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Fluid and Electrolyte balance in pregnancy and postpartum

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Abstract

Fluid management is one of the commonest but important tasks in medical practice which involves complex decisions on optimal volume, rate, and type of fluid to be given. Fluid and electrolyte management in pregnancy and postpartum is even more complex. Any disturbance in fluid and electrolytes may require correction in the form of Fluid therapy. It's essential to know the contents, osmolality, uses, side effects and contraindication of commonly used fluids for judicious management of such conditions. All patients receiving intravenous fluid therapy need regular monitoring including daily reassessments of clinical fluid status, laboratory values (urea, creatinine, and electrolytes), and fluid balance charts, along with weight measurement twice weekly. In this article we will be studying all aspects of fluid resuscitation.
Keywords: Electrolyte balance, pregnancy, postpartum, Oncotic pressure.

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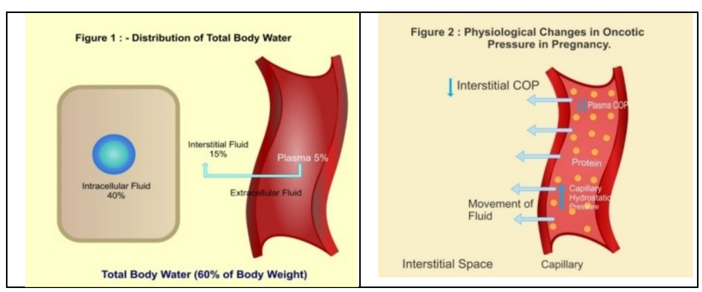
1. Introduction

Fluid management is one of the commonest but important tasks in medical practice which involves complex decisions on optimal volume, rate, and type of fluid to be given. Fluid and electrolyte management in pregnancy and postpartum is even more complex [1]. While dealing with management of fluids we need to know three basic points:

1) Distribution of water in human body
2) Normal physiological changes in pregnancy
3) Maintenance of oncotic pressure and its changes in pregnancy

1.1 Distribution of Fluids in Human Body:

50-60% of human body weight consists of water only. Compartment wise fluid distribution is shown in Figure 1. Body Fluid is present in two broad compartments that is intracellular that contains 40% and extracellular contains 20% of water. Extracellular compartment is divided into interstitial fluid and plasma which contain 15% and 5% of total fluid respectively.



[*COP= Colloid Oncotic Pressure]

2. Normal Physiology of Maternal Intravascular Volume Changes

Pregnancy is a state of physiological changes in a woman's body which is marked in haematological, hepatic, renal, gastrointestinal and various other systems of body. In a normal pregnancy, there is plasma volume expansion & increased cardiac output with increased renal blood flow associated with increased glomerular filtration. Blood volume in pregnancy is average 40-45% higher than non-pregnant levels after 32 to 34 weeks of gestation [2].

Plasma volume begins to rise as early as 5-6 weeks of gestation which is due to estrogen and progesterone induced relaxation. It increases until mid-pregnancy when it is 50% higher than pre-pregnancy levels. On the other hand the red blood cell volume increases only by about 25-30%. As a consequence of relatively much greater increase in plasma volume, RBC ‘s are 'diluted' and the venous haematocrit drops from a non-pregnant average of about 40 to about 33 during the last trimester. Increase in extracellular fluid space & total body water, decreased plasma albumin concentration, estrogen& progesterone related relaxation have an additional impact on renal water retention and serum electrolytes concentrations [3,4] .

2.1 Changes in Plasma Oncotic pressure in Pregnancy

Throughout the pregnancy Plasma and interstitial Colloid oncotic pressure (COP) fall and there is increase in capillary hydrostatic pressure. An increase in hydrostatic pressure or decrease in plasma COP overcomes the delicate balance and favor oedema formation in late pregnancy. As the pregnancy advances, oedema over the dependent body parts increases. This is the reason why the pregnant patients are more prone for pulmonary oedema and third spacing [5,6]. Figure 2 depicts the changes in Oncotic Pressure in pregnancy.

Serum osmolality is 275–295 mosm/kg. Based on osmolarity fluids can be Hypertonic, Isotonic and Hypotonic. Effect of tonicity on cells of body is as follows:

- **Hypertonic [> 360 Osmolar/ litre]:** Cells shrinks in hypertonic solutions.
- **Isotonic [280 Osmolar/ litre]:** No change in cell.
- **Hypotonic [< 200 Osmolar/ litre]:** Cells swell in hypotonic solutions.

3. Fluid Therapy

Any disturbance in fluid and electrolytes may require correction in the form of Fluid therapy. It’s essential to know the contents, osmolality, uses, side effects and contraindication of commonly used fluids. According to NICE guidelines IV fluids should be prescribed by skilled and competent healthcare professionals and five “R” s should be taken in account while prescribing it [7].

- Resuscitation
- Replacement
- Routine maintenance
- Redistribution
- Reassessment

3.1 Know your fluids

Mainly two types of fluids are used for fluid therapy

- **Crystalloids**
- **Colloids**

Crystalloids are solution of electrolytes and **Colloids** are solution of large molecules.

Commonly used Crystalloids are

- RL
- NS
- DNS
- D-5%
- ISOLYTES

Commonly used Colloids are

- 5% Albumin
- 25% Albumin
- 10% Pentastarch
- 10% Dextran -40
- 6% Dextran -70
- 10% Hetastarch

Table 2: Comparison of Crystalloids and Colloids

Crystalloids	Colloids
• Low tendency to stay intravascular (30 mins) • Solute of small molecules- low oncotic pressure • Equilibrate between interstitial space and intravascular compartment (1:3) • Overload – pulmonary/cerebral oedema (caution in PE) and peripheral oedema • Used in immediate resuscitation of lost volume	• High tendency to stay intravascular(24 hrs) • Larger molecules-exert oncotic pressure like natural blood constituents • Pulmonary oedema in states of capillary leak. • Risk of coagulation disorder, anaphylactic reaction and AKI. • Useful in some situations of massive blood loss till blood products are available or in severe hypovolumia

Crystalloids: Our plasma has pH 7.4, sodium 140 mEq/l, pottasium 4 mEq/l, chloride 100 mEq/l; calcium 24 mEq/l, glucose-0.85 and osmolality 290 mOsm/l. Table 1 describes the contents and osmolality of commonly used crystalloids.

Table 1: Constituents and osmolality of common crystalloid solutions

Fluid	pH	Na+ mEq/l	Cl- mEq/l	K+ mEq/l	Ca2+ mEq/l	Other	mOsm/l
0.9 % NaCl (NS)	5.5	154	154	0	0	0	308
Lactated ringer (RL)	6.5	130	109	4	3	Lactate 28 mEq/l	275
Dextrose 5% (D 5%)	4.5	0	0	0	0	Dextrose 50 g/l	285*
D5% LR	5	130	109	4	3	Dextrose 50 g/l	275
D5% NS	4	154	154	0	0	Dextrose 50 g/l	308
D5% NS 4.5%	4	77	77	0	0	Dextrose 50 g/l	154+285*
D5% NS 2.5%	4	34	34	0	0	Dextrose 50 g/l	65+285
Isoyte P in D5%	5	23	29	20	0	Mg^{2+} =3, HPO_4^{2-} =3,acetate$^-$ =23mEq/l, dextrose =50 g/l	75+265
Plasmalyte A	7.4	140	98	5	0	Mg^{2+} =3, acetate$^-$ =27, gluconate =23 mEq/l	294

3.2 Clinically Significant points of commonly available fluids

a. ***Normal Saline:***

- It's Osmolality and constitution is most close to plasma and it is most easily available fluid.
- It is first choice of fluid in replacement for hypovolumia, hypercalcemia, diabetic ketoacidosis and vomiting.
- It is compatible with massive blood transfusions and does not cause red cell lysis or coagulation in tubings.
- It is contraindicated in compromised renal and liver functions as its use will result in hyperchloremic acidosis and renal vasoconstriction [8].
- It is contraindicated in dehydration with severe hypokalemia.
- It is to be given with caution in severe preeclampsia.

Figure 3: Commonly used crystalloids

b. ***Hypotonic Saline solutions***

- It is mainly used in ketoacidosis and hyperosmolar hyperglycemia.
- It is contraindicated in patients at risk of cerebral oedema, excessive burns and trauma.

c. ***Ringer Lactate***

- It is Isotonic and used in severe dehydration, hypovolumia (trauma, surgery, anaesthesia) and postoperative period.
- It is contraindicated in severe metabolic acidosis or alkalosis, severe liver diseases, severe anoxic states.
- It contains calcium which binds with citrate in blood so it should not be given with blood in same tubing.

d. ***Plasma –Lyte***

- It is Isotonic and constitution similar to plasma.
- It is contraindicated in primary treatment of severe metabolic acidosis.
- Excess administration of Plasma-Lyte [pH 7.4] can result in metabolic alkalosis.

e. ***Dextrose 5%***

- It is useful for providing calorie and free water .Once the glucose is metabolised, the fluid is distributed throughout total body water.
- It is indicated in hypoglycemia, insulin shock, correction of hypernatremia, pre and
- Postoperative fluid replacement.
- Its side effects are Fluid and electrolyte imbalances (hypokalemia and dehydration, hyperglycaemia, hyperosmotic syndrome (mental confusion and loss of consciousness).
- Blood should not be in a same IV line with D-5%, it cause hamolysis and clumping.

f. ***Dextrose Normal Saline***

- It is particularly useful for Paediatric & very elderly, maintenance fluid in early post operative periods.
- It is compatible with blood transfusion
- It may interact with Indomethacin, oxytocin, Terbutalin.

g. *Colloids*

- Albumin is safest of all and may be used for volume expansion for a short duration.
- It is useful in severe sepsis, malnutrition, liver disease, burns and nephrotic syndrome.
- Its use for a longer duration and in excessive amount may lead to increased mortality.
- Eventually solutes enter the interstial space and holds lot of water in this space .
- Starch is associated with high risk of anaphylactoid reaction, hypercoagulabity and acute kidney injury [9].

In a Cochrane review of surgical and critically-ill patients, no colloid was found to be superior in efficacy or safety [10]. A meta-analysis comparing resuscitation with colloid solutions versus crystalloid favored the use of crystalloids with respect to mortality [11].

3.3 Five "R" s of Fluid Therapy

3.3.1 Resuscitation

Fluid resuscitation is the administration of fluids rapidly and in boluses to patients with acutely impaired hemodynamic status. Goal of fluid resuscitation is to maintain intravascular volume.

a) Indications of fluid resuscitation in obstetrics and gynaecology are,
b) Hypovolumic shock due to haemorrhage till blood products are available
c) Septic Shock
d) Immediate postoperative period
e) Diabetic ketoacidosis &Hyperglycemia

Few other conditions which may require fluid resuscitation are severe burns and severe gastro-intestinal losses e.g. Diarrhoea and vomiting.

Volume and rate of fluid resuscitation for different conditions

In patients with normal organ function , simple short duration of surgery or mild to moderate fluid / blood loss ,fluids are replaced in the ratio of 1: 1 [Estimated fluid loss : Replaced fluids]. In cases of severe stress response to surgery or sepsis fluid is replaced in the ratio of 1:3 [replace three times of estimated fluid loss] as two-third of administered intravenous crystalloid is expected to shift out of the vascular space within hours of administration due to capillary leak.

(a) Haemorrhagic Shock

Fluid resuscitation should be immediate and aggressive. Accurate assessment of actual loss is necessary. Blood and blood products are best replacement but crystalloids should be used for immediate resuscitation. A woman in haemorrhagic shock (40 percent or greater volume loss) will require rapid volume expansion with >2 L of fluid per hour with a wide bore / grey cannula [12]. Balanced salt solutions have an edge over normal saline because of risk of hyperchloremia in case of massive infusion. Dextrose is contraindicated for patients with shock as it will be converted to lactate, thereby generating an acidosis.

(b) Septic shock :

Initial resuscitation in first 3 hours include aggressive administration of intravenous fluids usually crystalloids (balanced crystalloids preferably normal saline) given at the rate of 30 ml/kg body weight in boluses of 500 ml each to be infused in 3 hours. It should be started as soon as possible within 45 minutes of presentation. The clinical and hemodynamic response and pulmonary oedema must be assessed before and after each bolus. Intravenous fluid challenges can be repeated until vitals are normalization.

It is necessary to check for fluid responsiveness before further load; timely initiation of vasopressors is better than overloading with fluid.

(c) Postoperative Period:

In postoperative replacement fluid therapy need to compensate for postoperative and intraoperative volume loss, the surgical stress, haemorrhage, and underlying disease state [14]. Consideration of preoperative and postoperative haemorrhage, drainage of nasogastric tube, ascites, pleural fluid and urine should be done along with insensible water loss. Operative notes and information regarding blood and blood product transfusion should be taken in account. If patient is not in shock then the rate of fluid should be 3.5 to 14 mL/kg aliquots per hour for initial 2 -3 litres. Further infusion is done after reassessment.

(d) Diabetic Ketoacidosis:

Ketoacidosis result in hypovolemia and/or potassium depletion. Moreover urinary losses driven by renal excretion of sodium and potassium with ketoacid anions (mostly beta-hydroxybutyrate), and third-spacing also worsen the electrolyte balance in severe cases. Fluid resuscitation, insulin therapy and correction of potassium deficit is done simultaneously. Normal saline is the fluid of choice which is infused at a rate of 15 to 20 mL/kg / hour (approximately 1000 mL/hour in a average built lady) for the first couple of hours. After that hydration status urine output, serum sodium and potassium and blood glucose levels are checked again. If serum sodium is less than 135 mEq/L, isotonic saline should be continued at a rate of approximately 250 to 500 mL/hour or if serum sodium is normal of elevated we can switch to one-half isotonic saline [15].

Fluid Restriction

Restricted rate of fluid infusion [75 ml/ hour] should be practiced in severe anemia, preeclampsia, renal disease and cardiac failure. Kidney paradox should be avoided. In case the patient is oligouric, one bolus of 300 cc should be infused and response should be checked. In case of persistent oligourea renal functions should be checked and hemodialysis should be considered.

Fluid responsiveness:

It is assessment that oxygen delivery to the tissues will improve after fluid administration. Fluid responsiveness can be measured by increase in Cardiac Output /Stroke volume of 15% after receiving 500ml bolus of fluid.

Dynamic Tests of fluid responsiveness:

45° Passive leg raise: Baseline Blood pressure is measured in patient lying recumbent at 45° then again within 1- 5 minutes of patient lying flat with legs raised passively at 45°. which is defined as an increase in stroke volume by more than 10 percent or Δ BP [Pulse Pressure] > 9% of Δ previous BP [16,17]. Δ BP [Pulse pressure] = Systolic BP –Diastolic BP

Figure 4 : 45° Passive leg raise test

- ***Collapsibility of IVC with inspiration:***

The IVC should first be identified in a transverse plane, with the cardiac probe in a subxiphoid position perpendicular to the skin. The IVC diameter can be measured either close to its entrance to the right atrium or 1 to 2 cm caudal to the hepatic vein–IVC junction (approximately 3–4 cm from the junction of the IVC and the right atrium). The IVC diameter is measured in time-motion mode using a moderate speed (25 mm/s); ideally with acquisition of respiratory traces .Three measurements should be averaged [18].

a) If IVC collapses more than 50% during inspiration and its diameter is less than 2 cm then the patient is fluid responsive and there is no fluid overload.
b) If the diameter of IVC>2.5 cms with no collapsibility/ collapsibility less than 50%, it suggests volume overload.

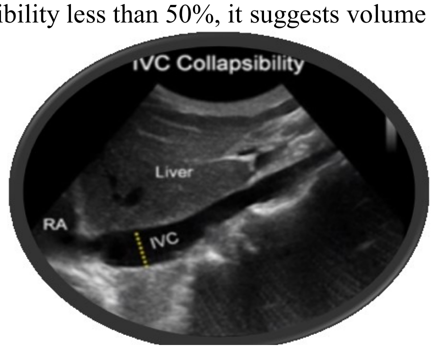


Figure 5: IVC Collapsibility Test End Point of Resuscitation

To determine the endpoint of resuscitation monitoring of the following points in necessary

a) Moist tongue, warm extremities and normal elasticity of skin.
b) MAP>65mmHg
c) Urine output> 0.5ml/kg/hour
d) CVP= 8-12mm Hg
e) $ScvO_2$ > 70%
f) Normalized lactate
g) Normalized mental status, improvement of anxiety and restlessness.
h) HR is not a reliable indicator of adequate resuscitation

3.2 Replacement

In some patients fluids are not needed urgently for resuscitation but are required to correct existing water and/or electrolyte deficits or ongoing external losses. Patients of diarrhoea, vomiting, fever and burns need replacement fluids. These deficits have developed slowly with associated compensatory adaptations of tissue electrolyte and fluid distribution and should be corrected slowly and judiciously to prevent complications like pontine demyelinosis. Amount and rate of fluid is decided on case to case basis.

3.3 Routine Maintenance Fluid Therapy

Mostly needed in hemodynamically stable patients who are not expected to tolerate oral or enteral fluids such as bowel obstruction and immediate postoperative period.

Goal of maintenance therapy

- To preserve blood volume
- Electrolyte balance
- To provide some calories to prevent muscle wasting.

Daily Requirement of fluid and electrolytes

- Fluid requirement = 1500+[(wt in kg- 20)×20]
  ~ 75-150 ml/hr for normal organ function **Or**
  0.5 ml/kg/ hour for compromised renal and cardiac system
- Daily Na requirement = 2 mmol/kg/24 hrs
- Daily K requirement = 1 mmol/kg/24 hrs

For patients with underlying organ dysfunction or ongoing fluid loss it needs to be adjusted. Calorie requirement of an average adult is 400-500 calories or 100-150 gm glucose per day which is sufficient to stimulate basal insulin secretion for prevention of catabolism. In absence of shock and hyponatremia dextrose 5% is added to half normal saline (0.45%). Potassium may be added to the fluids. Serum electrolytes should be checked at least once a day in maintenance therapy and 6 hourly in case of massive fluid infusion [> 4 litres a day] [19]. A modified amount of fluid, typically 25 to 50 percent of patient's daily goal [2 - 3 bottles /day] should be administered until patient is improved and enough enteral intake is demonstrated (i.e., 1mL/kg/hour intake).

3.4 Redistribution

Major surgery, haemorrhage and sepsis lead to stress response and release of stress hormones. These stress hormones cause hyperglycemia, hypokalemia and third spacing of fluids due to capillary leak. Major effect of this capillary lead may be acute renal failure, adult respiratory distress syndrome, abdominal compartment syndrome [20]. Third-spacing into the soft tissue results in edema, whereas fluid that leaks from the peritoneal or pleural surfaces generates ascites or pleural effusion.

As the stress response subsides the fluid in the "third-space" (i.e., extravasated fluid) will return to the vascular space, a process referred to as "mobilization of the third-space fluid." These patients will undergo auto-diuresis. At this time maintenance intravenous fluid rates should be reduced. In case of fluid overload active diuresis or hemodialysis should be practiced to remove excess fluid. Prescription of fluids in such patients should be individualised and rigorous monitoring [21].

3.5 Reassessment

Assessment of fluid therapy should be done 8-12 hourly in critical patients and at least daily in hemodynamically stable patients. Patient's vitals should be checked and signs of dehydration as well as fluid overload should be ruled out. Positive fluid balance to be prevented [22]. Investigating serum electrolytes should be individualized. Regular charting of patient's input and output and ongoing losses is vital to decide further management. Patient's intake of oral fluids should be evaluated to decide weaning off.

4. Management of Electrolyte Imbalance

4.1 Hyponatremia [Serum Na <135mEq/L]

Common causes of Hyponatremia in Obstetrics and Gynaecology are vomiting, diarrhoea, diabetic ketoacidosis, tube drainage, peritonitis, bowel obstruction and renal failure. A few Iatrogenic causes should also be remembered such as TURP Syndrome while doing operative hysteroscopy using glycine and excessive infusion of mannitol ,Severe symptoms of hyponatremia include seizures, obtundation, coma, and respiratory arrest. Mild to moderate hyponatremia manifest as relatively nonspecific symptoms which include headache, fatigue, lethargy, nausea, vomiting, dizziness, gait disturbances, forgetfulness, confusion, and muscle cramps.

Management

[1] Hypovolumic Hyponatremia: Sodium is replaced by isotonic saline which has Na 154 mEq /L.

Sodium Deficit = 0.6 x wt in Kg (Desired Na – Actual Na)

[2] Euvolemic Hyponatremia: Water restriction is the first line of management. Democycline is useful for SIADH.

[3] Hypervolemic Hyponatremia: Water restriction is the first line of management. 3% Hypertonic Saline which has Na 513 meq/ L in 50 ml boluses is used in acute deficit <130 mEq/L.

- Rapid correction is avoided instead goal of therapy is to raise the serum sodium concentration by 4 to 6 mEq/L in a 24-hour period. The same rate of rise can be continued on subsequent days until the sodium is normal or near normal.
- From 130-134 mEq/L we should try to correct the cause, stop drugs causing hyponatremia, stop hypotonic I.V. fluids, restrict water intake and monitor for autocorrection [23].

4.2 Hypernatremia [Serum Sodium >145mEq/L]:

Hypernatremia is mostly caused by dehydration resulting in excessive water loss only such as gastrointestinal tract (vomiting or osmotic diarrhoea), skin (sweat), high grade fever, or the urine (diabetes insipidus or an osmotic diuresis due to glycosuria or it may be iatrogenic.

Management

- Therapeutic approach is a net positive balance of 3 mL of electrolyte-free water per kilogram of lean body weight will lower the serum sodium by approximately 1 mEq/L.
- Calculation of Free Water Deficit = desired Na / measured Na x body weight in kg x 0.6
- Free water is replaced by infusion of D5%
- D 5% 1.35 mL/hour x patient's weight in kg Or

Approximately 70 mL/hour in a 50 kg patient [24]

- Hypernatremic patients who are also hypovolumic will be benefited by Isotonic fluids to expand the extracellular fluid volume.
- Fluid deficit to be corrected over 48-72 hr
- Rapid correction can lead to central pontine myelinosis

4.3 Hypokalemia [Serum Potassium < 3.5 mEq/L]:

Common causes of hypokalemia in Obstetrics and Gynaecology are diarrhoea, vomiting, insulin therapy, metabolic alkalosis, renal loss of potassium, and total parenteral nutrition. Our aim in management of hypokalemia should be to prevent or treat life-threatening complications (arrhythmias, paralysis, rhabdomyolysis, and diaphragmatic weakness), to replace the potassium deficit, and to diagnose and correct the underlying cause.

Management: Potassium replacement is the mainstay of therapy and hypomagnesemia should be suspected and corrected in case of ongoing G I losses.

- Management of mild to moderate hypokalemia is oral potassium chloride therapy with 10 to 20 mEq of potassium given two to four times per day (total 20 to 80 mEq/day).
- An immediately dispersing extended-release oral dosage form of potassium chloride containing 750 mg of microencapsulated potassium chloride, USP equivalent to 10 mEq of potassium.
- For renal causes potassium-sparing diuretic is likely to be more effective.
- Patients with severe and symptomatic hypokalemia [less than 2.5 to 3.0 mEq/L] are treated with intravenous potassium chloride in doses of 40 mEq, three to four times per day or 20 mEq every two to three hours.
- One ampule of KCl [15%]

1 Amp =10ml, (15%) = 1.5 gm KCl= 20 mEq of Potassium [25].

4.4 Hyperkalemia [Serum potassium > 5.5mEq/L]:

Common causes encountered in obstetrics and gynaecology is massive blood transfusions, excessive intake, acidosis, hyperglycemia and mannitol infusion. Patients with a hyperkalemic emergency presents with muscle weakness or paralysis, cardiac conduction abnormalities, and cardiac arrhythmias, including sinus bradycardia, sinus arrest, slow idioventricular rhythms, ventricular tachycardia, ventricular fibrillation, and asystole [25].

Moderate elevation of K levels (6 to 7 mEq/L)-

- Decrease oral K+ intake to 50-60 meq/24 hr.
- Cation exchange raisin intake 15-20 g, 2-4 times/day.
- Sodium bicarbonate tablets -600 mg, 2-3 times/day.
- Stopping medication leading to hyperkalaemia.

Life threatening elevation of K levels (>7mEq/L)-

- I.V Ca gluconate - 10-20 ml of 10 % given over 10-20 min
- Glucose plus insulin: Mix 25 g (50 mL of D50) glucose and 10-20 U regular insulin and give IV over 15 to 30 minutes. Initial bolus followed by continuous infusion with 5% dextrose at the rate of100ml/hr to avoid late hypoglycemia. Potassium falls by 0.5-1.5mEq/L. Effect of this regimen begins in 15 minutes, peaks at 60 minutes Lasts for 4-6 hours.

4.5 Hypocalcemia [Serum calcium < 8.8 mg/dl]

Hypocalcemia is rarely seen in obstetrics and gynaecology. It may occur in massive soft tissue infection as chronic fasciitis, acute and chronic renal failure etc. Hypocacemia may present with variety of symptoms like paresthesias, carpopedal spasm, tetany, seizures and signs (Chvostek's or Trousseau's signs, bradycardia, impaired cardiac contractility, and prolongation of the QT interval. Symptoms depend upon the absolute level of calcium, as well as the rate of decrease.

Management

Acute hypocalcemia should be treated as follows

- 10% calcium gluconate- 10-20 ml IV over 10 minutes.

+ IV infusion of 540 to 720 mg of elemental calcium (58 to77 mL of 10% calcium gluconate) in 500 to 1000 mL D5% at the rate of 0.5 to 2 mg/kg/ hour (10 to 15 mg/kg).

OR

10% calcium chloride- 5 mL IV over 10 minutes, followed by 36.6 mL (1 g) over the next 6 to 12 hours IV.

- Rapid infusion may lead to serious cardiac dysfunction, including systolic arrest. Chronic hypocalcemia should be treated with oral calcium with vitamin D [26].

4.6 Hypercalcemia [Serum calcium > 10.5 mg/dl] :

Cause of hypercalcemia in obstetrics and gynaecology are very few. It may be iatrogenic or due to hyperparathyroidism. Manifestations of Hypercalcemia range from few or no symptoms in patients with mild chronic hypercalcemia to severe obtundation and coma.

Management

- Asymptomatic or mildly symptomatic (e.g., constipation) hypercalcemia (calcium <12 mg/dL [3 mmol/L]) do not require immediate treatment. For mild hypercalcemia treatment of cause and hydration with 8-10 glass of water daily is enough.
- Acute severe hypercalcemia or patients with a serum calcium concentration >14 mg/dL (3.5 mmol/L) require treatment.
- Volume expansion with isotonic saline at an initial rate of 200 to 300 mL/hour targeted to maintain the urine output at 100 to 150 mL/hour.
- Administration of salmon calcitonin (4 IU/kg) and repeat measurement of serum calcium. Repeat 6 hourly as per response.
- Concurrent administration of Zoledronic acid (ZA; 4 mg intravenously [IV] over 15 minutes) or Pamidronate (60 to 90 mg over two hours).
- Hemodialysis for range of 18 to 20 mg/dL (4.5 to 5 mmol/L) and neurological symptoms.

Other therapeutic agents used in hypercalcemia are Loop diuretics, corticosteroids, Denosumab and calcimimetics [27,28].

5. Conclusion

Inappropriate fluid therapy is associated with increased mortality and morbidity [29]. All patients receiving intravenous fluid therapy need regular monitoring including daily reassessments of clinical fluid status, laboratory values (urea, creatinine, and electrolytes), and fluid balance charts, along with weight measurement twice weekly . Expert help should be sought if patient have a complex fluid or electrolyte redistribution issue or imbalance, or substantial comorbidity.

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