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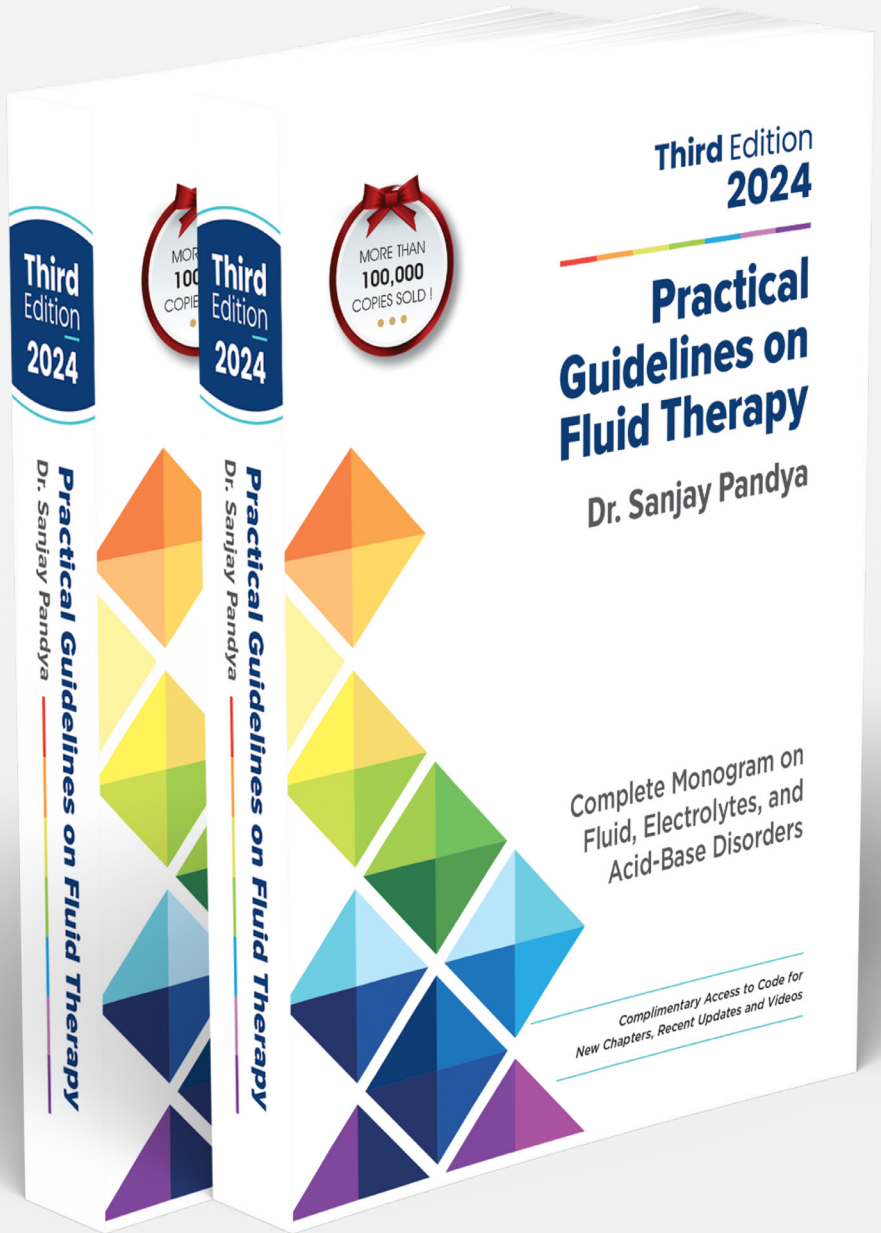
Chapter 53:

Fluid Management in Preeclampsia and Postpartum Hemorrhage



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53 Fluid Management in Preeclampsia and Postpartum Hemorrhage

Preeclampsia and postpartum hemorrhage are two common problems that need meticulous fluid management.

FLUID MANAGEMENT IN PREECLAMPSIA

Preeclampsia (PE) is a condition that is characterized by hypertension and significant proteinuria that occurs after 20 weeks of pregnancy.

One of the common clinical symptoms of preeclampsia is generalized edema. However, it's important to note that peripheral edema can occur in normal pregnancies. Therefore, one should suspect preeclampsia when weight gain is sudden and rapid (> 2.3 kg/week).

Fluid management for the patient with preeclampsia presents a challenge for the obstetrician as there are considerable controversies and data on the ideal fluid strategy are limited and insufficient [1].

In preeclampsia, two paradoxical findings, intravascular volume depletion, and increased extracellular fluid volume, lead to confusion and different opinions regarding optimal fluid management.

Excessive administration of IV fluids and mobilization of fluid sequestered in the extravascular space into the vascular space carries a high risk of pulmonary edema in preeclampsia [2].

Fluid management should be customized to the specific clinical situation and closely monitored to achieve optimal fluid balance. Fluid management aims to maintain circulating volume and preserve kidney function while minimizing the risk of pulmonary edema.

A. Basic principles of fluid balance in PE [1, 3, 4]

- As patients with preeclampsia are edematous, it is important to carefully infuse optimal IV fluids with the aim of restricting fluid to avoid pulmonary edema.
- Aggressive fluid therapy carries a risk of pulmonary edema; therefore, fluid management requires frequent

clinical assessment and meticulous attention. Record fluid balance carefully.

- For precise infusion of intravenous fluids, use a volumetric infusion pump.
- Replace obvious blood loss during delivery.
- Pulmonary edema carries a higher risk of death compared to oliguric renal failure. Therefore, it is important to avoid the overuse of crystalloid solutions to treat postpartum hemorrhage (PPH) in patients with preeclampsia.
- Avoiding IV fluids preloads before spinal anesthesia.
- To maintain optimal fluid balance, restrict fluid intake to a maximum of 40 ml per hour plus the previous hour's urine output, up to a total of 80 ml per hour or 1 mL/kg/hr. The type of fluids preferred are balanced crystalloids (Hartmann's solution, Ringer's lactate, or PlasmaLyte).
- As oliguria is common with severe preeclampsia, maintain fluid restriction until there is a postpartum diuresis.
- Administer infused drugs in concentrated solutions to avoid excessive fluid volume administration.
- Do not chase an increased urine output that follows delivery, as it carries a risk of volume overload.
- Insert the indwelling catheter and measure urine output hourly with a urometer.
- In preeclampsia, a central line is usually only indicated if there is significant obstetric bleeding or severe heart dysfunction. Before insertion of the central line, always check the coagulation profile and platelet count because Preeclampsia is often complicated by HELLP syndrome.
- Monitor SpO_2 closely. Fluid overload is the most likely cause of a decrease in oxygen saturation. Deterioration of SpO_2 below 95% may indicate impending pulmonary edema. Use diuretics only when the diagnosis of pulmonary edema is confirmed.

B. Antenatal fluid management in PE

Careful fluid balance is essential. In preeclampsia, it is important to restrict intravenous and oral fluid intake in order to prevent fluid overload and pulmonary edema. When the administration of syntocinon (oxytocin) is indicated, it is advisable to use a high-concentration infusion (30 IU in 500 mL) or, for even more concentrated solutions, dilute it in just 50 mL and deliver it using an infusion pump to prevent fluid overload [4].

Women with preeclampsia have an increased risk of requiring a cesarean delivery. Therefore, keeping them on a "nil by mouth" or limiting oral fluid intake to 30 ml per hour or less is recommended to minimize the risk of complications during surgery [3, 5].

In the antepartum period, furosemide is used only to treat patients with severe preeclampsia complicated by pulmonary edema [6].

C. Fluid management during labor in PE

IV fluid in PE: to use or not?

Fluid management in preeclampsia is complex, and there is limited and insufficient data on the ideal fluid strategy for women with this condition [1].

1. Volume restriction

Acute pulmonary edema is a common cause of death in women with preeclampsia and often leads to admission

to the intensive care unit [7]. Pulmonary edema kills, but oliguria and renal failure do not, so administer fluid cautiously in preeclampsia.

A fluid restriction regimen is associated with lower rates of pulmonary edema and good maternal outcome [8, 9]. Multiple recent guidelines recommend against plasma volume expansion (NICE, SOGC, SOMANZ) and recommend fluid restriction (NICE, GAIN, CMQCC, SOGC) [9–13]. For women with severe preeclampsia and without any fluid losses, it is recommended to restrict total fluid intake to 80 ml/hour, which includes oral, drug, and intravenous fluids [9, 10].

2. Volume expansion

Women with preeclampsia have reduced plasma volume and are usually oliguric. Therefore, fluid restriction is generally recommended in preeclampsia but may not be appropriate for all women. Achieving proper fluid balance before delivery is essential [14]. Intravenous fluid administration may be used judiciously as maintenance therapy or for resuscitation [15]. Replacement therapy is administered according to an estimated deficit and is usually transfused rapidly.

Common indications of fluid administration in preeclampsia are the following [15, 16]:

- As a vehicle to administered IV labetalol or IV hydralazine for the adequate and more reliable control of severe hypertension.
- To replace ongoing blood and fluid loss.
- As a vehicle for administering agents for induction/augmentation of labor and anticonvulsant medication.
- Maintenance therapy. The preeclamptic woman who is fasting may need intravenous fluid to maintain hydration. Maintenance fluid is commonly given intravenously slowly over 24 hours, and its volume should match the urinary output combined with the insensible loss [15].
- Oliguria due to suspected or confirmed intravascular volume deficit [17].

3. The choice of IV fluids: colloids vs. crystalloids

The theoretical benefits of colloids are that they remain in the vascular compartment longer than crystalloids, and a smaller volume of solution is required for volume expansion. However, most of the previous comparative trials of colloids and crystalloids excluded pregnant women in their studies, so choosing between these two solutions during labor is controversial [18].

There is no evidence in the literature of general critical care to support the use of colloids over crystalloids for fluid resuscitation, and current studies favor the use of crystalloids over colloids [18–20].

D. Fluid during spinal anesthesia in PE

Spinal or epidural anesthesia is generally considered better and safer for cesarean section in preeclampsia due to improved hemodynamic stability and better outcomes for newborns [21].

Women with preeclampsia develop less hypotension after spinal anesthesia than healthy women [22–24].

General anesthesia carries a higher risk compared to neuraxial anesthesia in preeclampsia. Some of the significant risks associated with general anesthesia include the risk of aspiration [25] and an abrupt, severe increase in hypertension during intubation and extubation [5, 26]. Such sudden, severe hypertension carries a risk of hypertensive crisis and stroke [27].

Additionally, preeclampsia-associated tissue edema can lead to narrowing around the larynx, making endotracheal intubation difficult [28].

A prophylactically or routine fixed intravenous fluid preload bolus should never be administered before initiating neuraxial anesthesia in preeclampsia [4, 5, 9].

Administer crystalloid/colloid carefully for co-loading. As a general rule, 500 mL to 1000 mL is sufficient unless the fluids are being used to replace blood loss [3, 5].

Phenylephrine is the optimal first-line vasopressor to reverse spinal hypotension in preeclampsia. However, prophylactic vasopressor infusion in preeclampsia is not usually required, and the dose of phenylephrine to treat hypotension may be lower than in healthy women.

It is essential to monitor the blood pressure carefully during cesarean section, as the fetus may not tolerate sudden decreases in blood pressure well. If necessary, a low dose of phenylephrine can be administered to treat spinal hypotension [22, 29].

E. Postpartum fluid management in PE

- Intravascular volume increases in the postpartum period because of the mobilization of extracellular fluid to the intravascular space and "autotransfusion" of blood from the contracted uterus.
- The greatest risk of postpartum eclampsia is in the first 48 hours because of the profound shift of third space fluid to intravascular volume space after delivery, which may worsen hypertension [30].
- After delivery, it is common for patients to experience a short period of oliguria lasting up to 6 hours. To manage postpartum oliguria, it is recommended to restrict fluid intake after delivery and wait for natural diuresis, which typically occurs within 36–48 hours [5]. During this time, the combined of intravenous and oral fluids intake should be kept at 80 mL per hour or less. The intravenous fluids should be gradually reduced and eventually stopped when the patient can take and tolerate more than 80 mL of oral fluids per hour.
- This approach can help to prevent excess fluid overload.
- Replace appropriate blood products in postpartum hemorrhage, as in cases of placental abruption.

F. Oliguria in preeclampsia

- A short period (up to 6 hours) of oliguria in the immediate postpartum period is common and physiological, so wait and observe [11].
- Avoid administering fluids to treat this physiological oliguria (<15 mL/h urine output during the initial six hours in the postpartum period) [9].
- If oliguria persists after 6 hours, exclude pre-existing renal disease or a rising creatinine, and subsequently try the fluid challenge to rule out a pre-renal failure.
- A fluid bolus of 250–500 ml of normal saline or Ringer's lactate can be tried as a fluid challenge [13].
- Both dopamine and furosemide should be avoided to treat persistent oliguria [11].
- It is unlikely that short-term oliguria caused by severe preeclampsia will result in irreversible kidney damage.
- Postpartum persistent oliguria (beyond 24 hours) and increased plasma creatinine suggest postpartum renal failure [11].

FLUID MANAGEMENT IN POSTPARTUM HEMORRHAGE

Postpartum hemorrhage (PPH) is a major cause of maternal mortality and is estimated to cause around 30% of maternal deaths or 10 deaths every hour [31, 32]. The definition of PPH varies in different guidelines (Table 53.1). But the common definition of postpartum hemorrhage is blood loss of ≥500 ml for a vaginal delivery and ≥1000 ml for a cesarean birth [32, 33]. In addition, PPH is classified into two categories based on the severity of blood loss: minor (500–1000 mL) or major (more than 1000 mL). Major PPH is further divided into moderate PPH (1000–2000 mL) and severe PPH (more than 2000 mL) [34].

Uterine atony is the most common cause of primary postpartum hemorrhage, accounting for 80% of PPH. Other important causes of PPH are placenta previa, uterine rupture, trauma, placental abruption, and retained placenta.

Diagnosis and estimation of blood loss

It is challenging to estimate blood loss accurately in PPH. But all possible efforts should be made for its assessment because PPH can be a serious and potentially life-threatening condition.

The volume and speed at which blood is lost in PPH are often underestimated because the blood loss may be

Table 53.1 Postpartum hemorrhage definitions

Guidelines	Definitions
World Health Organization (WHO) 2012 [35]	Blood loss >500 mL within 24 hours
International Federation of Gynecology and Obstetrics (FIGO) 2012 [36]	Blood loss >500 ml in a vaginal birth and >1000 ml in a cesarean section
Royal College of Obstetricians and Gynaecologists (RCOG) 2016 [34]	Minor PPH: Blood loss 500–1000 ml without clinical shock Major PPH: Blood loss >1000 mL and continuous bleeding or clinical shock
Royal Australian and New Zealand College of Obstetricians and Gynaecologists, (RANZCOG) 2017 [37]	Blood loss >500 ml during the puerperium Severe PPH: Blood loss >1000 mL
American College of Obstetricians and Gynecologists (ACOG) 2017 [38]	Blood loss ≥1000 ml or more, or signs and symptoms of hypovolemia due to blood loss
NHS Obstetric Hemorrhage Clinical Guideline 2018 [39]	Primary minor PPH: Blood loss of 500–1000 ml within 24 hours of the birth of a baby Primary moderate PPH: Blood loss 1000–1500 mL within 24 hours Primary severe PPH: Blood loss ≥1500 mL within 24 hours Massive PPH: Blood loss ≥2000 mL within 24 hours, hemodynamic instability or sign of shock
A NATA consensus statement 2019 [40]	Primary PPH: Blood loss >500 mL within 24 hours Severe PPH: Blood loss >1000 mL within 24 hours with signs/symptoms of hypovolaemia Massive life-threatening PPH: Blood loss >2500 mL or hypovolemic shock

concealed. In addition, the physiological hemodynamic changes that occur during pregnancy may mask the typical clinical signs of hypovolemia. Hemodynamic changes which may occur after PPH is variable and depend on several factors such as hematocrit before delivery, cardiovascular status, and the rate of blood loss.

So, the correlation between blood loss and clinical signs is not reliable [41].

Clinical and laboratory parameters that can provide clues for early or undetected postpartum hemorrhage are summarized in Table 53.2.

Shock index: This is a simple-to-use parameter helpful to assess the amount of blood loss and the degree of hypovolemia in hemorrhagic shock, including PPH [43, 44]. The calculation of the shock index is simple: divide the heart rate by the systolic blood pressure. The normal value of the shock index is between 0.5 and 0.7, and a higher value indicates the presence of shock and is associated with hemodynamic instability.

The peak shock index may be a superior parameter for detecting PPH compared to heart rate or systolic blood pressure [45]. However, the shock index alone is not a good screening tool and should be used with other parameters [46].

Other methods: Various methods, such as visual estimation, direct measurement using calibrated drapes, and the gravimetric technique (which involves weighing blood-soaked materials), are used for estimating blood loss after vaginal birth. However, there is insufficient evidence to support the use of one method over another [47].

Due to the variable clinical signs of hemorrhagic shock and the lack of a rapid and reliable method to accurately detect the amount of blood lost early, the delay in diagnosis of postpartum hemorrhage and its severity is common. This can lead to a delay in therapy. Therefore, the initial step in the appropriate management of PPH is maintaining a high index of suspicion, and the onset of symptoms and signs of volume loss warrants aggressive volume replacement.

Fluid management in PPH

The medical strategy described as damage control resuscitation (DCR) is used to manage severe acute PPH. Its goal is to limit secondary blood loss, stabilize the patient's condition as quickly as possible and prevent further tissue damage [48, 49].

The main measures for damage control resuscitation include:

Table 53.2 Clues for early or undetected postpartum hemorrhage [42]

Clinical parameters	Laboratory parameters
Tachycardia (>100 bpm) in the absence of clinical hypovolemia and with adequate pain control	Hb fall >2 gm/dL before administration of IV fluids
Hypotension (BP ≤85/45 mmHg or blood pressure fall by 20% from the baseline value)	Severe metabolic acidosis (e.g., base excess <-4, pH <7.2)
Oliguria (urine volume <500 ml/day)	Shock index of >0.9
Persistent or recurrent maternal hypotension despite active fluid resuscitation and/or use of vasopressor drugs	High serum lactate level >4.0 mmol/L
Excessive requirement of IV fluids	Presence of coagulopathy
Cool extremities, tachypnea, inappropriate fear, restlessness, or confusion	-

1. Hypotensive fluid resuscitation.
2. Blood product transfusion.
3. To identify and control the sources of bleeding as quickly as possible by medical and damage control surgery.

Supportive measures such as raising the legs, administering oxygen, and warming the body in patients with PPH can help improve hemodynamic stability.

1. Fluid resuscitation

Draw blood for baseline measurements, and obtain an intravenous line with wide a bore cannula. Compared to 18 gauge, 14 gauge cannula can infuse almost double the fluid volume.

Until blood is available, start immediate rapid replacement with crystalloids or colloids for resuscitation and to maintain adequate tissue perfusion.

All crystalloids administered during resuscitation should be warmed and, if possible, given using rapid infusion devices to improve effectiveness and speed.

a. How much crystalloid to infuse?

For resuscitation in PPH, infuse crystalloids initially to maintain blood pressure while waiting for blood products. Two modalities with different approaches used for fluid resuscitation in PPH are the conventional aggressive approach and the currently recommended hypotensive fluid resuscitation approach [48].

b. Aggressive fluid resuscitation

The conventional aggressive approach is a traditionally used method in which large volume (>2 liters) of crystalloids are administered to rapidly expand the effective circulating blood volume and restore blood pressure and hemodynamic stability [50, 51]. But current recommendations advise against using an aggressive resuscitation strategy due to the potential for adverse effects, such as coagulopathy due to dilution of coagulation factors, third spacing of fluids, and hypothermia, which can occur due to infusion of large volumes of cold crystalloids [52], and resultant adverse maternal outcomes [53].

c. Hypotensive fluid resuscitation

Permissive hypotension, also known as hypotensive fluid resuscitation, is an alternative method currently recommended as the preferred strategy for treating PPH. This more cautious approach involves restricting the use of crystalloid fluids to maintain the patient's blood pressure lower than normal to limit secondary blood loss until control of bleeding is achieved and to prevent fluid overload [50, 54]. The aim of administering small crystalloid volumes is to provide adequate tissue perfusion and oxygen delivery to the body's tissues but reduce the risk of dilutional coagulopathy and prevent the disruption of pre-formed blood clots [48, 55]. Multiple studies have shown that hypotensive resuscitation can improve survival rates and is considered a safe and effective fluid resuscitation strategy [50, 56–58].

Recent guidelines recommend avoiding using more than 2 liters of crystalloid solutions or 1.5 liters of colloids in the treatment of PPH before resorting to blood transfusion [34, 59]. In treating PPH, it is more important to rapidly replace fluids and warm the solutions than to focus on the specific type of fluid being infused [34].

d. Goals of fluid therapy

Crystalloids should be followed immediately with packed red cell replacement using packed red blood cells (RBC) to restore oxygen-carrying capacity and maintain hemoglobin greater than 8 gm/dL.

The goal of therapy is to maintain systolic pressure of 80–90 mm of Hg, urine

output >0.5 mL/kg/hr, and normal mental status. It is important to remember that, due to the benefits of permissive hypotension in PPH, the goal of therapy is not to maintain blood pressure in the normal range. So rather than following the standard practice of fluid administration, clinicians should adjust fluid infusion to maintain a target systolic blood pressure of 80–90 mm Hg until major bleeding has been controlled [60].

An alternative goal of fluid administration during the bleeding phase of severe postpartum hemorrhage is to achieve a low mean arterial pressure, which has been recommended to be between 50–60 mm Hg [60] and 55–65 mm Hg [40].

e. Colloids vs. crystalloids

Colloid solutions may be used as an alternative or an adjunct to crystalloids with the assumption of its greater and longer duration of volume expansion effect. But no colloid solution has been demonstrated to be superior to crystalloids. Compared to crystalloids, colloids are more expensive and carry a greater risk of adverse effects [61, 62]. According to guidelines from the World Health Organization (2012), an intravenous fluid replacement for PPH should be with isotonic crystalloids rather than colloids [35]. A Cochrane review (2018) that compared the use of colloids and crystalloids for fluid resuscitation in critically ill patients (excluding pregnant patients who had undergone cesarean section) found that resuscitation with colloids was not associated with an improvement in survival [20].

Based on these findings, for the resuscitation of women with PPH, isotonic crystalloids should be used in preference to colloids. Avoid dextrans in obstetric practice as they may interfere with platelet function and cross-matching and are hazardous [39]. Also, avoid using hydroxyethyl starch for resuscitation in major PPH [34].

f. Which crystalloid to give?

Ringer's lactate and normal saline are the two most commonly used crystalloid solutions for initial fluid resuscitation. They are routinely used, inexpensive, readily available solutions without significant side effects. Until blood is available, infuse crystalloid at a volume that is approximately three times the estimated volume of blood loss [39, 63].

Normal saline is usually administered in a labor ward because of its easy availability, low cost, and compatibility with blood transfusions and most drugs. But the infusion of large quantities (>2 L) of normal saline can cause hyperchloremic acidosis [63, 64] and acute kidney injury [65]. Ringer's lactate solution, compared to normal saline, has an electrolyte composition that more closely resembles plasma and can also buffer acidosis due to the metabolism of lactate to bicarbonate. Because of these properties, Ringer's lactate is considered more physiological than normal saline and is increasingly recommended as the first-choice resuscitation fluid [66].

Dextrose-containing IV solutions, such as 5% dextrose or dextrose with saline, should not be used in treating PPH because the rapid infusion of these solutions can cause hyperglycemia and resultant diuresis.

2. Blood replacement

Timely and adequate blood replacement is crucial and lifesaving in the treatment of severe PPH.

a. Intravenous fluids vs. blood

Because of the potential harms of large-volume crystalloid resuscitation (e.g., dilution coagulopathy, volume overload, and hypothermia) [67, 68], early blood transfusion should be managed after initial fluid administration.

The trend is growing (hemostatic resuscitation) to transfuse blood components early to correct hypovolemia and allow permissive hypotension in severe acute PPH [40, 48, 55, 69]. The rationale of this strategy is to reduce the contribution of crystalloid solutions and thereby prevent side effects associated with the administration of a large volume of crystalloids.

b. Indications of blood replacement

There are no clear guidelines for determining when a red blood cell transfusion should be infused [70, 71]. Patients with acute hemorrhage can have normal hemoglobin, so it is important to pay close attention to the clinical evaluation [71].

Common indications of red cell transfusion in PPH are [34, 38, 71–75]:

- Women with a hemoglobin value <6 gm/dL, irrespective of symptoms.
- Clinically severe uncontrollable postpartum hemorrhage.
- Blood loss of 1500 ml or more usually requires blood/pack cell transfusion.
- Blood is usually administered to symptomatic women (maternal tachycardia >110 beats per minute, dizziness, syncope) with active bleeding, irrespective of hemoglobin status. Do not wait for laboratory results; the decision to provide a blood transfusion should be based on clinical signs to avoid delay.
- The combination of a higher shock index (>9) and lactate levels (>4.0 mmol/L), with immediate postpartum lower hemoglobin, predicts the requirement for blood transfusion.
- Blood transfusion is usually not required when blood loss due to PPH is small, and the woman is asymptomatic.
- Women with PPH rarely require a blood transfusion if the hemoglobin is more than 10.0 gm/dL.

c. Selection of blood product

Packed red blood cells (PRBCs) are preferred for resuscitation and to avoid crystalloids-induced dilutional coagulopathy in women with massive hemorrhage. In cases of life-threatening PPH when the patient's blood group is unavailable or there is an anticipated delay in receiving cross-matched blood, consider using O Rh negative blood [34, 76].

Packed red blood cells are the preferred treatment for hypovolemic shock caused by hemorrhage, and each unit can be expected to increase the hemoglobin level by about 1 gm/dL [77].

Transfusion ratios: When a large volume of transfusion is required, recommended proportionate administration of red blood cells, fresh frozen plasma (FFP), and platelets are in a 1:1:1 ratio, which resembles the replacement of whole blood [38, 78]. Blood products transfused in a ratio, mimicking whole blood replacement, are associated with lesser complications and better survival [79].

d. Post-transfusion goals

The post-transfusion goals in the management of PPH are to maintain the following [80]:

- Hemoglobin level greater than 8 gm/dL.
- Platelet counts greater than 50,000/mm3.
- Fibrinogen level greater than 150–200 mg/dL.
- Prothrombin time is less than 1.5 times the normal value.

e. Adverse effects

With the changing trend to use early transfusions to achieve faster hemodynamic stability and avoid using the large

volume of crystalloids, a higher incidence of transfusion-related complications due to the administration of multiple units has been observed. Complications frequently encountered are hyperkalemia, hypocalcemia, allergic reactions, citrate toxicity, volume overload, and transfusion-related acute lung injury (TRALI).

Hyperkalemia and hypocalcemia (low ionized calcium) are common electrolyte abnormalities seen whenever multiple units of stored PRBCs are transfused rapidly. The risk of hyperkalemia is high following a massive transfusion because older stored PRBCs contain about 5 mEq of potassium per unit (300 mL).

The risk of developing hypocalcemia is high after rapidly transfusing large amounts of blood due to the presence of citrate, an anticoagulant, in the blood. Each unit of packed red blood cells contains about 3 mg of citrate. In very sick patients, the liver's ability to eliminate citrate may be impaired, leading to citrate accumulation in the blood. Accumulated citrate binds to circulating ionized calcium, leading to hypocalcemia and can cause citrate toxicity. Therefore, monitoring for and managing citrate toxicity in patients receiving large amounts of PRBCs or who have compromised liver function is essential Patients receiving large amounts of blood need the administration of calcium injections to prevent or correct hypocalcemia.

Ringer's lactate and blood should not be administered in the same line because the calcium in the RL solution may cause clotting.

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