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Postpartum Haemorrhage: A Persistent Threat in Maternal Health

Suchitra Mishra[1], Bhakti Kallirwar[2], Punam Sangrame[3], Ujwala Mahajan[4]

[1]Assistant Professor (Department of Pharmaceutics), Dadasaheb Balpande College of Pharmacy, Besa, Nagpur 440037, India
Corresponding Author Email: *suchitramishra38[at]yahoo.com*

[2, 3, 4]Dadasaheb Balpande College of Pharmacy, Besa, Nagpur 440037, India

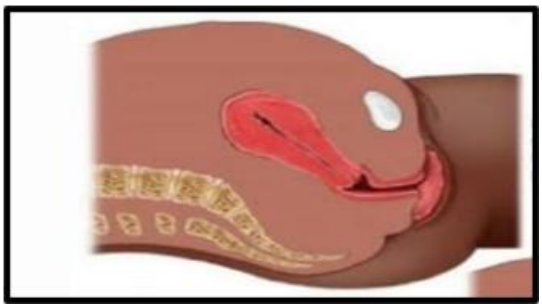
Abstract: ***Background**: Postpartum haemorrhage (PPH) remains a major contributor to maternal morbidity and mortality, particularly in low-resource settings, despite advances in obstetric care. It is commonly defined as blood loss exceeding 500 mL after vaginal delivery or more than 1000 mL following caesarean section within the first 24 hours after childbirth. Uterine atony is the leading cause of PPH, wherein the uterus fails to contract effectively after delivery. Other contributing factors include genital tract trauma, retained placental tissue, and coagulation disorders. Several maternal and obstetric risk factors- such as prolonged labour, multiple gestation, hypertensive disorders of pregnancy, and a prior history of PPH- further increase the risk of developing this condition. **Treatment**: Preventive strategies play a crucial role in reducing the incidence of PPH. Active management of the third stage of labour (AMTSL), which includes timely administration of uterotonic agents such as oxytocin, controlled umbilical cord traction, and uterine massage, is widely practiced to minimize blood loss. However, early recognition of PPH remains challenging due to underestimation of blood loss and delays in clinical intervention. Effective treatment requires a combination of pharmacological approaches- such as uterotonics and antifibrinolytics like tranexamic acid- and mechanical measures including uterine balloon tamponade and compression sutures. In cases of severe haemorrhage, surgical interventions such as arterial ligation or hysterectomy may be necessary. Timely access to blood transfusion services and advanced critical care facilities is essential for improving maternal outcomes. **Conclusion**: Despite significant progress in obstetric care, effective management of postpartum haemorrhage remains challenging in developing countries due to disparities in healthcare infrastructure, shortages of trained healthcare professionals, and limited access to essential medical supplies. Addressing these issues requires strengthening healthcare systems, implementing standardized clinical protocols, and providing continuous professional training. Improving emergency obstetric care and ensuring access to life-saving interventions can substantially reduce the global burden of postpartum haemorrhage.*

Keywords: Postpartum haemorrhage, vaginal delivery, placental tissue, maternal morbidity, maternal mortality

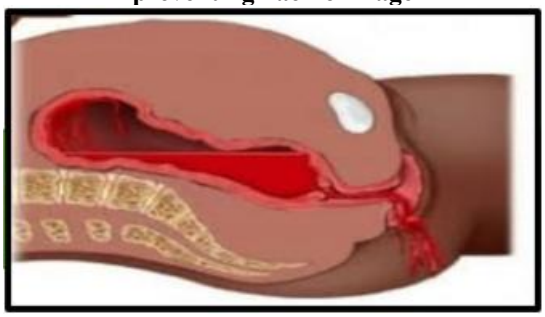
1. Introduction

Postpartum haemorrhage (PPH), defined as blood loss greater than 500 mL within the first 24 hours after delivery, (fig. 1) is the leading cause of maternal mortality worldwide. It accounts for approximately 13% of maternal deaths in developed countries and nearly 28% in developing countries (World Health Organization, 2012). Uterine atony is recognized as the most common cause of PPH. Intravenous or intramuscular oxytocin is recommended by the World Health Organization (WHO) as the first-line agent for the prevention of PPH (World Health Organization, 2012).

Oxytocin is widely used to induce or augment labour and has become routine practice in many developed countries. This endogenous hormone plays a critical physiological role in maintaining uterine contractility during labour and enhancing uterine tone after delivery to prevent postpartum bleeding (1). However, prolonged exposure to exogenous oxytocin during labour may lead to receptor desensitization, thereby reducing its effectiveness in the postpartum period and increasing the risk of atonic PPH. The impact of oxytocin administered during labour may vary depending on whether additional oxytocin is given after delivery as part of routine prophylaxis (2).



Normal postpartum condition with contracted uterus preventing haemorrhage



Postpartum haemorrhage with excessive uterine bleeding

Figure 1: Postpartum Haemorrhage

Current scenario of Postpartum Haemorrhage

Postpartum haemorrhage continues to pose a serious public health challenge worldwide, with approximately 14 million cases reported annually (1). The global case-fatality rate is around 1%, indicating that a woman dies from PPH

approximately every four minutes (2). Obstetric haemorrhage accounts for nearly 25% of all maternal deaths globally, with immediate postpartum haemorrhage responsible for almost half of these fatalities. The true incidence is likely underestimated due to underreporting and lack of reliable data in many regions.

Maternal mortality rates due to PPH vary widely across countries. In high-income nations, the risk of death from PPH is approximately 1 in 100,000 births, whereas in low-income settings the risk increases to nearly 1 in 1,000 births. According to WHO reports, postpartum haemorrhage remains the leading cause of maternal mortality in Africa and Asia, accounting for 34% and 30.8% of maternal deaths, respectively as shown in figure 2 (3).

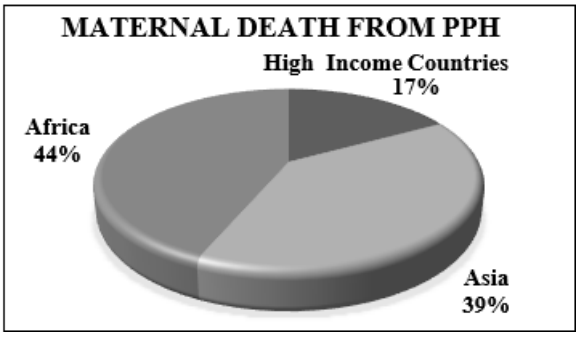


Figure 2: Current scenario of Postpartum Haemorrhage

Reducing the incidence of severe PPH remains a major challenge. Although individual risk factors are present in approximately 40% of women who develop PPH, these factors alone are insufficient for accurate prediction. Studies consistently highlight delayed diagnosis and inadequate management of blood loss as key contributors to maternal mortality (5). Improving clinical response systems and standardizing care protocols are therefore essential to reducing preventable deaths. Consequently, attention has been directed toward improving care procedures, as these aspects are modifiable and can significantly influence patient outcomes. Earlier research on maternal mortality has consistently shown that late detection and inadequate handling of blood loss are major factors leading to fatal cases of postpartum Haemorrhage. (6,7). Results from a population-level study on severe but non-fatal postpartum Haemorrhage raised comparable concerns, highlighting the importance of enhancing response measures (8).

Classification of Postpartum Haemorrhage

Postpartum haemorrhage is commonly classified based on timing and volume of blood loss. Primary PPH refers to blood loss of 500 mL or more occurring within the first 24 hours after delivery, is estimated to occur in around 6% of all births, while secondary PPH occurs from 24 hours up to six weeks postpartum whereas severe cases marked by a loss of 1000 ml or more known as secondary PPH, are seen in approximately 1.86% of deliveries (Table 1.) (9). Severe haemorrhage remains a major cause of maternal complications, including hypovolemic shock, coagulopathy, renal failure, acute respiratory distress syndrome, myocardial ischemia, hysterectomy, and long-term anemia- particularly in low-income countries (2).

Each year, an estimated 20 million women across the globe suffer from acute or long-term health impairments caused by immediate postpartum Haemorrhage. (2). Severe maternal morbidity associated with postpartum Haemorrhage is estimated to affect between 4.5 and 6.7 women per 1,000 births (10,11).

Table 1: Classification of Postpartum Haemorrhage

Types	Definition	Criteria
Primary PPH	Takes place within the first 24 hours after childbirth.	Blood loss > 500 mL (Vaginal) or > 1000 mL (C- section)
Secondary PPH	Takes place from 24 hours after delivery up to six weeks postpartum.	Prolonged or excessive bleeding

Recent population-based research from high-income nations shows an increasing trend in the occurrence of postpartum Haemorrhage and related maternal complications. This alarming increase necessitates further investigation to determine underlying factors contributing to the growing burden of PPH in settings with otherwise advanced healthcare systems (12,13).

A key challenge in managing the risk of postpartum Haemorrhage is the delay in its diagnosis and treatment. Such delays are often due to varying definitions of postpartum Haemorrhage, underreporting of blood loss during childbirth, insufficient management protocols, lack of communication among healthcare providers, and organizational weaknesses within healthcare systems (14). Despite the implementation of appropriate management protocols, severe PPH still follows approximately 3% of vaginal deliveries (15). Filling these gaps in care is essential for lowering maternal morbidity and mortality related to postpartum Haemorrhage.

Table 1 outlines the primary challenges encountered in PPH risk management and highlights the crucial areas requiring intervention. Upcoming research and healthcare efforts should prioritize improving early diagnosis, strengthening clinical response systems, and better allocating resources to reduce the negative impact of postpartum Haemorrhage on maternal health outcomes globally.

Causes of postpartum haemorrhage

The causes of postpartum haemorrhage are commonly summarized by the mnemonic “4 Ts”: Tone (uterine atony), Trauma (genital tract injury), Tissue (retained placental fragments), and Thrombin (coagulation disorders) shown in figure 3 (Table 2). Uterine atony accounts for approximately 80% of all PPH cases. Risk factors include uterine overdistension, multiple gestation, polyhydramnios, fetal macrosomia, and uterine fibroids (16).

Trauma-related PPH results from injuries to the cervix, vagina, or uterus and is often associated with instrumental delivery, prolonged labour, or uterine rupture. Retained placental tissue and abnormal placentation, including placenta previa and placenta accreta spectrum disorders, are also significant contributors. Coagulation disorders both inherited and acquired such as von Willebrand disease, HELLP syndrome, and disseminated intravascular coagulation (DIC) further increase the risk of severe haemorrhage (17).

This condition occurs when the myometrium does not contract adequately after childbirth, causing excessive bleeding during the postpartum period. Various maternal factors can increase the risk of uterine atony, such as the presence of fibroids (leiomyomata), carrying multiple fetuses, excessive amniotic fluid (polyhydramnios), and delivering a large baby, typically weighing 4,000 grams (8 pounds, 13 ounces) or more. (19).

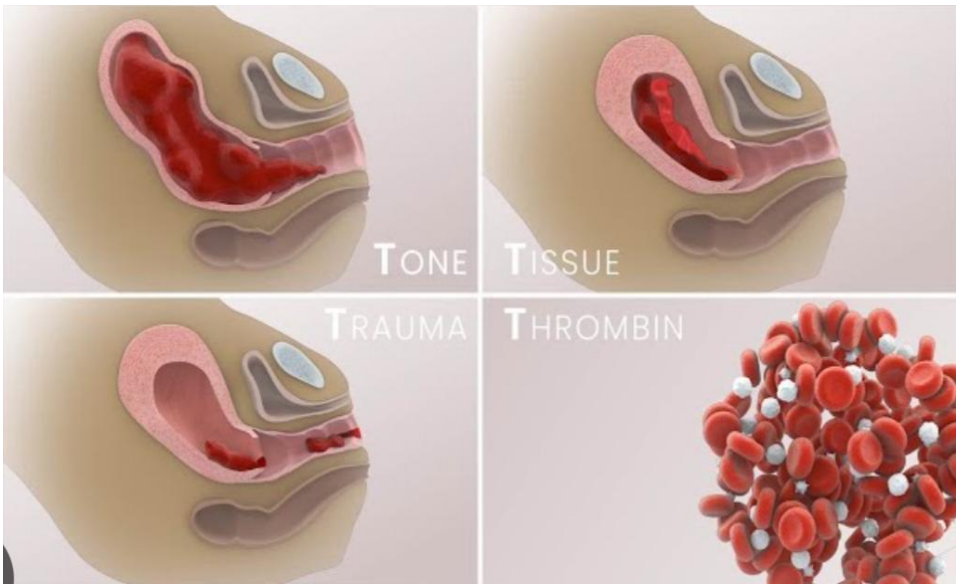


Figure 3: Four Ts of Postpartum Haemorrhage

Table 2: Causes of postpartum Haemorrhage

Causes	Description	Examples
Tone	Uterine atony	Overdistended uterus, Multiple gestation
Tissue	Retained placental fragments	Placenta accreta, Incomplete placenta removal
Trauma	Genital tract injuries	Uterine rupture, Cervical laceration
Thrombin	Coagulopathy	DIC, HELLP syndrome

Risk factors of Postpartum Haemorrhage

Risk factors for PPH include previous history of PPH, anemia, hypertensive disorders of pregnancy, prolonged or augmented labour, retained placenta, fetal macrosomia, multifetal gestation, and placental abnormalities. Importantly, a substantial proportion of PPH cases occur in women without identifiable risk factors, emphasizing the need for universal vigilance during childbirth. Certain medications are also associated with an increased risk of uterine atony. For example, magnesium sulfate used for neuroprotection in cases of severe preeclampsia and eclampsia and nifedipine commonly prescribed to control high blood pressure during pregnancy are known to contribute to this condition. In addition, specific obstetric complications such as chorioamnionitis, placental abruption, and abnormal placental attachment in the lower part of the uterus can heighten the likelihood of uterine atony, thereby worsening the severity of postpartum Haemorrhage. (1,20).

Table 3: Risk factors for postpartum Haemorrhage

Sr. No.	Issues	Reasons
1.	Medical or surgical history	Previous postpartum Haemorrhage
		Leiomyoma
		Previous caesarean delivery or other uterine instrumentation
2.	Foetal issues	Multifetal gestation
		Polyhydramnios
		Large-for-gestational-age foetus
3.	Maternal issues	Hypertensive disorders of pregnancy
		Anaemia
		Inherited or Acquired coagulopathy such as von Willebrand & HELLP syndrome
		Prolonged labor
		Induction and augmentation of labor
		Arrest of progress during the second stage of labor
		Prolonged third stage of labor
		Instrumentation during delivery (forceps)
4.	Placental/uterine issues	Placental abruption
		Placenta previa
		Retained placenta
		Chorioamnionitis
		Acute uterine inversion

Postpartum Haemorrhage caused by trauma is due to injuries sustained in the birth canal, often linked to factors like the use of instruments during delivery, extended labor, or the use of uterine stimulants such as IV oxytocin and vaginal prostaglandins (21,22). Uterine rupture is a severe form of trauma-related postpartum Haemorrhage, especially in women attempting vaginal birth after a previous cesarean section. The likelihood of uterine rupture increases notably in individuals who have had a previous cesarean delivery involving a low-vertical or high-vertical incision on the uterus

(22). Other contributing risk factors include placental abnormalities like retained fragments of the placenta, placenta previa, and placenta accreta (21).

The term "placenta previa spectrum" refers to situations in which the placenta is located on the lower part of the uterus, either partially or completely covering the cervical opening. Placenta accreta spectrum disorders are characterized by the abnormal attachment of the placenta to the uterine wall, with classification based on how deeply it invades: accreta (superficial attachment), increta (deeper invasion into the muscle), and percreta (penetration through the uterine wall). Placenta percreta represents the most extreme form of the condition, where the placenta penetrates completely through the uterine wall and may extend into surrounding organs (23).

Coagulopathies, both inherited and acquired, are another major cause of postpartum Haemorrhage (24). Von Willebrand disease is one of the most prevalent inherited coagulopathies that can lead to postpartum Haemorrhage (25). Acquired coagulopathies include disorders like HELLP syndrome (characterized by hemolysis, elevated liver enzymes, and low platelets) and disseminated intravascular coagulation (DIC) (26). Disseminated intravascular coagulation (DIC) can be triggered by serious obstetric issues such as placental abruption, amniotic fluid embolism, sepsis, foetal death, and HELLP syndrome (27). Placental abruption and amniotic fluid embolism are the most commonly seen causes in patients who present with acute coagulopathy and postpartum Haemorrhage (27). Placental abruption usually presents with pelvic pain, and vaginal bleeding might not be noticeable if the blood stays confined within the uterus. Continuous uterine monitoring with a tocodynamometer may reveal uterine tachysystole, characterized by excessive contractions. In contrast, individuals with an amniotic fluid embolism may experience sudden respiratory failure, hemodynamic collapse, and disseminated intravascular coagulation (DIC), often leading to high rates of morbidity and mortality (28).

Other frequent primary causes of postpartum Haemorrhage include lacerations of the cervix and vagina, as well as uterine inversion (22). Uterine inversion is a medical emergency that happens when the uterine fundus collapses into the uterine cavity, causing the uterus to turn inside out. This condition can be identified during a vaginal examination or may be seen protruding through the vaginal opening (29). A significant secondary cause of postpartum Haemorrhage is uterine subinvolution, where the uterus does not shrink back to its normal size after delivery, often due to retained placental fragments or infections like endometritis.

Various risk factors increase the likelihood of postpartum Haemorrhage, such as a history of previous PPH, hematocrit levels below 30%, retained placenta, failure to progress during the second stage of labor, a prolonged third stage lasting more than 30 minutes, fetal macrosomia, hypertensive conditions, and the use of labor induction or augmentation. (17,22). Moreover, racial disparities are present, as women of color are at a greater risk of experiencing complications related to postpartum Haemorrhage. Risk factors can be categorized into medical or surgical history, conditions related to the fetus, maternal health issues, and abnormalities in the placenta or uterus (Table 3). It is important to note that a significant number of PPH cases happen in women without any identifiable risk factors, emphasizing the necessity for careful monitoring during all deliveries.

Prevention of Postpartum Haemorrhage

Prevention of PPH relies primarily on active management of the third stage of labour, early identification of high-risk patients, and prompt access to emergency obstetric care. **Active Management of the Third Stage of Labor (**AMTSL) includes administration of uterotonic agents, controlled cord traction, and uterine massage. Oxytocin remains the preferred uterotonic agent due to its proven efficacy and safety profile.

Given its potentially life-threatening consequences, prompt and efficient management is necessary for improving maternal outcomes. Despite significant progress in obstetric care, postpartum Haemorrhage remains a significant public health issue, especially in areas with limited resources and restricted access to emergency obstetric care (30, 31). The most successful approaches to preventing postpartum Haemorrhage involve actively managing the third stage of labor (AMTSL), promptly administering uterotonic drugs, identifying high-risk patients early, and ensuring the availability of necessary obstetric care services (32).

1) Importance of Prevention

Recognizing risk factors is a key component in PPH prevention. The primary risk factors linked to postpartum Haemorrhage are uterine atony, retained placental fragments, birth-related trauma, and clotting disorders (33). Nevertheless, around 20% of postpartum Haemorrhage cases arise in women with no identifiable risk factors, emphasizing the importance of being universally prepared (34). Giving birth in healthcare facilities that have access to surgical care, intensive care units, and blood transfusion services has been proven to greatly lower the risk of maternal death due to postpartum Haemorrhage. (35).

2) Active Management of the Third Stage of Labor (AMTSL)

Giving birth in healthcare facilities that have access to surgical care, intensive care units, and blood transfusion services has been proven to greatly lower the risk of maternal death due to postpartum Haemorrhage. This method involves three key steps: the use of uterotonic medications, controlled traction of the umbilical cord, and massaging the uterus (36). Oxytocin (Pitocin) is the primary uterotonic drug used in active management of the third stage of labor and should be given right after the birth of the anterior shoulder or the newborn. (37). Clinical studies have shown that using oxytocin greatly lowers the occurrence of postpartum Haemorrhage, with an estimated number needed to treat (NNT) of seven to prevent one episode of blood loss (38).

Controlled cord traction, commonly referred to as the Brandt-Andrews maneuver, is an essential component of AMTSL that facilitates placental expulsion while minimizing the risk of retained placental tissue (39). Additionally, uterine massage following placental delivery promotes uterine contractility and enhances tone, thereby reducing excessive postpartum blood loss (40). While controlled cord traction alone may not

prevent severe PPH, it has been shown to significantly reduce the necessity for manual placental extraction, which carries its own risks (41).

3) Uterotonic Agents for PPH Prevention

Among the various pharmacological interventions for PPH prevention, oxytocin is the preferred uterotonic agent due to its well-established efficacy and favorable safety profile. It is typically administered either intravenously (10 IU in 1 L of saline at 250 mL/hr) or intramuscularly (10 IU) immediately following birth (42). Certain studies indicate that giving oxytocin after the placenta is delivered, rather than at the time of anterior shoulder delivery, may further decrease the risk of postpartum Haemorrhage (43).

In cases where oxytocin is contraindicated or insufficiently effective, alternative uterotonic agents may be used. Ergot alkaloids, such as methylergonovine (Methergine), enhance uterine contractions but are contraindicated in patients with hypertensive disorders due to their vasoconstrictive effects (44). Additionally, prostaglandin analogs such as carboprost (Hemabate) may be administered to improve uterine contractility; however, their side effects, including nausea, vomiting, and hypertension, require careful monitoring (45).

4) Non-Pharmacological Strategies for PPH Prevention

Beyond pharmacological approaches, several non-drug-based strategies contribute to reducing PPH-related complications. The involvement of skilled birth attendants, prompt identification of uterine atony, and swift resuscitation with blood products are essential for preventing and managing severe postpartum Haemorrhage (46). Moreover, ensuring that high-risk pregnancies are identified early and that deliveries take place in well-equipped healthcare settings significantly enhances maternal survival rates (47).

Treatment of Postpartum Haemorrhage

Postpartum Haemorrhage (PPH) continues to be a major childbirth complication, significantly impacting maternal health and survival, especially in low-resource settings where timely interventions may be difficult (51). Clinically, postpartum Haemorrhage is defined as blood loss greater than 500 mL after a vaginal delivery or over 1000 mL following a cesarean section, occurring either within the first 24 hours (primary PPH) or between 24 hours and six weeks postpartum (secondary PPH) (52). This condition is primarily attributed to four main causes, often referred to as the "4 Ts": uterine atony, retained placental fragments, trauma to the genital tract, and coagulation abnormalities. (53). Even with progress in obstetric care, postpartum Haemorrhage remains a serious risk to maternal health, requiring a comprehensive treatment strategy. Prompt identification, swift resuscitation, and specific interventions are crucial to managing bleeding, avoiding hypovolemic shock, and reducing the risk of severe complications like disseminated intravascular coagulation (DIC). (54).

1) Initial Assessment and Resuscitation

Prompt detection of PPH plays a pivotal role in reducing maternal mortality (55). Visual estimation of blood loss is frequently inaccurate and commonly leads to underreporting in clinical settings. (56). The use of calibrated drapes and collection bags for quantitative blood loss (QBL) measurement has enhanced the accuracy of diagnosis. (57). Once a diagnosis is made, it is essential to promptly stabilize the patient by evaluating vital signs, level of consciousness, and the tone of the uterus (58). At the same time, it is important to secure large-bore intravenous access and begin fluid resuscitation using isotonic crystalloids like normal saline or Ringer's lactate (59). When blood loss surpasses 1500 mL, it is necessary to initiate massive transfusion protocols, which involve administering packed red blood cells (PRBCs), fresh frozen plasma (FFP), platelets, and cryoprecipitate to manage hypovolemic shock and correct coagulation abnormalities. (60). Emerging research suggests that early fibrinogen replacement therapy may enhance survival outcomes in severe PPH cases complicated by DIC (61).

2) Pharmacological Management: Uterotonic Therapy

Treatment of uterine atony the most common cause of postpartum Haemorrhage (PPH) requires the use of uterotonic agents that stimulate contractions of the uterine muscles and help minimize blood loss. (62). Oxytocin is the preferred first-line agent due to its rapid efficacy (63). It is typically administered through an intravenous infusion, with a dose of 20–40 IU mixed in 1 liter of saline at a rate of 250 mL per hour, or as a 10 IU intramuscular injection in situations where IV access is limited. (64). Despite its effectiveness, oxytocin has a short half-life, requiring continuous administration to maintain uterine tone (65).

3) Mechanical and Surgical Interventions for PPH

When pharmacological management fails, mechanical and surgical interventions become essential (66). Immediate measures include uterine massage and bimanual compression to stimulate contraction (67). If uterine atony continues despite initial interventions, intrauterine balloon tamponade (IUBT) devices like the Bakri balloon, condom catheter, or Sengstaken-Blakemore tube can be employed to exert direct pressure within the uterus and help control bleeding. (68). Studies indicate that balloon tamponade successfully controls bleeding in 80-90% of cases, making it a highly effective minimally invasive option (69).

4) Tranexamic Acid: A Breakthrough in PPH Management

Tranexamic acid (TXA), an antifibrinolytic medication, has become an important supportive therapy in the management of postpartum Haemorrhage (PPH). (70). By preventing fibrin clot breakdown, TXA effectively reduces bleeding and improves survival rates when administered promptly (71). The World Health Organization (WHO) firmly recommends the use of tranexamic acid (TXA) in every instance of postpartum Haemorrhage (72). The pivotal WOMAN trial revealed that giving tranexamic acid (TXA) within three hours of the onset of postpartum Haemorrhage led to a 30% decrease in maternal deaths, especially in situations related to surgical issues or trauma (73).

5) Management of PPH Due to Coagulopathies and Trauma

PPH caused by coagulopathy, including DIC, HELLP syndrome, or amniotic fluid embolism, requires targeted hematologic management, such as transfusion of fresh frozen

plasma, platelets, cryoprecipitate, and recombinant factor VII a in severe cases (74). Trauma-induced PPH, resulting from perineal tears, cervical lacerations, or uterine rupture, necessitates prompt surgical repair or exploratory laparotomy. In extreme cases of uterine rupture or intractable bleeding, hysterectomy remains a last-resort intervention (75).

2. Future Directions and Innovations

Ongoing research continues to investigate novel treatment modalities for PPH, including recombinant clotting factors, non-pneumatic anti-shock garments (NASG), and gene therapy targeting coagulation pathways (76). The integration of point-of-care diagnostics, such as real-time coagulation monitoring and rapid hemostatic assays, is expected to refine treatment protocols and enhance maternal survival rates globally (77).

3. Conclusion

Postpartum haemorrhage remains a leading cause of maternal morbidity and mortality worldwide. Preventive strategies such as active management of the third stage of labour, early recognition of haemorrhage, and prompt intervention are essential to reducing its impact (48). Strengthening healthcare systems, improving access to skilled obstetric care, and implementing standardized treatment protocols are critical to lowering the global burden of postpartum haemorrhage, particularly in resource-limited settings. Although current interventions have demonstrated positive outcomes, additional research is needed to refine prevention strategies and enhance access to quality maternal healthcare, especially in resource-limited areas. (49,50).

Effectively managing postpartum Haemorrhage requires a comprehensive approach involving early recognition, aggressive resuscitation, and targeted interventions. Uterotonics remain the primary treatment, while mechanical and surgical techniques play a crucial role in refractory cases. Tranexamic acid has revolutionized PPH management by significantly reducing maternal mortality when administered early. Continuous advancements in minimally invasive procedures, pharmacologic agents, and interventional radiology continue to enhance the accessibility and efficacy of PPH treatment worldwide (78).

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