Perspective Article ISSN 2767-5416

Journal of Medical Clinical Case Reports

Optimizing Coagulopathy Management in Postpartum Hemorrhage : Preventive and Reversal Strategies for Resource-Limited Settings

Jolana Schmiedl[1*], Tshililo Mashamba[2], Gabriel Dogbanya[3] and Giancarlo Castaman[4]

[1]*CSL, Bern, Switzerland.*

[2]*Sefako Makgatho Health Science University, Ga- Rankuwa, Pretoria, South Africa.*

[3]*Doctoral student, Maternal and Child Health Family Science Department, School of Public Health at University of Maryland College Park, Maryland, US.*

[4]*Center for Bleeding disorders and Coagulation, Careggi University Hospital, Florence, Italy.*

***Corresponding Authors**

Jolana Schmiedl,
CSL, Bern, Switzerland.
E- Mail : jolanaschmiedl@gmail.com

Submitted: 9 Mar 2026; **Accepted:** 16 Mar 2026; **Published:** 25 Mar 2026

Citation: Schmiedl, J. et al., (2026). Optimizing Coagulopathy Management in Postpartum Hemorrhage : Preventive and Reversal Strategies for Resource-Limited Settings. *J Medical Case Repo* 8(2):1-11. DOI : https://doi.org/10.47485/2767-5416.1148

Abstract

Unexpected bleeding following childbirth remains the leading cause of maternal mortality worldwide. In 2023, an estimated 260,000 women died during pregnancy, delivery, or the postpartum period—equivalent to nearly one maternal death every two minutes (1). Since the launch of one of the pioneering global initiatives to reduce maternal and child mortality in 1987, maternal mortality has declined by approximately 40% since 2000 (2). However, progress remains insufficient. The recently published Consolidated Guidelines for the Prevention, Diagnosis, and Treatment of Postpartum Hemorrhage (3) introduce new strategies for predicting maternal mortality and severe morbidity, aiming to contribute to the global target of 70 maternal deaths per 100,000 deliveries. Coagulopathies, both acquired and inherited represent a significant risk for development of postpartum hemorrhage. This perspective aims to examine the affordability and implementation readiness of countries contributing most significantly to the persistently high maternal mortality burden.

Keywords: Postpartum hemorrhage, coagulopathy reversal, patients' blood management, risk factors for massive blood loss, protocols for bleeding management.

Introduction

Despite notable advances in the prevention, diagnosis, and management of obstetric risk factors, as well as improved dissemination of health information over the past two decades, childbirth continues to represent a substantial health risk for women in many countries.

In 2017, the American College of Obstetricians and Gynecologists (ACOG) defined PPH as an estimated blood loss exceeding 500 mL following vaginal delivery or more than 1000 mL after cesarean section (4). However, because visual estimation of blood loss is often inaccurate, ACOG subsequently revised its definition to emphasize clinical relevance: cumulative blood loss greater than 1000 mL accompanied by signs or symptoms of hypovolemia within 24 hours of birth, regardless of the mode of delivery (4). PPH is further categorized by timing into primary and secondary forms. Primary PPH typically occurs within the first 24 hours postpartum, whereas secondary PPH develops from 24 hours up to 12 weeks after delivery (5).

The Royal College of Obstetricians and Gynecologists (RCOG) traditionally defines primary PPH as blood loss of 500 mL or more from the genital tract within 24 hours of birth (5), a definition endorsed by the World Health Organization (WHO). In addition, RCOG provides a severity-based classification: minor PPH refers to blood loss between 500 and 1000 mL, while major PPH is defined as blood loss exceeding 1000 mL. Major PPH is further subdivided into moderate (1000–2000 mL) and severe (>2000 mL) categories (5, 26). These evolving definitions underscore the importance of both quantitative and clinical criteria in guiding timely diagnosis and intervention.

According to the World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC), maternal mortality is defined as the death of a woman during pregnancy or within 42 days after the termination of pregnancy, from any cause related to or aggravated by the pregnancy or its management, regardless of the duration or location of the pregnancy, but not from accidental or incidental causes (6).

Hemorrhage continues to be the leading cause of maternal mortality worldwide. Over the past four decades, numerous global health initiatives have prioritized the reduction of hemorrhage-related deaths, underscoring the persistently high and unacceptable burden among pregnant and postpartum women (7). A recent WHO report estimates that

more than 260,000 maternal deaths occurred in 2023, with approximately 92% of these deaths taking place in low- and middle-income countries. Between 2000 and 2023, high-income countries achieved nearly a 40% reduction in maternal mortality; however, global progress has been considerably slower. Factors such as remaining early maternal age , HIV, COVID 19 infections, and hypertension have contributed to this stagnation, impeding progress toward the Sustainable Development Goal of reducing maternal mortality to fewer than 70 deaths per 100,000 live births worldwide (8). In 2023, Sub-Saharan Africa and Southern Asia together accounted for approximately 87% (225,000) of global maternal deaths, with Sub-Saharan Africa alone responsible for about 70% (182,000) with mortality rate > 1000 in 100 000 in Nigeria, Chad and Uganda (Makuochi Okafor BBC correspondent, November 2024, based on information from - Nigeria offers free Caesareans to poorer women) and Southern Asia for 17% (43,000) (6, 8).

Pregnancy is characterized by increased levels of procoagulant factors alongside a reduction in anticoagulant activity, resulting in a physiological prothrombotic state (9). Coagulopathies associated with postpartum hemorrhage (PPH), however, differ fundamentally from those observed in trauma-induced massive hemorrhage when shock plays an important role in coagulopathy development. The underlying mechanisms of coagulopathy in PPH reflect varying contributions of dilutional coagulopathy, localized factor consumption, disseminated consumption, and/or enhanced fibrinolysis (10). Special attention needs to be given to history of heavy menstrual bleeding, as it can be a symptom of undiagnosed von Will brand disease. Similarly to carriers of hemophilia A pr B who did not present severe bleeding symptoms before or during pregnancy. Inherited bleeding disorders, in particular the mild and moderate forms are often not diagnosed and could put the women at risk of developing PPH (11).

Dilutional coagulopathy arises from the replacement of blood loss with crystalloid or colloid fluids, leading to reduced concentrations of coagulation factors and platelets. Localized consumption of coagulation factors at the placental bed and uterus is most pronounced in cases of placental abruption and may also be observed consequently of uterine atony or when placental tissue is retained or abnormally adherent. Although disseminated intravascular coagulation (DIC) is uncommon in PPH, it may develop in association with amniotic fluid embolism (AFE), severe infection, or in severe cases of placental abruption and pre-eclampsia (12).

Early coagulopathy is uncommon when postpartum hemorrhage (PPH) is predominantly caused by uterine atony or genital tract trauma. Wikkelso et al. reported on a cohort of 244 women with severe PPH primarily attributable to uterine atony (50%), followed by trauma, or retained placental tissue, in whom the median baseline fibrinogen concentration was 4.5 g L^{-1}; notably, 25% of fibrinogen values were below the pregnancy-adjusted normal range (<3.7 g L^{-1}) (13). Similarly, in a cohort of 272 women, with estimated blood loss of 1000–2000 mL secondary to atony or trauma, Collins et all showed that more than 97% exhibited normal prothrombin time (PT), activated partial thromboplastin time (aPTT), and fibrinogen concentrations >2 g L^{-1} (10).

In contrast, early coagulopathy is more frequently observed in cases of placental abruption and amniotic fluid embolism (AFE) (12). Importantly, PPH of any etiology may become complicated by coagulopathy when diagnosis is delayed or blood loss is underestimated, highlighting the critical importance of early recognition and prompt, appropriate management of PPH (15).

Several initiatives towards improvements in maternal mortality ratio (MMR) have been successfully implemented in high income countries among them systematic education and implementation of a bundle of population-based initiatives to reduce hemorrhagic maternal deaths in Italy (15). Approaches that prioritize early identification of warning signs and need for timely intervention are particularly relevant in resource-limited settings, where access to advanced corrective measures is often constrained. Global initiatives such as the Every Woman Every Child strategy and WHO's maternal health guidelines have demonstrated positive impacts on maternal health outcomes, contributing to significant reductions in MMR in countries like India and Tanzania (17). In addition, several scientific organizations have sought to standardize strategies for reducing uncontrolled hemorrhage as a cause of maternal death. However, clear alignment remains limited across key measures, including the prevention of difficult-to-control bleeding, methods for quantifying blood loss, timing of coagulation-corrective interventions, and the thresholds and clinical correlations guiding decisions on coagulation factor replacement (16). The recently published WHO Consolidated Guidelines for the Prevention, Diagnosis, and Treatment of Postpartum Hemorrhage introduced new strategies for predicting maternal mortality and severe morbidity. These approaches are particularly relevant for low- and lower-middle-income countries, as they focus on early identification of warning signs to prevent life-threatening bleeding situations where corrective options are limited. However, translating these high-level strategies into practical, stepwise implementation plans that are both feasible and affordable in LMIC contexts remains a major barrier to progress. Common challenges include inadequate health infrastructure, shortages of skilled healthcare professionals, limited availability of educational and training resources, financial constraints, and sociocultural factors that hinder timely care-seeking behaviour (18).

Both the maternal and fetal outcomes of pregnancy vary greatly according to a pregnant woman's community and her condition. When obstetric hemorrhage occurs, an acute acquired coagulopathy evolves unless hemorrhage is controlled.

In this perspective, we aim to address these gaps by examining the feasibility of implementing. Our investigation focuses on identifying structural and operational barriers, highlighting opportunities for context-specific adaptation. We seek to

contribute to the global effort to reduce maternal mortality and advance equity in maternal health care.

Material and Methods

We conducted literature search from two regions in Africa- Nigeria and South Africa- to assess the affordability of implementing evidence-based interventions for the prevention, diagnosis, and management of postpartum hemorrhage. In addition, we revised information from local experts in this field. These findings were subsequently compared against FIGO ICM *WHO Consolidated Guidelines for the Prevention, Diagnosis, and Treatment of Postpartum Hemorrhage.*

Findings

South Africa

In 2022, maternal mortality data were analyzed using reports from the National Committee for Confidential Enquiries into Maternal Deaths (NCCEMD) and the District Health Information System (DHIS). A total of 993 deaths during pregnancy, childbirth, and the puerperium were recorded, of which 969 were classified as maternal deaths after excluding coincidental causes. Following adjustments for discrepancies between NCCEMD and DHIS reporting in Gauteng, Limpopo, and KwaZulu-Natal, the corrected number of maternal deaths was 1,062 among 986,128 live births, yielding an institutional maternal mortality ratio (iMMR) of 109.6 per 100,000 live births. This represents a decline from 148.1 in 2021 and 126.1 in 2020, approaching pre-pandemic levels (98.8 in 2019). The reduction in iMMR was observed across all provinces. Non-pregnancy-related infections remained the leading cause of maternal death (18.6%), though markedly reduced compared to 2021 (37%). COVID-19-related deaths decreased substantially (12 in 2022 vs. 369 in 2021). Hypertensive disorders (17.1%) and obstetric hemorrhage (16.7%) were the next most common causes, followed by medical and surgical disorders (14.4%) and early pregnancy complications (10%). These findings indicate a reversal of the pandemic-related increase in maternal mortality and highlight persistent causes requiring targeted interventions.

According to Professor Fawcus' 2024 report from a promoter trial, only 26% of women with blood loss between 500 and 600 mL received uterotonics. Even among those with blood loss exceeding 1,000 mL, only 30% received uterotonics. These findings indicate that the recommended first-line intervention for a life-threatening condition was not implemented in more than half of the cases with moderate to severe postpartum hemorrhage (19). In addition to these clinical findings, logistical constraints in laboratory turnaround times further complicate management of PPH. Data from Sefako Makgatho Health Sciences University indicate that fibrinogen activity results are typically available within one day in private hospitals, compared with approximately two days in government facilities. For specialized assays, such as Factor VIII and von Will brand factor activity levels, turnaround times may extend up to four days. These delays highlight the importance of protocols that prompt initiating replacement therapy empirically, without awaiting laboratory confirmation, while reserving available results for subsequent confirmation of congenital coagulation disorders (19).

To reduce the MMR in South Africa, a comprehensive approach combining nutritional optimization, risk stratification, preparedness, availability of laboratory test and vigilant monitoring might be essential to minimize the occurrence of PPH and improve maternal outcomes.

Nigeria

The latest global report highlights Nigeria as bearing the highest estimated maternal mortality burden worldwide, accounting for approximately 28.3% of all maternal deaths. This translates to an estimated 8,200 maternal deaths annually and a maternal mortality ratio (MMR) of 1,047 per 100,000 live births. These figures are compounded by significant gaps in maternal healthcare coverage: only 43% of births are attended by skilled health providers, 39% occur in health facilities, and 59% take place at home. Such disparities reflect systemic challenges in access to quality obstetric care and underscore the urgent need for targeted interventions (20).

Achieving the Sustainable Development Goal 3(SDG) target of reducing maternal mortality will require a multifaceted approach, including strengthening health systems, expanding skilled birth attendance, improving emergency obstetric care, and implementing robust community-based advocacy programs. Without accelerated efforts, Nigeria's maternal mortality burden will continue to pose a major global health challenge.

A large-scale study utilizing data from the Maternal and Perinatal Database for Quality, Equity, and Dignity in Nigeria (MPD-4-QED) examined the prevalence of primary postpartum hemorrhage (PPH), associated risk factors, and maternal and neonatal outcomes across a nationwide network of 54 tertiary referral hospitals (48 public and 6 private) spanning six geopolitical zones in Nigeria (21). The analysis included 68,754 women with documented mode of delivery and PPH status. Among these, 2,169 cases of PPH were identified, corresponding to an overall prevalence of 3.2% (95% CI: 3.07–3.30). When stratified by delivery mode, the prevalence was 2.7% following vaginal birth and 4.0% after cesarean section. The sociodemographic analysis indicated that women who experienced PPH were disproportionately characterized by the absence of formal education, higher parity, and inadequate or absent antenatal care, or antenatal care received at a different facility. Regarding PPH prophylaxis, 45.5% of women were administered oxytocin alone, whereas 43% received a combination of oxytocin and misoprostol (21).

A secondary analysis of samples collected during the WOMAN trial at University College Hospital, Ibadan, Nigeria, investigated hematological and hemostatic parameters in 167 women with postpartum hemorrhage (PPH) (22). ROTEM (Rotational thrombo-elastometry-a point of care viscoelastic test that provides a comprehensive, real – time graphical analysis of whole blood clot formation, strength

and breakdown) analysis revealed that 23% of participants demonstrated evidence of hyperfibrinolysis. In addition, 12% exhibited coagulopathy based on prothrombin ratio criteria, while 34% presented coagulopathy according to EXTEM A5 measurements. These findings highlight a substantial proportion of women with impaired coagulation profiles, suggesting that both fibrinolytic activity and clot firmness abnormalities are common in PPH cases within this cohort (22).

The authors concluded that women in the analyzed cohort exhibited a higher prevalence of hyper fibrinolytic activity compared with reports from high-income countries. For instance, de Lange et al. documented a prevalence of 9% following normal delivery and one hour after placental expulsion (ML <15%) with D-dimers elevation (47). In contrast, the mean blood loss in the present cohort was 1,548 mL (SD 897), indicating more severe hemorrhage. Unforeseen, the mean fibrinogen level was 8.4 g/l (SD 6.6), fibrinogen levels below 1g/L occurred only in 2,9% of participants and below 2g/L in 11,8% (in 33% of participants was the fibrinogen level < 4g/l), which the authors attributed to chronic inflammation associated with HIV infection and its treatment. Furthermore, a substantial proportion of participants (88%) had hemoglobin concentrations below 110 g/L, and 34% were below 70 g/L. The increased incidence of coagulopathy was therefore considered as consequence of more severe PPH in this population. Considering the Consolidated guidelines for prevention, diagnostic and treatment of PPH it is noteworthy that the mean systolic blood pressure was approximately 110 mmHg at baseline.

Recommendations

Consolidated Guidelines for the Prevention, Diagnosis, and Treatment of Postpartum Hemorrhage (3).

Despite the availability of proven interventions for preventing, diagnosing, and managing postpartum hemorrhage (PPH), implementation remains inconsistent and often delayed due to late recognition and fragmented, sometimes conflicting, international guidelines. Broader health system challenges—including weak supply chains, workforce shortages, and limited infrastructure—further hinder uptake of evidence-based practices, contributing to persistent maternal morbidity and mortality. Comprehensive, harmonized guidance addressing these systemic barriers is essential to strengthen global PPH response. These guidelines aim to inform national and subnational health policies, clinical protocols, and programmatic strategies. The primary audience includes health professionals involved in developing maternal care guidelines and those providing direct care during pregnancy, childbirth, and the postpartum period, such as midwives, obstetricians, nurses, anaesthesiologists, and program managers. They are also relevant to professional societies, NGOs promoting woman-centered care, and implementers of maternal and child health programs across all settings.

Antenatal Prevention

Full blood count testing is the preferred method for diagnosing anemia in pregnancy; where unavailable, on-site hemoglobin testing using a haemoglobin meter is recommended over the hemoglobin colour scale. To prevent maternal anemia, puerperal sepsis, low birth weight, and preterm birth, daily oral supplementation with 30–60 mg of elemental iron and 400 µg of folic acid is recommended for all pregnant women. Higher iron doses are advised for women with low hemoglobin levels at booking to ensure hemoglobin concentrations are optimized and pose minimal risk at the time of labour. In populations with anemia prevalence below 20%, or where daily iron is not tolerated, intermittent weekly supplementation with 120 mg elemental iron and 2.8 mg folic acid may be considered. For women with iron-deficiency anemia who cannot tolerate oral iron or require rapid correction, intravenous iron therapy is recommended, provided appropriate monitoring for anaphylaxis is available.

For intrapartum prevention of bleeding complications, routine or liberal use of episiotomy is not recommended in women undergoing spontaneous vaginal birth (3). Evidence indicates that episiotomy does not reduce the risk of severe perineal trauma or postpartum hemorrhage and may increase maternal morbidity, including pain, infection, and delayed healing. Restrictive use, limited to clear clinical indications, is associated with better maternal outcomes and reduced complications.

A significant shift in the timing for alerting the multidisciplinary team and/or transferring the mother to a tertiary facility lies in the early identification of women at risk of adverse outcomes and the prompt initiation of first-response therapy. Specifically, intervention should be triggered by an objectively measured blood loss of ≥300 mL accompanied by any abnormal hemodynamic sign (pulse >100 bpm, shock index >1, systolic blood pressure <100 mmHg, or diastolic blood pressure <60 mmHg), or by a blood loss of ≥500 mL, whichever occurs first within 24 hours after birth, with heightened vigilance during the first two hours postpartum.

The use of a quality-assured uterotonic is recommended for the prevention of postpartum hemorrhage (PPH) during the third stage of labour for all births. To ensure effectiveness, only one uterotonic should be administered: oxytocin (10 IU intramuscularly or intravenously), carbetocin (100 µg intramuscularly or intravenously, with heat-stable formulation preferred where cold chain cannot be guaranteed), or misoprostol (400–600 µg orally). When intravenous access is already established, oxytocin should be given intravenously—diluted and administered slowly over 1–2 minutes—in preference to intramuscular injection. Uterotonic options that are not recommended for the prevention of postpartum hemorrhage include ergometrine/methylergometrine, fixed-dose combination of oxytocin and ergometrine, and injectable prostaglandins Heat-stable carbetocin (100 µg intramuscularly or intravenously) is recommended for the prevention of postpartum hemorrhage (PPH) in settings where the oxytocin cold chain cannot be maintained. If carbetocin is unavailable, misoprostol (400–600 µg orally) may be used as an alternative. Misoprostol administration by community or lay health

workers is advised where skilled personnel are not present, and antenatal distribution for self-administration can be considered in home-birth settings with appropriate monitoring. Although the above mentioned guidelines do not recommend the use of tranexamic acid (TXA) for the prevention of postpartum hemorrhage (PPH) prior to either vaginal or cesarean delivery (page 12), the 2021 ASH/ISTH/NHF/WFH guidelines support the use of TXA in women with inherited bleeding disorders in addition to appropriate replacement therapy (23). For women with von Will brand factor (VWF) levels of at least 50 IU/dL, TXA is the recommended hemostatic agent during delivery and throughout the postpartum period. A dose of 1 g should be administered once the patient is in established labour and then repeated every 6-8 hours. Postpartum, oral TXA should be continued for 4–6 weeks to reduce the risk of secondary PPH (24).

Sustained uterine massage is not recommended for the prevention of postpartum hemorrhage (PPH) in women who have received prophylactic oxytocin. For all births, routine objective measurement of postpartum blood loss is advised to improve early detection and timely treatment of PPH. Methods such as calibrated drapes for vaginal deliveries provide a reliable approach to quantifying blood loss.

Early Intervention

For the treatment of PPH, intravenous oxytocin is the first-line uterotonic. If oxytocin is unavailable or ineffective, intravenous ergometrine, an oxytocin–ergometrine fixed-dose combination, or a prostaglandin (including 800-µg sublingual misoprostol) may be used. Uterine massage is recommended as part of initial management. Early administration of intravenous tranexamic acid within 3 hours of birth, in addition to standard care, is advised for all women with PPH following vaginal or caesarean birth. For fluid resuscitation, isotonic crystalloids are preferred over colloids.

Uterine balloon tamponade is recommended for the treatment of PPH due to uterine atony after vaginal birth when standard first-line interventions fail, provided specific conditions are met: immediate access to surgical intervention and blood products if required; implementation of a first-line PPH protocol (including uterotonics, tranexamic acid, and intravenous fluids); exclusion of other causes such as retained tissue or trauma; performance by trained health personnel; and the ability to monitor maternal condition for early signs of deterioration. Cell salvage is recommended for the treatment of PPH only in the context of rigorous research.

If available, fibrinogen replacement should be prioritized, with a therapeutic target of ≥2 g/L. When fibrinogen is <2 g/L, cryoprecipitate should be administered to achieve this level, typically requiring 3–4 g of fibrinogen (approximately 8–10 units), preferably pathogen-reduced. The effectiveness of recombinant factor VIIa and prothrombin complex concentrate remains uncertain. Fresh frozen plasma (FFP) may be considered in cases of documented coagulation factor deficiency, guided by laboratory results; if results are delayed and four units of RBCs have been transfused, 15-20 mi/kg of FFP can be administered, or in an infusion in the ratio of 1:2 (FFP: RBC), using AB plasma if blood type is unknown. The therapeutic goal is PT/aPTT <1.5 and INR ≤1.5. Platelet transfusion should be considered when microvascular bleeding is evident and platelet count falls below 50 × 10^9/L, with a standard dose of 4-5 pooled whole blood-derived platelet units. In massive PPH, a stepwise approach is recommended: early TXA administration (1 g IV over 10 minutes), fibrinogen replacement over FFP when coagulopathy is suspected, FFP for confirmed factor deficiency or massive blood loss, and platelet transfusion as indicated.

Postpartum women may receive oral iron supplementation, alone or combined with folic acid, for 6–12 weeks after delivery to reduce the risk of anemia in settings where gestational anemia is a public health concern. For women with iron-deficiency anemia who cannot tolerate oral iron or require rapid correction, intravenous iron therapy is recommended, provided trained staff are available to manage potential anaphylactic reactions.

Health systems interventions for PPH

Health facilities should implement formal protocols for the prevention, diagnosis, and treatment of PPH, as well as clear referral pathways to higher-level care when needed. Regular simulation-based training for both pre-service and in-service programs is recommended to strengthen provider readiness. Monitoring the use of uterotonics after birth should be adopted as a process indicator for programmatic evaluation to ensure adherence to best practices.

Recommendation South Africa

Preventive measures include addressing anemia in girls and women through balanced diets, treatment of heavy menstrual bleeding including appropriate referral to hematologists, **monitoring and treatment of** chronic infections, and routine iron supplementation during pregnancy.

Risk anticipation involves identifying women at high risk and ensuring delivery at referral hospitals equipped with PPH kits containing intravenous fluids, cannulas, uterotonics, internal tamponade devices, and blood products. Intrapartum strategies include preventing prolonged labour using programs and active management of the third stage of labour with oxytocin (10 IU intramuscularly). Postpartum and post-cesarean monitoring of vital signs and bleeding is critical for early detection and prevention of severe PPH and associated complications.

A comprehensive approach combining nutritional optimization, risk stratification, preparedness, and vigilant monitoring is essential to minimize PPH and improve maternal outcomes.

Clinical Assessment and Monitoring of Postpartum Hemorrhage

Timely diagnosis and management of PPH depend on accurate assessment of blood loss. Blood loss exceeding 500 mL, brisk bleeding, or the presence of multiple clots should prompt

immediate evaluation. Blood loss may be assessed using calibrated drapes or trays, visual estimation, weighing of soaked materials, and measurement from suction containers.

Vital signs offer important diagnostic information but often reflect advanced blood loss. Tachycardia (heart rate >110 beats/min), systolic blood pressure <100 mmHg, and a shock index >0.9 suggest hemodynamic compromise, while late signs include pallor, confusion, cold extremities, and restlessness. Clinicians should remain alert to the possibility of concealed bleeding.

Post-delivery monitoring is essential and should continue for 1–2 hours in the labour ward, followed by structured handover to the postnatal ward with clear documentation of maternal status.

The EMOTIVE approach—comprising early detection and recognition of triggers, uterine massage, administration of oxytocin (uterotonics), tranexamic acid, intravenous fluid resuscitation, systematic examination, and timely escalation—represents the minimum standard of care for managing signs of postpartum hemorrhage (PPH) in resource-limited settings. In addition, early referral to the operating theatre is recommended to enable definitive interventions when required.

An international cluster-randomized trial involving over 200,000 women across four countries evaluated a multicomponent clinical intervention for postpartum hemorrhage among women undergoing vaginal delivery. The study demonstrated that objectively measuring blood loss using a simple, low-cost collection device ("drape") and implementing WHO-recommended treatments as a bundled intervention—rather than sequentially—led to substantial improvements in maternal outcomes. Severe postpartum hemorrhage, defined as blood loss exceeding one liter, was reduced by approximately 60%, with a corresponding reduction in maternal mortality (19).

Management of Refractory Postpartum Hemorrhage

Refractory PPH, affecting approximately 10–20% of women unresponsive to first-line therapy, requires rapid escalation to prevent maternal morbidity and mortality (25). According to South African Ministry of Health guidelines, initial management includes bimanual uterine compression and, if necessary, aortic compression to reduce uterine blood flow. Pharmacologic therapy should be optimized with repeat tranexamic acid, intramuscular syntometrine (avoided in women with hypertension or cardiac disease), and sublingual misoprostol 400–600 µg.

Ongoing assessment should focus on identifying contributing causes such as cervical trauma or retained products of conception. Persistent bleeding warrants consideration of mechanical measures, including uterine balloon or suction tamponade. Failure of conservative management necessitates escalation to examination under anaesthesia and, if required, laparotomy.

Throughout management, ongoing resuscitation with intravenous fluids and blood products is critical. Point-of-care testing should guide transfusion strategies, and early administration of fibrinogen is recommended in massive PPH to correct coagulopathy and improve outcomes.

Discussion

The re-evaluated and additional recommendations in the Consolidated Guidelines for the Prevention, Diagnosis, and Treatment of Postpartum Haemorrhage represent a significant contribution toward achieving the SDG 3 of ensuring healthy lives and promoting well-being for all, including reducing maternal mortality to fewer than 70 deaths per 100,000 live births by 2030. Emphasis is placed on early detection of increased risk of severe morbidity and mortality for women in postnatal period (Recommendation 22), alongside detailed guidance on the use of tranexamic acid, uterine massage, and the critical role of standardized protocols and their implementation across health facilities (3).

The recommendations in the recently published consolidated guidelines primarily apply to cases where bleeding complications can be diagnosed and managed within health facilities. However, reducing maternal mortality in high-prevalence countries remains challenging due to the large proportion of home births (21). Additional barriers include a notable prevalence of HIV and malaria, often as co-infections, which significantly contribute to severe anemia during the antenatal and postpartum periods through critically low hemoglobin levels (22, 33). Supporting evidence from a cross-sectional and health demographic survey in 7 counties in Sub-Saharan Africa reported anemia prevalence of 48,3% among individuals with HIV and malaria co- infection, 56,0% with malaria only experienced anemia while 62,5% those with HIV infection only. Data from the survey showed higher prevalence of anemia in women with malaria, HIV, and malaria-HIV coinfection compared to population without infection, 27, 41 and 22 percent respectively (28). The cut of value for anemia in pregnancy is 100- 110 g/L haemoglobin (29). Women are disproportionately affected due to higher exposure and lower immunological response to malaria, and they are statistically more frequently infected with HIV, making anemia a critical risk factor for adverse maternal outcomes (31, 33, 36). The World Malaria Report 2024 further highlights that 70% of women in sub-Saharan Africa serve as caregivers for malaria-infected individuals while experiencing immune suppression during pregnancy (32, 33). According to studies conducted in Sub-Saharan Africa, the prevalence of malaria–HIV/AIDS coinfection ranges from **0.7% to 47.5% in nonpregnant adults, 1.2% to 27.8% in children, and 0.94% to 37% in pregnant women** (37). HIV infection compromises the immune system, increasing susceptibility to malaria. This leads to higher parasite densities, more frequent and severe malarial episodes, and a greater risk of adverse outcomes such as severe anemia and enhanced malaria transmission among coinfected individuals. This interaction accelerates malaria progression and worsens disease severity.

Both malaria and HIV independently induce significant alterations in hematological profiles, in addition to causing various non-hematological complications. These hematological changes, which affect nearly all blood cell lineages, represent some of the most frequent and clinically relevant abnormalities observed in malaria patients and contribute substantially to disease severity. Common alterations include reductions in erythrocytes, thrombocytes, and total leukocytes, alongside relative lymphocytosis. The magnitude and pattern of these changes, however, vary according to multiple host and environmental factors.

The interplay between malaria endemicity and anemia burden is further complicated by the unique immunological adaptations associated with malaria during pregnancy. Women progressively acquire an antibody-mediated immune response that mitigates placental sequestration of parasites in successive pregnancies. This adaptive mechanism, is associated with adverse outcomes, including low birth weight, placental abruption, and diminished uterine tone.

The impact of HIV and malaria on fibrinogen levels before, during, and after delivery warrants consideration. HIV infection induces immune activation with increased plasminogen activator inhibitor-1 (PAI-1) expression, promoting a procoagulant state and increasing thromboembolic risk. Due to endothelial activation and damage, multiple inflammatory markers are involved in adhesion, both intracellular and vascular besides increased hCPR, IL-6, TNF-α, D-dimer (31).

In contrast, malaria is associated with accelerated fibrinogen turnover, antithrombin consumption, reduced factor XIII activity, and elevated fibrin degradation products, reflecting heightened coagulation activation and consumption. These abnormalities often present as prolonged prothrombin time (PT) and activated partial thromboplastin time (APTT) due to reduced synthesis and increased consumption of coagulation factors (31, 37). Disseminated intravascular coagulation occurs in more than 10% of severe malaria cases and is characterized by reduced platelet survival (39). These mechanisms may help explain findings from the Nigerian cohort, in which mean blood loss exceeded 1500 mL despite elevated fibrinogen levels (8.4 g/L), although factor XIII concentrations were not reported.

The consolidated guidelines recommend fibrinogen replacement when plasma fibrinogen activity falls below 2 g/L. However, in resource-limited settings, routine monitoring of clotting factor activity is often not feasible, making empirical correction of coagulopathy a more practical approach in urgent clinical situations (35).

The goal of replacement therapy in restoring hemostasis is to maintain fibrinogen levels above 2 g/L. Retrospective studies in women with PPH report fibrinogen replacement doses typically ranging from 3–8 g in cases of severe hemorrhage, including obstetric bleeding or placental abruption (14, 35). This approach represents an appropriate therapeutic option in individuals who are not infected with HIV or malaria. Alternatively, fibrinogen dosing may be calculated using the formula proposed by Collins et al. (34).

In individuals with active HIV infection, altered fibrinolysis accompanied by elevated D-dimer levels may increase the risk of thromboembolic events when antifibrinolytic agents such as tranexamic acid are administered. In such cases, careful consideration should be given to bleeding management using alternative therapeutic options, including fresh frozen plasma or cryoprecipitate.

In the context of potential HIV and malaria coinfections, factor XIII (FXIII) replacement may also be clinically relevant. Given the limited availability of specific factor concentrates in many regions, cryoprecipitate can serve as an alternative, as it provides comparable fibrinogen content along with FXIII and other coagulation factors. Cryoprecipitate provides fibrinogen and FXIII, with a similar FXIII/fibrinogen ratio of approximately 0.30 IU FXIII per mg of fibrinogen (FXIII: ~60 ± 30 IU per unit; volume ~15–25 mL) and typical fibrinogen content ~150–300 mg/unit, yielding FXIII concentration of ~2 to 4 IU/mL and fibrinogen ~8 to 12 mg/mL(40) Nevertheless, cryoprecipitate administration carries notable risks, particularly in patients with chronic HIV infection and compromised immune function (e.g., decreased CD4 counts). Cryoprecipitate not treated with solvent-detergent or other pathogen-reduction methods, may increase the risk of transfusion-transmitted infections and immune-mediated reactions due to donor-derived HLA/HNA antibodies which activates donors' neutrophils. These factors can contribute to serious complications, including transfusion-related acute lung injury (TRALI) (41). Alternative mitigation option would be to use plasma rich products from male or never pregnant women (42).

In chronic malaria infection, transfusion of red blood cells and platelets may be required, particularly in the setting of severe anemia, which is commonly defined by hemoglobin levels below 4 g/L. Whole blood transfusion has been described as an alternative therapeutic approach in certain contexts; however, its use entails a careful appraisal of both potential benefits and associated risks, including transfusion-related complications.

Severe cases may be complicated by pancytopenia, when hematopoietic stem cell transplantation from a human leukocyte antigen–compatible sibling has been reported as the most effective intervention, with published success rates ranging from 56% to 89% (43).

Anemia resulting from HIV and malaria co-infection, combined with limited access to adequate antenatal, intrapartum, and postpartum care, appears to be a contributing factor to the high prevalence of PPH in geographically high-risk regions. Despite the availability of clinical guidelines and recommendations aimed at reducing maternal morbidity and mortality, meaningful progress remains challenging in these settings.

Historically documented experiences with HIV and multidrug-resistant tuberculosis in sub-Saharan Africa (45) and Peru (44) underscore the critical role of community engagement in the successful implementation of public health interventions. These experiences highlight how health outcomes can be improved in regions strongly influenced by social norms and constrained by limited educational opportunities. By decentralizing care and delivering treatment within the community, it was possible to maintain the quality of therapy while simultaneously reducing costs and minimizing the risk of nosocomial transmission of multidrug-resistant tuberculosis (45).

Given the complexity of hematological alterations and the limited availability of healthcare personnel with specialized training, the development and implementation of PPH management protocols tailored to the local epidemiological context may represent an effective strategy for reducing maternal morbidity and mortality (46). Strengthening preparedness through standardized, context-specific protocols is particularly important in resource-constrained settings, where access to advanced diagnostic and therapeutic options may be limited. Each maternity unit may benefit from implementing a well-defined, multidisciplinary PPH management protocol, ensuring that all members of the clinical team are familiar with its steps and able to apply it consistently in acute situations. Beside an accurate anamnestic data collection (presence of bleeding at another delivery, other bleeding symptoms etc.) to address appropriate laboratory testing for inherited bleeding disorders, a structured hemostatic treatment algorithm incorporating clear decision-making pathways could serve as the foundation for tailoring institution-specific protocols to the local healthcare environment. Hofer et al. proposed, based on a literature review and expert consensus, the importance of viscoelastic testing (VET) for the early detection of coagulopathy in PPH, enabling goal-directed hemostatic therapy and potentially reducing blood loss exceeding 2500 mL. Comparative studies have demonstrated that point-of-care (POC)–guided coagulation management in women with PPH is associated with reduced blood product transfusion and improved clinical outcomes compared with experience-based transfusion based PPH management. In contrast to massive transfusion protocols, which advocate fixed transfusion ratios and empirical administration of plasma, red blood cells, and platelets, VET-based and Point- of care (POC)-guided correction of coagulopathy allows individualized treatment. This approach minimizes the risk of over-transfusion and subsequent dilutional coagulopathy and is better suited to the pathophysiology of PPH than protocols primarily designed for trauma-induced coagulopathy (14, 47).

Comprehensive training in obstetric emergencies, including PPH, might be provided to all personnel involved in maternity care. Such training should be multiprofessional and include regular, team-based simulation exercises to strengthen coordination, communication, and role clarity. Evidence from a systematic review demonstrates that multidisciplinary simulation training improves knowledge, technical skills, communication, and overall team performance in the management of obstetric emergencies, including PPH, although centralized simulation training offers no additional benefit compared with training conducted within local units.

In such settings, simple, structured screening tools—drawing on antenatal history, heavy menstrual bleeding history, HIV and malaria status, and prior obstetric outcomes—may offer a pragmatic alternative to comprehensive risk stratification approaches. These questionnaires can support the early identification of women at increased risk of PPH in geographically vulnerable regions, thereby enabling timelier preventive and therapeutic interventions.

Limitation

Our perspective evaluates the feasibility of implementing consolidated guidelines for the prevention, diagnosis, and management of PPH in two African regions—one demonstrating improvements in maternal mortality ratios (MMR) and another exhibiting one of the most concerning MMR prevalences. Comparable attention should be directed toward geographic areas in Southern Asia and Latin America, as well as other settings characterized by high burdens of HIV and co-infections, including multidrug-resistant tuberculosis.

Aknowledgement

I would like to express my sincere gratitude to Professor Giancarlo Castaman for his valuable comments, and to Tshililo Mashamba and Gabriel Dogbanya for sharing regional insights and providing helpful feedback.

Conclusion

Hemorrhage remains a leading cause of maternal morbidity and mortality worldwide, with a disproportionate impact in regions characterized by heightened clinical and health-system vulnerabilities. In such settings, the coexistence of inherited coagulopathies, obstetric complications, HIV and malaria co-infections, and other complex medical conditions affecting women—together with limited access to antenatal care and skilled birth attendance—poses substantial challenges to the consistent application of existing clinical guidelines and recommendations.

Although standardized guidelines form the foundation of evidence-based care, their effectiveness in resource-constrained environments may be limited by restricted diagnostic capacity, workforce shortages, and socio-cultural barriers. Adaptation of recommendations to local epidemiological patterns and available resources may therefore be necessary to enhance feasibility and potential impact. Furthermore, community-based approaches and strategies aimed at increasing awareness of maternal health risks—including the use of widely accessible communication channels—may support earlier recognition of complications and facilitate more timely engagement with healthcare services. However, the effectiveness and scalability of such interventions require further evaluation to determine their contribution to sustained reductions in maternal morbidity and mortality in high-risk regions.

Conflict-of-interest Disclosure

Jolana Schmiedl is the employee of CSL, this publication was not supported by CSL.

References

1. World Health Organization (WHO). (2021, November 16). Ending preventable maternal mortality (EPMM): a renewed focus for improving maternal and new-born health and well-being. https://www.who.int/publications/i/item/9789240040519
2. Rushwan, H. (2014). The FIGO Leadership in Obstetrics and Gynecology for Impact and Change (LOGIC) Initiative in Maternal and Newborn Health. *IJGO*, 127 S1-S2, DOI: https://doi.org/10.1016/j.ijgo.2014.09.002
3. World Health Organization (WHO). (2025, October 5). Consolidated guidelines for the prevention, diagnosis and treatment of postpartum haemorrhage. https://www.who.int/publications/i/item/9789240115637
4. Wormer K.C et al, (2024, July). Acute Post partum hemorrhage, National Library of Medicine.
5. Mavrides, E., Allard, S., Chandraharan, E., Collins, P., Green, L., Hunt, B. J., Riris, S., & Thomson, A. J. (2016). Prevention and management of postpartum haemorrhage. *BJOG, 124*(5), e106–e149. DOI: https://doi.org/10.1111%2F1471-0528.14178
6. National Center for Health Statistics (NCHS). (2024, April 29). Frequently Asked Questions. https://www.cdc.gov/nchs/maternal-mortality/faq.htm
7. Costa, M. L., & Cecatti, J. G. (2025). Urgent and decisive action needed in maternal morbidity and mortality to prevent stagnation in progress, *Lancet Glob Health, 13*(4), e600-e601. DOI: https://doi.org/10.1016/s2214-109x(25)00069-5
8. World Health Organization (WHO). (2025, April 7). Maternal mortality fact sheet. https://www.who.int/news-room/fact-sheets/detail/maternal-mortality#:~:text=Key%20facts,17%25%20(43%20000).
9. Bremme, K. A. (2003). Hemostatic changes in pregnancy, *Best Pract Res Clin Haematol, 16*(2), 153-68. DOI: https://doi.org/10.1016/s1521-6926(03)00021-5
10. Collins, P., Abdul-Kadir, R., & Thachil, J. (2016). Management of coagulopathy associated with postpartum hemorrhage: guidance from the SSC of the ISTH, *Journal of Thrombosis and Haemostasis, 14*(1), 205–210, DOI: https://doi.org/10.1111/jth.13174
11. Schmiedl, J., & Castaman, G. (2024). The role of inherited coagulopathies in development of primary and secondary postpartum hemorrhage. Intechopen. https://www.intechopen.com/chapters/1203273
12. Levi, M. (2013). Pathogenesis and management of peripartum coagulopathic calamities (disseminated intravascular coagulation and amniotic fluid embolism). *Thromb Res, 131*(Suppl. 1), S32–4. DOI: https://doi.org/10.1016/s0049-3848(13)70017-3
13. Wikkelsø, A. J., Edwards, H. M., Afshari, A., Stensballe, J., Langhoff-Roos, J., Albrechtsen, C., Ekelund, K., Hanke, G., Secher, E. L., Sharif, H. F., Pedersen, L. M., Troelstrup, A., Lauenborg, J., Mitchell, A. U., Fuhrmann, L., Svare, J., Madsen, M. G., Bødker, B., & Møller, A. M. (2015). Pre-emptive treatment with fibrinogen concentrate for postpartum haemorrhage: randomized controlled trial. *British Journal of Anesthesia, 114*(4), 623-633. DOI: https://doi.org/10.1093/bja/aeu444
14. Hofer, S., Blaha, J., Collins, P. W., Ducloy-Bouthors, A. S., Guasch, E., Labate, F., Lança, F., Nyfløt, L. T., Steiner, K., & Van de Velde, M. (2022). Haemostatic support in postpartum haemorrhage: A review of the literature and expert opinion. *Eur J Anesthasiology, 40*(1), 29–38, DOI: https://doi.org/10.1097/eja.0000000000001744
15. Donatti, S., Buoncristiano, M., Lega, I., D'Aloja, P., & Maraschini, A. (2021). The Italian Obstetric Surveillance System: Implementation of a bundle of population-based initiatives to reduce haemorrhagic maternal deaths. *Plosone, 16*(4), e0250373. DOI: https://doi.org/10.1371/journal.pone.0250373
16. de Vries, P. L. M., Deneux-Tharaux, C., Baud, D., Chen, K. K., Donati, S., Goffinet, F., Knight, M., D'Souzah, R., Sueters, M., & van den Akker, T. (2023). Postpartum hemorrhage in high-resource settings: Variations in clinical management and future research directions based on a comparative study of national guidelines. *BJOG, 130*(13), 1639-1652. DOI: https://doi.org/10.1111/1471-0528.17551
17. World Health Organization (WHO). (2025, April 7). Maternal mortality fact sheet. https://www.who.int/news-room/fact-sheets/detail/maternal-mortality
18. Gallos, I., Devall, A., Martin, J., Middleton, L., Beeson, L., Galadanci, H., Alwy Al-Beity, F., Qureshi, Z., Hofmeyr, G. J., Moran, N., Fawcus, S., Sheikh, L., Gwako, G., Osoti, A., Aswat, A., Mammoliti, K. M., Sindhu, K. N., Podesek, M., Horne, I., … Coomarasamy, A. (2023). Randomized Trial of Early Detection and Treatment of Postpartum Hemorrhage. *N E J Medicine, 389*(1),11-21. DOI: https://doi.org/10.1056/nejmoa2303966
19. Teshale, M. Y., Bante, A., Gedefaw Belete, A., Crutzen, R., Spigt, M., & Stutterheim, S. E. (2025). Barriers and facilitators to maternal healthcare in East Africa: a systematic review and qualitative synthesis of perspectives from women, their families, healthcare providers, and key stakeholders. *BMC Pregnancy and Childbirth, 25*(1), 111. DOI: https://doi.org/10.1186/s12884-025-07225-8
20. Fawcus, S. (2024, March 20). Orientation MNH Guidelines Chapters: Postpartum Care and Obstetric Emergencies https://knowledgehub.health.gov.za/system/files/2024-04/PPH%20updated-%20%20whats%20new%20Prof%20Sue%20Fawcus%2020%20March%202024.pdf
21. Dogbanya, G. (2025). Maternal Mortality in Nigeria: Holding the Line in Uncertain Times. *Ann Global Health, 91*(1), 16. DOI: https://doi.org/10.5334/aogh.4710
22. Adebayo, T., Adefemi, A., Adewumi, I., Akinajo, O., Akinkunmi, B., Awonuga, D., Aworinde, O., Ayegbusi, E., Dedeke, I., Fajolu, I., Imam, Z., Jagun, O., Kuku, O., Ogundare, E., Oluwasola, T., Oyeneyin, L., Adebanjo-Aina, D., Adenuga, E., Adeyanju, A., … Adesina, O. (2024). Burden and outcomes of postpartum hemorrhage in Nigerians referral- levels hospitals. BJOG,

131(Supplement 3), 64-77.
DOI: https://doi.org/10.1111/1471-0528.17822
23. Roberts, I., Shakur, H., Fawole, B., Kuti, M., Olayemi, O., Bello, A., Ogunbode, O., Kotila, T., Aimakhu, C. O., Olutogun, T., Hunt, B. J., & Huque, S. (2018). Hematological and fibrinolytic status of Nigerian women with post-partum haemorrhage. *BMC Pregnancy and Childbirth, 18*(1), 143.
DOI: https://doi.org/10.1186/s12884-018-1794-1
24. Connell, N. T., Flood, V. H., Brignardello-Petersen, R., Abdul-Kadir, R., Arapshian, A., Couper, S., Grow, J. M., Kouides, P., Laffan, M., Lavin, M., Leebeek, F. W. G., O'Brien, S. H., Ozelo, M. C., Tosetto, A., Weyand, A. C., James, P. D., Kalot, M. A., Husainat, N., & Mustafa, R. A. (2021). ASH ISTH NHF WFH 2021 guidelines on the management of von Willebrand disease. *Blood Adv, 5*(1), 301-325.
DOI: https://doi.org/10.1182/bloodadvances.2020003264
25. Kadir, R. A., & Ragni, M. V. (2026). Gynecologic and obstetric management of girls and women with von Willebrand disease. *Haemotologicy, 111*(1), 67-82.
DOI: https://doi.org/10.3324/haematol.2024.286059
26. Liu, L. Y., Nathan, L., Sheen, J. J., & Goffman, D. (2023). Review of Current Insights and Therapeutic Approaches for the Treatment of Refractory Postpartum Hemorrhage. *Int J Womens Health*, 15, 905-926.
DOI: https://doi.org/10.2147/ijwh.s366675
27. Royal College of Obstetricians and Gynaecologists (2017). Prevention and management of postpartum haemorrhage: green-top guideline No. 52. *BJOG, 124*(5), e106-49.
DOI: https://doi.org/10.1111/1471-0528.14178
28. WOMAN Trial Collaborators (2017). Effect of early tranexamic acid administration on mortality, hysterectomy, and other morbidities in women with post-partum haemorrhage (WOMAN): an international, randomised, double-blind, placebo-controlled trial. *Lancet, 389*(10084)
DOI: https://doi.org/10.1016/s0140-6736(17)30638-4
29. Ssentongo, P., Ba, D. M., Ssentongo, A. E., Ericson, J. E,, Wang, M., Liao, D., & Chinchilli, V. M. (2020). Associations of malaria, HIV, and coinfection, with anemia in pregnancy in sub-Saharan Africa: a population-based cross-sectional study. *BMC Pregnancy and Childbirth, 20*(1), 379. DOI: https://doi.org/10.1186/s12884-020-03064-x
30. World Health Organization (WHO). (2011, May 31). Hemoglobin concentrations for the diagnosis of anaemia and assessment of severity.
https://www.who.int/publications/i/item/WHO-NMH-NHD-MNM-11.1
31. Njuki, J., & Ntonjita, L. (2025). Independent Global Health reporting: Malaria's Gender Divide: Why Women Bear the Brunt of a Global Health Crisis https://healthpolicy-watch.news/malarias-gender-divide-why-women-bear-the-brunt-of-a-global-health-crisis
32. Demango, F., Tadasa, E., & Kiya, G. T. (2025). Hematological Profiles of Adults Coinfected With HIV and Malaria Receiving Highly Active Antiretroviral Therapy at Bonga Gebretsadik Shawo General Hospital, Southwest Ethiopia: A Comparative Cross-Sectional Study. *Advances in Hematology*, 2025,
DOI: https://doi.org/10.1155/ah/3894305
33. World Health Organization (WHO).sss (2024, 11 December). *World malaria report* 2024.
https://www.who.int/teams/global-malaria-programme/reports/world-malaria-report-2024
34. Walker, P. Leuba, S., Verity, R., Gutman, J., Weiss, D., Cairns, M., Williams, J., Khairallah, C., Bojang, K., Dodd, J., Noor, A., Taylor, S., Otieno, K., Coulibaly, S., Kayentao, K., Kariuki, S., Greenwood, B., Desai, M., Chandramohan, D., Tagbor, H., Kuile, F., & Madanitsa, M. (2025). The burden of malaria-attributable maternal anemia and the impact of IPTp across sub-Saharan Africa. *Research square*.
DOI: https://doi.org/10.21203/rs.3.rs-7179149/v1
35. Collins, P. W., Solomon, C., Sutor, K., Crispin, D., Hochleitner, G., Rizoli, S., Schöchl, H., Schreiber, M., & Ranucci, M. (2014). Theoretical modelling of fibrinogen supplementation with therapeutic plasma, cryoprecipitate, or fibrinogen concentrate. *Br J Anaesth, 113*(4), 585-95.
DOI: https://doi.org/10.1093/bja/aeu086
36. Ishida, Y., Homma, Y., Murakoshi, T., & Toba, Y. (2023). Clinical experience of the use of fibrinogen concentrates for massive postpartum hemorrhage: a retrospective case series study. *Journal of Anesthesia, 37*(5), 820–822.
DOI: https://doi.org/10.1007/s00540-023-03247-8
37. Ololade, A. A., Bello, A. J., Adeleye, I. A., & Nutor, J. J. (2022). Evaluation of HIV infection in febrile patients visiting health centers in Lagos, Nigeria. *BMC Res Notes, 15*(1), 71.
DOI: https://doi.org/10.1186/s13104-022-05961-0
38. Kwenti, T. E. (2018). Malaria and HIV Coinfection in Sub-Saharan Africa: Prevalence, Impact, and Treatment Strategies. *Re-search and Reports in Tropical Medicine*, 9, 123–136. DOI: https://doi.org/10.2147/rrtm.s154501
39. Tegenaw, T., Almaw, A., Abebaw, A., Kiros, T., Berhan, A., Damtie, S., Legese, B., Feleke, D. G., Sema, M., Chanie, E. S., Dires, T., Andargie, D., Achaw, B., & Eyayu, T. (2024). Basic coagulation parameters and platelet count among malaria patients attending at Addis Zemen Primary Hospital, Northwest Ethiopia. *BMC Infect Dis*, 24, 1069.
DOI: https://doi.org/10.1186/s12879-024-09944-3
40. Zhang, Q., Peng, F., Li, M., Yi, Q., Tang, W., & Wu, S. (2022). *Elevated Risk of Venous Thromboembolism in People Living with HIV. Viruses, 14*(3), 590.
DOI: https://doi.org/10.3390/v14030590
41. Caudill, J. S., Nichols, W. L., Plumhoff, E. A., Schulte, S. L., Winters, J. L., Gastineau, D. A., & Rodriguez, V. (2009). Comparison of coagulation factor XIII content and concentration in cryoprecipitate and fresh-frozen plasma. *Transfusion, 49*(4), 765-70.
DOI: https://doi.org/10.1111/j.1537-2995.2008.02021.x
42. Kuldanek, S. A., Kelher, M., & Silliman, C. C. (2019). Risk factors, management and prevention of transfusion-related acute lung injury: a comprehensive update. *Expert Rev Hematology. 12*(9), 773–785.
DOI: https://doi.org/10.1080/17474086.2019.1640599

43. Marietta, M., Franchini, M., Bindi, M. L., Picardi, F., Ruggeri, M., & De Silvestro, G. (2016). Is solvent/detergent plasma better than standard fresh-frozen plasma? A systematic review and an expert consensus document. *Blood transfusion, 14*(4), 277–286. DOI: https://doi.org/10.2450/2016.0168-15
44. Shah, M. U., Sundhu, M. A., & Hussain. M. Z. (2013). Postpartum Aplastic Anemia Presenting as Pancytopenia Due to Malarial Infection, Case report. *Journal of the College of Physicians and Surgeons Pakistan, 23*(11), 809-810. https://pubmed.ncbi.nlm.nih.gov/24169391/
45. Mitnick, C., Bayona, J., Palacios, E., Shin, S., Furin, J., Alcántara, F., Sánchez, E., Sarria, M., Becerra, M., Fawzi, M. C., Kapiga, S., Neuberg, D., Maguire, J. H., Kim, J. Y., Farmer, P. (2003). Community-Based Therapy for Multidrug-Resistant Tuberculosis in Lima, Peru. *N E J Med, 348*(2), 119-128. DOI: https://doi.org/10.1056/nejmoa022928
46. UNAIDS (2025, January 30). Impact of community-led and community-based HIV service delivery beyond HIV: case studies from eastern and southern Africa. Geneva: Joint United Nations Program on HIV/AIDS. https://www.unaids.org/en/resources/documents/2025/jc3129_community-service-delivery-impact-beyond-hiv
47. Shields, L. E., Wiesner, S., Fulton, J., & Pelletreau, B. (2015). Comprehensive maternal hemorrhage protocols reduce the use of blood products and improve patient safety. *Am J Obstet Gynecol, 212*(3), 272–80. DOI: https://doi.org/10.1016/j.ajog.2014.07.012
48. de Lange, N. M., van Rheenen-Flach, L. E., Lancé, M. D., Mooyman, L., Woiski, M., van Pampus, E. C., Porath, M., Bolte, A. C., Smits, L., Henskens, Y. M., & Scheepers, H. C. (2014). Peri-partum reference ranges for ROTEM®thromboelastometry. *Br J Anaesth. 112*(5), 852–859. DOI: https://doi.org/10.1093/bja/aet480