an adequate urine output is obtained.
- Ca"" and Mg~" may need to be given in case of massive subcutaneous infections, acute pancreatitis or chronic starvation.

Intraoperative fluid management:

- Hypotension may develop with induction of anaesthesia if ECF volume loss was not replaced preoperatively due to loss of the protective reflexes by anaesthesia
- Replacement intraoperatively should take into account the third space loss and evaporation from the wound in addition to blood loss, in order to avoid post-operative oliguria.

Clinical guidelines for replacement:

- Blood should be replaced by blood to maintain oxygen carrying capacity
- ECF replacement (of ongoing loss) should begin intraoperatively and balanced salt solution needed is about 0.5 - 1 L/h
- Replacement of other measurable losses

Post-operative fluid therapy

Aims: the following three fields should be covered

1. To maintain fluid input (**maintenance**) required under normal circumstances when the patient is unable of full oral intake,
2. To match any **ongoing losses**.
3. To replace any **deficit** occurring preoperatively.

Immediate postoperative period

• Postoperative fluid orders not written till the patient in recovery room and fluid status assessed **which include:**

- Preoperative fluid status
- Gain and loss in surgery
- Clinical exam of vital signs
- Urine output

- First fluids given is to correct deficit then maintenance fluids
- ECF volume depletion may continue postoperatively, whether **absolute** as loss from site of injury or burn or **relative** as third space depletion as with manipulated bowel wall oedema or in case of vasodilatation in septic shock
- Any of which may result in vascular instability (tachycardia, postural hypotension, low pulse pressure, poor urine output., and so on)
- In complicated cases with excessive losses 1 L (shoot) are given with follow up till stabilization
- For a patient with vascular instability further 1 L volume replacement of normal saline may solve the problem, paying attention to any continuing losses or other possible causes
- No K^+ supplement is necessary during the first 24hrs postoperatively because of:
    - **i.** Cell injury releases K into the plasma
    - **ii.** Blood transfusions
    - **iii.** Decreased renal K clearance due to transient renal impairment in the immediate postoperative period.
    - **iv.** Opposed action of insulin by 'stress hormones' tend to cause K release from the cells

Later postoperative period

- Normal people control their fluid intake subconsciously through the thirst mechanism.
- Acutely ill or perioperative patients may be unable to control their own fluid intake, so it must be controlled for them.

Postoperative Fluid & Electrolyte Management

Postoperative fluid replacement should be based on the following considerations**: (1)** maintenance requirements, **(2)** extra needs resulting from systemic factors (eg, fever, burns), **(3)** losses from drains, and **(4)** requirements resulting from tissue edema and ileus (third space losses).
In other wards **When planning fluid/electrolyte orders, three questions must be answered:**
1. What are the patient's existing deficits?
2. What is the basal requirement?
3. What are the ongoing losses?

The degree of dehydration (deficit) can be estimated using the ***2-4-6*** *rule*. The patient who is mildly dehydrated (e.g., thirsty, decreased urine output, dry skin, normal blood pressure with minimal orthostatic change) has a fluid deficit of 2% of total body weight. If the dehydration is more pronounced and includes orthostatic blood pressure changes and decreased skin turgor, the free water deficit is approximately 4% of total body weight. When hypotension at rest is present and oliguria is profound, the deficit is 6% of total body weight.
Replacement of pre-existing loss is best accomplished over 24 hours, with one-half of the replacement given over the first 8 hours and the remainder over the ensuing 16 hours. This approach should be modified for older patients with the potential for congestive heart failure who cannot tolerate large volume infusions. Conversely, in younger patients who are being prepared for emergency surgery, the deficit can be replaced quickly.

Surgical patients frequently have catheters, fistulas, and drains, all of which are sources of ongoing fluid and electrolyte loss. Unless these losses are replaced, dehydration and electrolyte/acid-base imbalances will result. The volume lost can be measured, while the electrolyte composition can be estimated. If the source of the loss (i.e., a fistula) is unknown, a sample of the effluent should be analyzed for electrolyte composition. Once the electrolyte content is known, an appropriate replacement fluid can be selected. Look to the table below.

General rule for the replacement of lost fluid:

- Fever and insensible loss (lung and perspiration), replaced by glucose water. The amount of fluid lost in feverish patient is calculated by giving 250 ml/24 hrs for every 1 degree increase in the temperature.
- GIT secretions by normal saline if small amount or ringer lactate if to replace large amount. Also, add potassium.
- The urine is generally replaced by glucose water. If you want to replace it perfectly take a sample of urine for measuring the concentrations of the electrolytes.

Daily maintenance requirements for sensible and insensible loss in the adult are about 1500- 2500 mL (1.5 ml/Kg/hr) depending on the patient's age, sex, weight, and body surface area. A rough estimate can be obtained by multiplying the patient's weight in kilograms times 30 (eg, 1800 mL/24 h in a 60-kg patient).
Another method for calculating the daily requirement is as follow:
For the first 10 kg body weight: 100 mL/kg/day or 4ml/Kg/hr
PLUS for the second 10 kg body weight: 50 mL/kg/day or 2ml/Kg/hr
PLUS for weight above 20 kg: 20 mL/kg/day or 1ml/Kg/hr
The total amount per day is divided by 24 hours to determine hourly rate.

Maintenance requirements are increased by fever, hyperventilation, and conditions that increase the catabolic rate.
For patients requiring intravenous fluid replacement for a short period (most postoperative patients), it is not necessary to measure serum electrolytes at any time during the postoperative period, but measurement is indicated in complicated cases (patients with extra fluid losses, sepsis, preexisting electrolyte abnormalities, or other factors). Assessment of the status of fluid balance requires accurate records of fluid intake and output and is aided by weighing the patient daily. As a rule, 2000-2500 mL of 5% dextrose in normal saline or in lactated Ringer's solution (Glucose saline) is given daily for adult patient. Potassium should usually not be added during the first 24 hours after surgery, because increased amounts of potassium enter the circulation during this time as a result of operative trauma and increased aldosterone activity.
In most patients, fluid loss through a nasogastric tube is less than 500 mL/d and can be replaced by increasing the infusion used for maintenance by a similar amount. About 20 meq of potassium should be added to every liter of fluid used to replace these losses. One must remember, however, that with the exception of urine, body fluids are iso-osmolar and that if large volumes of gastric or intestinal juice are replaced with normal saline solution, electrolyte imbalance will eventually result (hyperchloremic acidosis) .Ringer is preferred if to give large quantities.
Whenever external losses from any site amount to 1500 mL/d or more, electrolyte concentrations in the fluid should be measured periodically, and the amount of replacement fluids should be adjusted to equal the amount lost. Losses that result from fluid sequestration at the operative site are usually adequately replaced during operation, but in a patient with a large retroperitoneal dissection, severe pancreatitis, etc, third space losses may be substantial and should be considered when postoperative fluids are given.
Fluid requirements must be evaluated frequently. Intravenous orders should be rewritten every 24 hours or more often if indicated by special circumstances. Following an extensive operation, fluid needs on the first day should be reevaluated every 4-6 hours. Insensible fluid losses associated with an open abdomen can reach 500 to 1000 mL/hour.

K E Y P O I N T S

• Under pathologic conditions, interstitial space fills with edema fluid and constitutes part of the third space
• Increased number of osmolals in one compartment causes flow of water into that compartment, decreasing oncotic pressure
• Because body secretions are formed by components in the intravascular space, fluid loss due to fistulas, diarrhea, and drains ultimately leads to intravascular dehydration
• Fluid and electrolytes normally lost through three routes: urine output, gastrointestinal loss, and insensible loss
• Decreased intravascular pressure after traumatic or surgical stress leads to increased secretion of aldosterone, causing physiologic oliguria; use of diuretics to increase urine output ill advised— may worsen dehydration, and loss of sodium and water
• Most intravenous fluids contain small amount of dextrose (5%, or 50 g/L), providing limited calories (4 kcal/g dextrose = 200 kcal/L), preventing protein catabolism
• Dextrose also added to some solutions (e.g., D5 × 1⁄2 NS making them isosmotic, to avoid RBC lysis on infusion
• Replacement of pre-existing loss usually accomplished over 24 hours, with one-half of replacement given over first 8 hours, and remainder over next 16 hours

- **Fluid balance chart** is essential to be checked daily along with volume status exam and essential investigations of serum electrolytes, when nil by mouth status is prolonged for more than 3 days or in complicated cases.
- Excess urine output need not be replaced fully as it may indicate diuresis of fluids given at surgery or it indicates too enthusiastic fluid replacement, otherwise a state similar to diabetes insipidus will be created (10 L output per day).

Table 17.2 Composition of crystalloid and colloid solutions (mM l^{-1})

Solution	Na	K	Ca	Cl	Lactate	Colloid
Hartmann's	130	4	2.7	109	28	
Normal saline (0.9% NaCl)	154			154		
Dextrose saline (4% dextrose in 0.18% saline)	30			30		
Gelofusine	150		<1	150		Gelatin 4%
Haemacel	145	5.1	6.26	145		Polygelin 75 g l^{-1}
Hetastarch						Hydroxyethyl starch 6%

Table 17.3 Composition of gastrointestinal secretions (mM l^{-1})

	Na	K	Cl	HCO_3
Saliva	10	25	10	30
Stomach	50	15	110	–
Duodenum	140	5	100	–
Ileum	140	5	100	30
Pancreas	140	5	75	115
Bile	140	5	100	35

Table 17.1 Average daily water balance of a healthy adult in a temperate climate (70 kg)

Output	Volume (ml)	Intake	Volume (ml)
Urine	1500	Water from beverage	200
Insensible losses	900	Water from food	1000
Faeces	100	Water from oxidation	300

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