Red Alert
Managing Anemia & Postpartum Hemorrhage in Pregnancy

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Foreword

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Dedicated to

This book is dedicated to all mothers—past, present, and future—whose courage, sacrifice, and resilience inspire us to work tirelessly toward a world where no woman loses her life to preventable causes during pregnancy and childbirth.

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Foreword

Maternal health has always been at the heart of obstetric and gynecologic practice. Yet, challenges such as anemia in pregnancy and postpartum hemorrhage (PPH) continue to compromise the lives and well-being of countless women. These are not merely clinical conditions; they mirror deeper inequities in nutrition, access to quality care, and the preparedness of our health systems. Globally, anemia remains one of the most widespread nutritional disorders, while PPH continues to be a leading cause of maternal mortality. Both demand urgent, coordinated, and sustained action.

Red Alert: Managing Anemia and Postpartum Hemorrhage in Pregnancy arrives at a critical juncture. This comprehensive volume unites evidence-based perspectives from distinguished experts across public health, clinical practice, and research. It highlights not only the burden of anemia and PPH but also offers practical, actionable solutions—ranging from preconception nutrition to advanced therapeutic approaches—that can transform outcomes for women everywhere.

The editors—Dr Hrishikesh Pai, Dr Anne–Beatrice Kihara, Dr Sunita Tandulwadkar, Dr Pikee Saxena, and Dr Alka Pandey—together with their accomplished team—deserve recognition for curating such a wide-ranging body of knowledge. This book reflects the collective wisdom of leaders in obstetrics and gynecology and underscores the importance of a continuum-of-care approach, bridging prevention, timely diagnosis, and effective management.

"Every maternal death is not just a statistic—it is a story of loss, inequity, and a reminder of the work still left undone."

As a Past President of FOGSI and through my work with FIGO as the Division Director of Well Women Health Care, I view this book as more than a reference text. It is, in truth, a call to action—for clinicians, policymakers, and community health workers alike—to collaborate in eliminating preventable maternal deaths and in improving women's health at every stage of life.

"Red Alert is both a guide for practice and a beacon for progress—uniting science, compassion, and commitment to safeguard mothers."

I wholeheartedly commend this initiative and trust that Red Alert will serve as an invaluable guide for practitioners and an enduring inspiration for continued advancement in maternal health.

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Preface

Maternal health remains the cornerstone of a nation's progress. Among the many challenges that threaten safe motherhood, anaemia and postpartum hemorrhage (PPH) stand as two of the most formidable adversaries—silently weakening women during pregnancy and too often claiming lives during childbirth. Addressing them is not only a medical imperative but also a moral responsibility.

This book, Red Alert: Addressing Anemia and Postpartum Hemorrhage in Pregnancy, brings together the expertise of global and national leaders who have worked tirelessly in the field of maternal health. From prevention and community-level strategies to clinical management and consensus guidelines, the chapters reflect a comprehensive approach, enriched with evidence-based recommendations and practical insights.

As President of the Federation of Obstetric and Gynecological Societies of India (FOGSI), I take immense pride in presenting this scholarly contribution. At FOGSI, our mission "Ek Rashtra, Ek Mission: Swasth Nari, Samruddha Vatan" underlines the belief that the health of every woman is the foundation of a prosperous nation.

The collaboration of distinguished editors—Dr Hrishikesh Pai, Dr Anne Kihara, and my own humble involvement—together with Prof. Pikee Saxena, Dr Alka Pandey and other co-editors and authors—have resulted in a work that I believe will serve as both a reference for clinicians and an inspiration for policymakers and public health advocates. It reminds us that science must always translate into action, and knowledge must lead to transformation.

I am confident that this book will ignite renewed efforts, not only within the medical community but also among governments, organizations, and societies at large, to reduce the burden of anemia and preventable maternal deaths due to hemorrhage. Let this be our **red alert**—a call to vigilance, preparedness, and above all, compassion in the service of women.

With gratitude to all contributors and with hope for healthier mothers and brighter futures, I commend this volume to the global medical fraternity.

Sunita Tandulwadkar
President, FOGSI

Acknowledgments

The editors extend their deep gratitude to all the distinguished contributors of this volume, whose scholarship and dedication have made this work possible. Their insights on anemia and postpartum haemorrhage in pregnancy have enriched the book and created a valuable resource for clinicians, researchers, and policymakers.

We are grateful to the Federation of Obstetric and Gynaecological Societies of India (FOGSI) and the International Federation of Gynecology and Obstetrics (FIGO) for their constant support and leadership in promoting safe motherhood initiatives worldwide. Our heartfelt thanks to Dr Sunita Tandulwadkar, President of FOGSI, for her inspiring Preface and continued encouragement. We are especially grateful to Dr Hema Divakar, Past President of FOGSI and Division Director of Well Women Health Care, FIGO, for graciously contributing the Foreword and lending her vision and endorsement to this book.

We acknowledge with appreciation the contributions of colleagues, reviewers, and professional peers whose guidance strengthened the scientific content of this work. We also recognize the many healthcare providers working tirelessly at the community, national, and global levels to reduce maternal morbidity and mortality. Their efforts remain the true inspiration for this book.

Finally, we express our gratitude to our families and institutions, whose patience, encouragement, and unwavering support have enabled us to dedicate time and effort to this academic endeavor. Without their understanding, this work would not have been possible.

Editors

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Chapter 1

Implementation of Anemia Prevention and Treatment at Community and Global Level

Hrishikesh Pai, Alka Pandey

INTRODUCTION

Globally, about one-third of the population is affected by anemia. The burden is higher in children under five, women of reproductive age and pregnant women, with rates disproportionately affecting regions like Sub-Saharan Africa and South Asia.

Anemia is a condition in which the number of red blood cells or the hemoglobin concentration within them is lower than normal, causing insufficient oxygen delivery throughout the body. Anemia is classified as mild, 10–10.9 dL/L, moderate, 7–9.9 g/dl, and severe, lower than 7 g/dL.[1] It is a major public health problem across the globe. It causes fatigue, decreased productivity, and reduces quality of life.[2] It is associated with neurocognitive deficits, impairs memory, attention and learning.[3] It impacts maternal and fetal health in pregnancy. Severe anemia in pregnancy remains strongly associated with hemorrhage, sepsis, maternal mortality, preterm birth, low birth weight and intrauterine death.[4] Anemia contributes to productivity losses and economic burden in low and middle-income countries, including India.[5]

The causes of anemia are diverse:

- **Iron deficiency** (the most common cause, especially among women and children) folic acid, vitamin B12, and vitamin A deficiency.[6]
- **Chronic infections** like TB, HIV and worm infestations such as malaria, hookworm, schistosomiasis.[7]
- **Genetic/hemoglobin disorders** like sickle cell anemia, thalassemia and G6PD deficiency.[8]
- **Physiological states:** Pregnancy, adolescence, lactation[9]
- **Chronic diseases and inflammation** Chronic Kidney Disease (CKD) cancers, autoimmune disorders.[10]

PREVALENCE

Though anemia is preventable and treatable, anemia continues to persist at alarmingly high levels globally. The 2025 projection of global prevalence of anemia by population group shows 36.5% pregnant women are anemic **(Fig. 1)**. Women

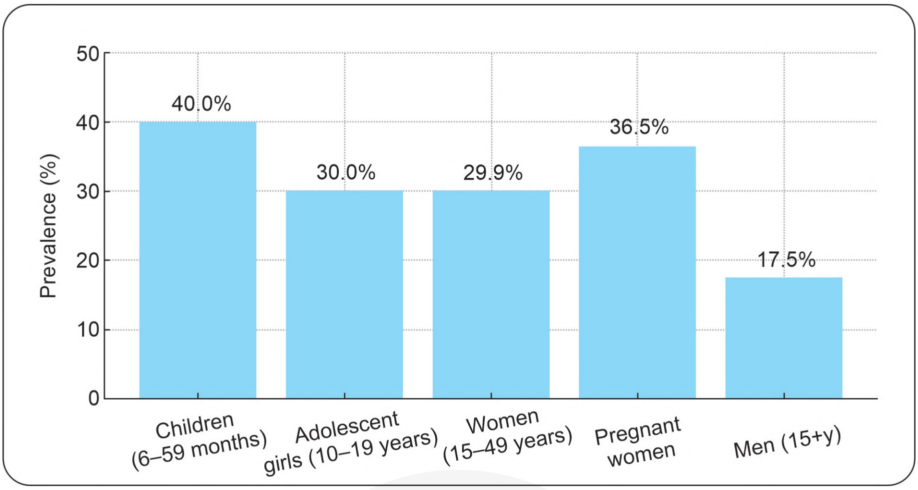

Fig. 1: Global prevalence of anemia by population group (2025 projection)

with anaemia in the WHO African and South-East Asia regions together account for more than 60% of the global burden among women of reproductive age (source WHO gobaI anemia estimates, key finding , 2025) In India , anemia is a severe public health issue, with over half of women in reproductive age group affected. National Family Health Survey (NFHS 5 2019-2021) reported 57% of women aged 15 to 49 were anemic **(Table 1)**.

Overall Progress (2000–2019)

- Non-pregnant women: Prevalence decreased slightly from 31% to 30%.
- Pregnant women: Prevalence decreased from 41% to 36%.
- Children (6–59 months): Prevalence fell from 48% to 40%, though it remained above 70% in some countries.[11]
- Overall global progress has been slow, with prevalence only slightly improving.[12]
- The burden of anemia remains high, especially in developing regions and among vulnerable populations like children and adolescent girls.[12] While the original target was to halve this prevalence by 2030, current trends suggest this may not be achieved, indicating a need for revised targets and interventions.[13] The ambitious 50% target is considered unachievable with current recommended interventions.[14] The deadline has shifted focus from 2025 towards 2030.[14]

ANEMIA IN CONTEXT WITH SDG GOALS

Anemia is directly addressed as an indicator under Sustainable Development Goal (SDG) 2 and is also significantly linked to other SDGs, including those for health, gender equality, education, and poverty reduction.

Table 1 Anemia prevalence in India (NFHS-5, 2019–2021)

State/UT	*Children (6–59 months) %*	*Women (15–49 years) %*	*Men (15–49 years) %*
India (total)	67.1	57.0	25.0
Andhra Pradesh	64.0	58.8	28.0
Arunachal Pradesh	56.6	54.6	19.8
Assam	68.4	65.9	29.7
Bihar	69.4	63.5	25.0
Chhattisgarh	67.2	61.8	23.6
Goa	48.3	31.4	20.6
Gujarat	79.7	65.0	28.7
Haryana	71.7	61.5	28.2
Himachal Pradesh	56.3	53.7	19.8
Jammu & Kashmir	67.5	64.2	27.5
Jharkhand	67.9	65.3	29.0
Karnataka	65.5	50.6	23.0
Kerala	39.4	34.6	16.0
Madhya Pradesh	72.7	54.7	22.0
Maharashtra	68.9	54.6	21.9
Manipur	41.1	29.4	11.6
Meghalaya	48.0	33.4	12.9
Mizoram	34.0	34.7	16.5
Nagaland	46.1	27.9	11.2
Odisha	64.2	61.8	26.2
Punjab	71.2	54.5	21.5
Rajasthan	72.4	54.8	21.5
Sikkim	45.6	35.3	15.1
Tamil Nadu	58.0	55.1	25.4
Telangana	70.0	56.0	24.0
Tripura	57.0	67.2	27.7
Uttar Pradesh	66.4	50.5	22.0
Uttarakhand	59.8	50.1	19.5
West Bengal	71.4	71.0	30.6
Andaman and Nicobar	49.6	33.6	16.4
Chandigarh	68.0	54.2	24.5
Dadra & Nagar Haveli and Daman & Diu	75.8	69.2	32.8
Delhi	72.0	56.3	21.0
Lakshadweep	53.4	45.9	18.2
Puducherry	54.3	50.6	21.1

SDG 2: Zero Hunger

Anemia is recognized as a malnutrition issue and is a key indicator for this goal. Target 2.2 aims to end all forms of malnutrition by 2030, including addressing nutritional needs. Indicator 2.2.3 specifically measures anemia prevalence in women of reproductive age. While the original target was to halve this prevalence by 2030, current trends suggest this may not be achieved, indicating a need for revised targets and interventions.

SDG 3: Good Health and Well-being

Anemia during pregnancy increases the risk of maternal and perinatal mortality (Target 3.1) and can lead to low birth weight and impaired cognitive development in children (Target 3.2). Addressing anemia also contributes to combating communicable diseases like malaria, which are significant causes of anemia (Target 3.3).

SDG 4: Quality Education

Anemia in children negatively impacts their cognitive development, concentration, and energy levels, thereby affecting their ability to learn and receive a quality education.

SDG 5: Gender Equality

Anemia affects women and girls disproportionately due to biological factors and societal inequities. Addressing anemia can improve women's productivity and education, promoting gender equality. The prevalence of anemia in women is also an indicator of progress towards women's health needs and empowerment, linking it to Target 5.6 on sexual and reproductive health.

ANEMIA—THE INDIAN PERSPECTIVE

The National Family Health Survey (NFHS-5) data (2019–2021) **Table 1** shows that over half of children and women were affected, with specific figures for children and adolescents as high as 67.1% and 59.1%. The prevalence of anemia varies by region and demographic, disproportionately affecting vulnerable groups. The government is actively working to combat it through various programs.

INDIAN GOVERNMENT INITIATIVES TO REDUCE ANEMIA

- **National Nutritional Anemia Prophylaxis Programme (NNAPP), 1970**
- **National Iron Plus Initiative (NIPI), 2013**
- **Weekly Iron and Folic Acid Supplementation (WIFS), 2012**
- **Intensified National Iron Plus Initiative (I-NIPI), 2018**
- **POSHAN Abhiyaan (2018)**
- School Health and Wellness Programme (2019)

- Janani Suraksha Yojana (JSY) and Janani Shishu Suraksha Karyakram (JSSK)
- Mid-Day Meal Scheme (MDMS)
- Integrated Child Development Services (ICDS)

▪ **Anemia Mukt Bharat (AMB), 2018—Anemia Mukt Bharat (Fig. 2) is a** landmark program of the Government of India. Today, AMB reaches millions annually through a comprehensive strategy that includes **iron-folic acid supplementation, deworming, fortified nutrition, and behavior change communication** across all age groups.[15]

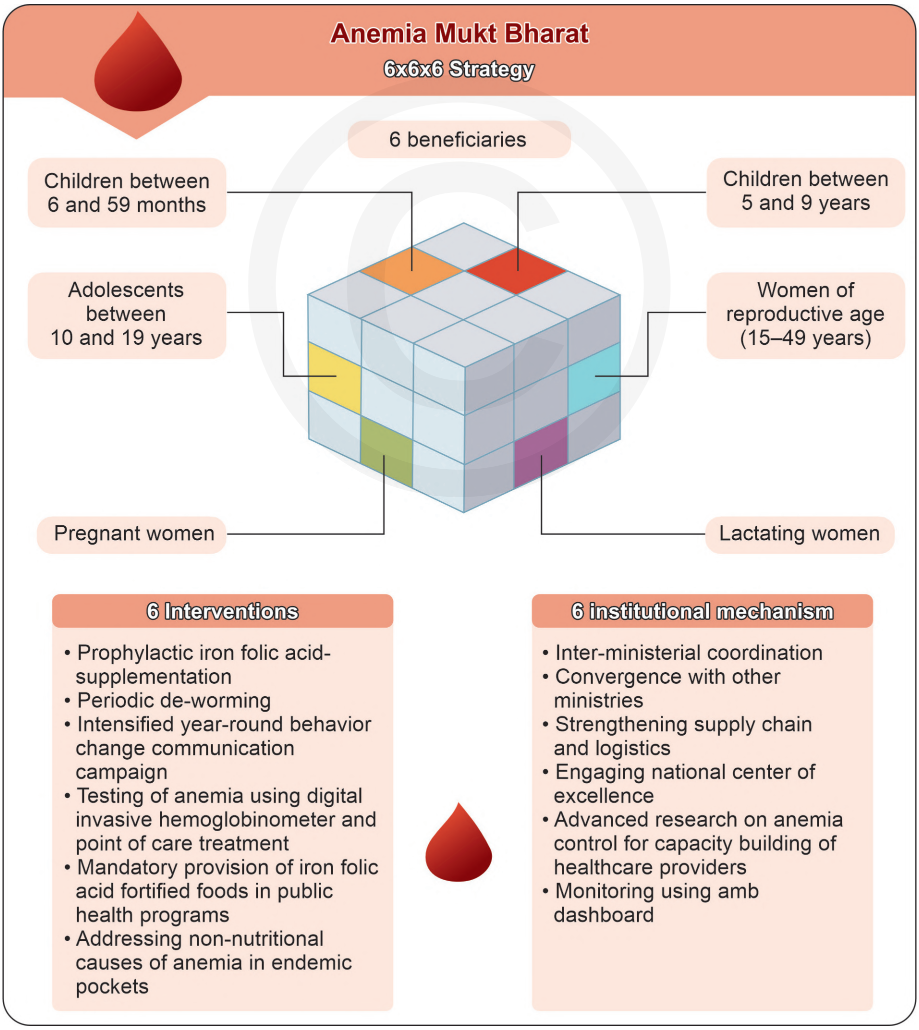

Fig. 2: Anemia Mukt Bharat 6x6x6 Strategy

OVERALL TRENDS AND CONTEXT

- **National increase**: The national prevalence of anemia among pregnant women increased from 50.4% in NFHS-4 (2015–2016) to 52.2% in NFHS-5 (2019–2021),
- **Regional disparities**: The NFHS-5 data reveals significant disparities. For instance, northern and eastern states like Bihar, Gujarat, West Bengal, Odisha, and Tripura showed high rates of maternal anemia, while states like Kerala, Manipur, and Nagaland had comparatively lower rates.
- **High-burden states**: Large states with over 60% prevalence include Bihar, Gujarat, West Bengal, Odisha, and Tripura.
- **Factors influencing prevalence**: Recent research highlights several factors influencing anemia prevalence, including geographic location, socioeconomic status, education level, and toilet facilities.

KEY TAKEAWAYS

- More than half of Indian women (57%) and two-thirds of children (67%) are anemic.
- Highest prevalence is in Gujarat, West Bengal, Dadra and Nagar Haveli, and Bihar.
- Lowest prevalence is in Kerala, Manipur, Mizoram, and Nagaland.

PROGRESS

Despite these programs, NFHS 5 2019–2021 showed rising anemia prevalence in Women 15–49 years 57% Children 6–59 months 57%. This highlights gaps in implementation, compliance, and dietary diversity.

ROLE OF FEDERATION OF OBSTETRIC AND GYNAECOLOGICAL SOCIETIES OF INDIA (FOGSI) IN REDUCING ANEMIA

FOGSI has organized many CMEs on anemia, rural and urban health camps, anemia campaigns, screening drives, and prepared clinical guidelines on anemia and newer iron therapies. In 2023, under the presidentship of Dr Hrishikesh Pai, FOGSI undertook the Nari SwasthyaJanandolan Yatra, also known as Na Na anemia yatra, which was an extraordinary and transformative journey, a testament to FOGSI's collective commitment to improving women's health across the nation.

Spanning **90 days**, this ambitious Yatra traveled a staggering **9,000 kilometers**, weaving through **10 states and 39 cities**. This Yatra touched lives, sparked conversations, and created a ripple effect of awareness and action. The campaign reached an awe-inspiring **100 million people** through its wide-ranging activities. In each city, the Na Na Anemia Yatra conducted three activities, namely: Medical

Screening Camps with Free Investigations, Public Education Forums, and **Continuing Medical Education.**

Another project during this period was **FOGSI's Anemia Mukt Nari,** which was recognized and awarded by the Asia Book of Records. **2,10,780 women** were screened for anemia in camps conducted by 270 local societies of FOGSI.

Both community-based strategies and global-level initiatives are crucial to reduce the burden of anemia in a sustainable way.

WHY FOCUS ON COMMUNITY AND GLOBAL LEVELS?

Health interventions often succeed only when they are implemented at multiple levels. The **community level** is where prevention and treatment become practical and relatable for families and individuals. The **global level** is where resources are mobilized, knowledge is shared, and governments are held accountable. Both are necessary, and both reinforce each other.

IMPLEMENTATION OF ANEMIA PREVENTION AND TREATMENT AT THE COMMUNITY LEVEL

Nutrition Education and Dietary Diversification

At the community level, food choices play the biggest role in preventing anemia. Many families are unaware of iron-rich foods or how to combine foods for better absorption. Community health workers, NGOs, and schools can organize:

- **Cooking demonstrations** using locally available iron-rich foods such as green leafy vegetables, pulses, and fortified cereals.
- **Education about enhancers and inhibitors of iron absorption.** For example, vitamin C (from fruits like guava, lemon, or oranges) increases iron absorption, while tea and coffee reduce it.
- **Promotion of balanced diets** that include not only iron but also folic acid, vitamin B12, and protein sources. [3]

Iron and Folic Acid Supplementation

In many communities, especially where anemia is prevalent among women and adolescents, iron and folic acid tablets are distributed. Regular supplementation programs can be run through:

- **Schools**, where adolescents can be given weekly iron tablets.
- **Anganwadi centers or community clinics**, where women of reproductive age and pregnant mothers receive regular supplies.
- Village-level campaigns to improve compliance, because many people stop taking tablets due to side effects. [17]

Food Fortification

Another community-level strategy is the fortification of commonly consumed foods with iron and other nutrients. For example:

- Fortified wheat flour and rice.
- Double-fortified salt (with iodine and iron).
- Fortified cooking oils with vitamin A and D. [18]
- These are effective because they do not require behavior change; people consume them naturally in their diets.

Control of Parasitic Infections

In many rural areas, worm infestations and malaria are major contributors to anemia. Community-based interventions include:

- **Regular deworming programs** for children and adults.
- **Mosquito control measures** like insecticide-treated bed nets and community spraying.
- Awareness drives on sanitation and hygiene to prevent reinfection. [19]

MATERNAL AND CHILD HEALTH PROGRAMS

Pregnant women are especially vulnerable to anemia, which can lead to premature births, low birth weight, and maternal deaths. Community-level interventions include:

- Early registration of pregnancy and regular antenatal check-ups.
- Distribution of iron and folic acid tablets throughout pregnancy.
- Promotion of institutional deliveries to manage complications better.
- Breastfeeding and complementary feeding counseling to prevent anemia in infants

SCHOOL-BASED INTERVENTIONS

Schools are a powerful setting for prevention. Teachers can be trained to deliver health education, supervise iron tablet distribution, and encourage mid-day meals that are fortified and balanced. Anemia screening camps in schools help identify children at risk early.

COMMUNITY INVOLVEMENT AND BEHAVIOR CHANGE

No program works unless the community itself feels ownership. Mobilizing self-help groups, women's collectives, village councils, and youth clubs to spread awareness and track progress can make interventions more effective. Storytelling, folk theater, and local media can also be used to spread messages in culturally appropriate ways. Use of a digital app and mobile reminder for compliance with the IFA Way Forward supplementation.[20,21]

IMPLEMENTATION OF ANEMIA PREVENTION AND TREATMENT AT THE GLOBAL LEVEL

Anemia is not just a local health problem—it is a global development issue. International organizations, governments, and NGOs work together to design frameworks, fund interventions, and monitor progress.

Global Policies and Goals

- The **World Health Organization (WHO)** has recognized anemia as a major public health problem. WHO's target is a **50% reduction of anemia in women of reproductive age by 2025**.
- The **United Nations Sustainable Development Goals (SDGs)** link anemia prevention to goals like ending hunger, improving maternal health, and ensuring quality education.
- Global nutrition summits and declarations provide platforms for countries to commit resources and share best practices.[22]

Large-Scale Supplementation Programs

Many countries have national policies, often supported by UNICEF, WHO, and other organizations, to provide iron-folic acid tablets, micronutrient powders, or fortified foods to vulnerable populations. For example:

- **Weekly Iron and Folic Acid Supplementation (WIFS)** programs for adolescents in several Asian countries.
- **Home fortification with micronutrient powders** for infants and young children in African and South American nations. [23]

International Food Fortification Initiatives

Global partnerships such as the **Global Alliance for Improved Nutrition (GAIN)** work with governments and industries to fortify staple foods like flour, rice, and oil. These interventions reach millions of people without requiring individual compliance.[24]

Research and Innovation

International collaborations fund research into:

- New forms of iron supplements with fewer side effects.
- Biofortification of crops (e.g., iron-rich beans, rice, or maize).
- Genetic studies to address inherited anemias like thalassemia.[25]

Funding and Resource Mobilization

Programs at scale need financial support. Organizations like the **World Bank**, **Bill and Melinda Gates Foundation**, and **UNICEF** provide funding for anemia-related programs, especially in low- and middle-income countries. [26]

Global Monitoring and Data Systems

Reliable data is crucial for tracking progress. WHO and UNICEF maintain global databases on anemia prevalence, allowing policymakers to design targeted strategies. International surveys like DHS (Demographic and Health Surveys) help measure real-world impact.[27]

Integration with Other Global Health Initiatives

Anemia prevention is often integrated with broader programs, such as:

- **Malaria control programs** in sub-Saharan Africa.
- **Maternal and child health programs** in South Asia.
- **HIV/AIDS programs** that include anemia screening and treatment.[28]
- This integration ensures that resources are shared and interventions reach more people.

Way Forward

- More cost-effective and ambitious global targets are needed.
- Continued advocacy, policy development, and implementation of proven interventions are essential to accelerating anemia reduction efforts globally.
- Focusing on countries with high prevalence and addressing the needs of vulnerable groups will be key to achieving progress on the SDGs.

RECOMMENDED ACTIONS

Increased Investment

Greater global political commitment and investment in nutrition-based interventions are crucial.

Targeted Interventions

Effective strategies include:

- **Iron and micronutrient supplementation:** For pregnant people and children.
- **Food fortification:** Fortifying foods with iron and other essential nutrients.
- **Improved health services:** Ensuring access to diagnostics and healthcare for prevention and treatment.

Healthy diet: Encouraging consumption of iron-rich foods, folate, vitamin B12, and other vital nutrients.

CHALLENGES AND SOLUTIONS IN ANEMIA

Table 2 depicts (2020–2025) challenges in the implementation of anemia prevention and treatment programs, along with evidence-based solutions and references.

Table 2 Prevention and treatment (2020–2025)

Challenge	***Way forward (solution)***	***Recent reference (2020–2025)***
Low adherence to iron-folic acid (IFA) supplementation due to side effects, poor taste, forget fullness.	Introduce improved iron formulations (e.g., micronized, heme iron); weekly dosing for adolescents; digital reminders and counseling.	WHO Guideline on Daily Iron Supplementation, 2020; Pasricha et al., *Lancet Haematology*, 2021
Supply chain disruptions (stock-outs, delayed procurement)	Strengthen logistics with digital supply tracking, buffer stocks, and public–private partnerships for fortification supply	UNICEF Supply Report, 2022; GAIN Fortification Progress, 2022
Weak health systems and workforce shortages	Train community health workers; integrate anemia into maternal, child, and school health programs.	WHO Global Nutrition Report,2021; UNICEF Nutrition Strategy, 2025
Socioeconomic and gender factors in equities limit access to iron-rich foods and healthcare.	Promote social protection schemes (cash transfers, school meals); empower women in household food decisions.	UNSDG Progress Report, 2023; UNICEF Nutrition Strategy, 2025
Multifactorial etiology (infections, hemoglobinopathies, and inflammation are often ignored)	Combine nutrition with malaria control, deformity, and genetic screening programs.	WHO Global Anemia Estimates,2023; Balarajan et al., *Lancet Global Health*, 2022
Poor monitoring and weak data quality	Develop real-time Hb dashboards, bio markers beyond hemoglobin, and annual program scorecards.	WHO Global Anemia Estimates,2023; UNICEF/ WHO Joint Monitoring, 2024
Unsustainable financing, donor dependence	Increase domestic health budgets; blended financing models (public, private, donor); mainstream anemia into Universal Health Coverage (UHC)	SUN Movement Financing Report, 2023; Global Nutrition Report, 2021
Limited behavior change and low awareness	Design culturally tailored communication, involve community leaders, peer support groups, and school-based campaigns.	Pasricha et al., 2021; UNICEF Behaviour Change Report, 2022

Conclusion

Anemia prevention and treatment are not just medical responsibilities but social commitments. At the community level, change begins with awareness, nutrition, supplementation, and local participation. At the global level, policies, funding, and large-scale programs set the direction. Neither level alone is enough.

If we can weave together local action with global momentum, we can make anemia a problem of the past. The result would not just be healthier individuals, but also stronger families, more productive economies, and a fairer world where no one is held back by something as preventable as anemia.

References

1. World Health Organization. WHO/NMH/NHD/MNH/11.1. Geneva: WHO; 2011.
2. World Health Organization. Global anemia estimates: 2021 edition. Geneva: WHO; 2023.
3. Bailey RL, West KP, Black RE, et al. The epidemiology of global micronutrient deficiencies. Nutrients. 2022;14(3):613.
4. Balarajan Y, Ramakrishnan U, Özaltin E, et al. Anemia in women of reproductive age: progress and future directions. Lancet Glob Health. 2021;9(7):e770-2.
5. Pasricha SR, Colman K, Centeno-Tablante E, et al. Anemia: a comprehensive global estimate and economic implications. Lancet Haematol. 2021;8(9):e626-35.
6. World Health Organization. Global anemia estimates. Geneva: WHO; 2023—Bailey RL, et al. Nutrients. 2022.
7. Pasricha SR, Tye-Din J, Muckenthaler MU, et al. Iron deficiency. Lancet. 2021;397(10270):233-48.
8. BalarajanY,etal.LancetGlobHealth.2021. Lancet . 2011 Dec 17;378(9809):2123-35. doi: 10.1016/S0140-6736(10)62304-5. Epub 2011 Aug 1.
9. World Health Organization. Nutrition Landscape Information System (NLiS). Geneva: WHO; 2023.
10. Camaschella C. Iron-deficiency anemia. N Engl J Med. 2021;385:231-43.
11. Stevens GA, Paciorek CJ, Flores-Urrutia MC, et al. National, regional, and global estimates of anaemia by severity in women and children for 2000-19: a pooled analysis of population-representative data. Lancet Glob Health. 2022;10(5):e627-39.
12. Daru J. Sustainable Development Goals for anemia: 20 years later, where are we now? Lancet Glo Health. 2022;10(5):e586-7.
13. World Health Organization. Global anemia estimates. Geneva: WHO; 2023—United Nations. SDG progress report. New York: UN; 2024—UNICEF. Nutrition strategy. New York: UNICEF; 2025.
14. Blythe R, Rohner F, Namaste S, et al. Cost-effective targets for anaemia reduction in 191 countries: a modelling study. Lancet Haematol. 2025;12(9):e674-83.
15. Ministry of Health and Family Welfare (India). India's fight against anemia: nourish, prevent, protect. Press Information Bureau, Government of India; 2025.

16. International Institute for Population Sciences (IIPS), ICF. National Family Health Survey (NFHS-5), 2019-21: India. Mumbai: IIPS; 2022.
17. World Health Organization. Global iron and anemia estimates. Geneva: WHO; 2023—Ministry of Health and Family Welfare (India). Anemia Mukt Bharat dashboard. New Delhi: MoHFW; 2023.
18. Global Alliance for Improved Nutrition. Annual report. Geneva: GAIN; 2022—UNICEF. Nutrition strategy. New York: UNICEF; 2025.
19. World Health Organization. Global anemia estimates. Geneva: WHO; 2023—UNICEF. Progress report. New York: UNICEF; 2024.
20. Ministry of Health and Family Welfare (India). Anemia Mukt Bharat. New Delhi: MoHFW; 2023.
21. Sontakke P, Dwidmuthe KS, Kawathalkar A, et al. Effect of Mobile Phone Call Reminders With Standard Therapy Versus Standard Therapy Alone on Compliance With Iron Supplementation in Antenatal Women With Iron Deficiency Anemia: A Randomized Controlled Trial. Cureus. 2022;14(9):e29501
22. Hasan MM, Soares Magalhaes RJ, Garnett SP, et al. Anaemia in women of reproductive age in low- and middle-income countries: progress towards the 2025 global nutrition target. Bull World Health Organ. 2022;100(3):196-204.
23. Weekly iron and folic acid supplementation as an anaemia-prevention strategy in women and adolescent girls. World Health Organ. 2018. Available from: https://www.who.int/publications/i/item/WHO-NMH-NHD-18.8.
24. Global Alliance for Improved Nutrition. Report 2021-22. Geneva: GAIN; 2022—UNICEF. Nutrition strategy. New York: UNICEF; 2025. Available from: https://www.unicef.org/documents/nutrition-annual-results-2022
25. Meenakumari B, K C, Dhanasekar S. Advanced molecular approaches to thalassemia disorder and the selection of molecular-level diagnostic testing in resource-limited settings. Hematol Transfus Cell Ther. 2025;47(3):103860.
26. UNICEF, World Health Organization. Financing notes 2022-24: SUN movement financing analysis. Geneva: WHO; 2023.
27. World Health Organization. Global anemia estimates. Geneva: WHO; 2023—UNICEF, WHO. Joint monitoring. Geneva: WHO; 2024. Avilable from: the DHS Program https://dhsprogram.com
28. Obeagu EI, Obeagu GU, Ukibe NR, et al. Anemia, iron, and HIV: decoding the interconnected pathways: A review. Medicine (Baltimore). 2024;103(2):e36937.

Chapter 2

Tackling Maternal Anemia in Prevention and Management of Postpartum Hemorrhage: An Integrated Continuum-of-Care Approach

Anne–Beatrice Kihara

INTRODUCTION

Anemia is defined in pregnancy as hemoglobin below 11 g/dL or any hemoglobin level that results in hemodynamic instability. This remains a global public-health problem affecting roughly a third of pregnant women, concentrated in low- and middle-income countries where food and nutrition insecurity, infections, and genetic disorders converge. Causes are multifactorial: iron and folate deficiency driven by poor diets and climate-sensitive food systems; parasitic and infectious burdens such as malaria, hookworm, and schistosomiasis; HIV, tuberculosis, hemoglobinopathies, and inflammation-mediated iron sequestration. Addressing anemia, therefore, demands both clinical treatment and upstream action on nutrition, WASH, and agro-ecological systems, and" think nutrition first "with a life course approach in women's health.[1]

Moderate to severe prenatal anemia carries particular obstetric risk: it reduces physiologic reserve so that any blood loss yields disproportionate hemodynamic compromise, and plausibly increases uterine atony, the commonest cause of PPH. Meta-analytic evidence shows severe antenatal anemia is associated with a markedly higher risk of postpartum hemorrhage, underscoring the need for prevention and timely correction.

Prevention and correction must span the continuum: preconception and reproductive-age interventions (iron/folate programs, adolescent supplementation, family planning and deworming, malaria control, nutrition-sensitive agriculture and biofortification to improve diet quality) raise baseline hemoglobin; antenatal care must screen early and repeatedly, offer oral or, when indicated, intravenous iron, and treat infectious causes; intrapartum planning should direct anemic women to comprehensive obstetric and neonatal facilities or provision of timely referrals equipped for PPH management. Nutrition-sensitive agricultural and market interventions that increase dietary diversity and bioavailable iron are essential complements to clinical care.

PPH prevention relies on universal active management of the third stage of labour, facility *readiness* (uterotonics including oxytocin or heat-stable carbetocin where appropriate), *recognition* with rapid blood-loss measurement, and emergency bundles. Bundled, early detection-and-response approaches such as E-MOTIVE have demonstrated large reductions (~60%) in severe PPH outcomes.[2-4] When bleeding occurs, tranexamic acid given early reduces death from hemorrhage. Where medical measures fail, a clear escalation ladder—uterine balloon tamponade, compression sutures, devascularization or interventional radiology, and ultimately hysterectomy—must be available, alongside strong blood transfusion systems and continuous vital-sign monitoring.

Because anemia and PPH profoundly affect fetal growth and newborn survival—raising risks of IUGR, prematurity, low birth weight and later noncommunicable-disease programming—solutions must be multidisciplinary and multisectoral: integrate WASH, agriculture, education and social protection with high-quality obstetric and newborn services; strengthen competency-based EmONC training; embed maternal death/perinatal review and quality networks; and mobilize community engagement, blood drives and sustainable financing to eliminate delays in seeking, reaching and receiving care. Only an integrated systems response will protect mothers and their babies from the avoidable harms of anemia and postpartum hemorrhage.

FIGO'S STRATEGIC ACTIONS TO COMBAT ANEMIA AND IMPROVE PPH CARE

The International Federation of Gynecology and Obstetrics (FIGO), in concert with its Member Societies and partners like the World Health Organization, the PMNCH International Confederation of Midwives (ICM), and the CBO, leads multifaceted efforts to reduce maternal and perinatal morbidity and mortality linked to anemia and postpartum hemorrhage. Key initiatives include:

- Development of the PPH roadmap in 2023 and undertaking consolidated PPH prevention and management guidelines.
- Providing clinical leadership through the LDI-REACH Initiative and AMPLI-PPH has seen an address to resilience of the health system through regular barrier and gender analysis in combating PPH, and clinical competencies,[5,6] in countries like Kenya, Ethiopia, Nigeria, Bangladesh, India, Nepal, Uganda, Rwanda, South Sudan, Liberia, and Ghana.
- *Participating in advocacy:* Every woman, every newborn, everywhere targets and milestones for acceleration of reduction of maternal, still births, and neonatal mortality towards attainment of SDG 3, particularly in LMIC. Additionally, the Healthy Beginnings and Hopeful Future campaign that commenced at the World Health Assembly.[7]

- *Capacity-building and advocacy:* Through expert working groups and virtual workshops, FIGO supports local societies to tailor protocols, develop job aids, and bolster health-worker competencies in PPH prevention and management through EmONC. The formation of a community of practice, clinical care networks, and twinning for shared learning and resources. Conduct regular clinical audits of near misses and MPDSR. The midwifery model of care is gaining implementation momentum in LMIC, where midwifery programs exist. Innovations in PPH, including the anemia screening caravan and intravenous iron program in India. Catalyzed advocacy drives to end PPH run[8] in SSA.
- *Evidence-based treatment focus:* In collaboration with ICM, FIGO endorses the timely use of tranexamic acid (TXA) within 3 hours postpartum, as part of the first-response care bundle, the E-MOTIVE.
- *Comprehensive guidance supplement:* A dedicated IJGO supplement (2022) reviewed best practices across settings, emphasizing uterotonic prophylaxis for all births, community-level misoprostol use when needed, and the PPH care bundles.

BACKGROUND

Anemia is a global public health problem accounting for 35% of the population below the WHO threshold of 11 g%. It is principally seen in LMIC and is attributable to poor food and nutrition security. Contributory factors include malnutrition aggravated by climate change, resulting in both macro and micronutrient deficiencies, the most common being iron and folic acid. Infectious diseases—malaria, hookworm/soiltransmitted helminths, schistosomiasis, chronic infections (HIV, TB); hemoglobinopathies and genetic causes—sickle cell disease, thalassemia, G6PD deficiency, and chronic disease/inflammation with mediated iron sequestration.

Linkage of anemia to postpartum hemorrhage notably worsens with severity anemia and arises from the following mechanisms: lowers tolerance for blood loss resulting in hemodynamic instability; uterine atony due to the hypoxic state of uterine muscle, altered nitric oxide metabolism and altered calcium ionic activity affecting myometrial contractility; altered hemostasis/coagulation and fibrinolysis with reduced ability to form stabilized clot formation when bleeding occurs and other risk factors such as overdistended uterus, prolonged labour, chorioamnionitis, HELLP syndrome and prolonged IUFD.

Corrective measures for anemia should be undertaken in the preconceptual period and proactively screened and corrected throughout pregnancy, intrapartum, and into the postpartum period. The reason for this is the posed dangers to the mother that include: fertility compromised, miscarriages, stillbirth, intrauterine fetal growth restriction, premature labour, abruption placenta, vulnerability to other infections such as UTI and respiratory diseases, Sheehan's syndrome with inability to initiate lactation, congestive cardiac failure, and maternal mortality. The fetus may suffer from fetal anomalies, IUFD, fetal programming for NCD, small and sick vulnerable newborn and related complications, poor breastfeeding practice, neonatal anemia, failure to thrive, and risk of neonatal mortality.

OPTIMIZATION OF THE MATERNAL INTERNAL MILIEU DURING THE PRECONCEPTION AND REPRODUCTIVEAGE WOMEN (HIGHEST LEVERAGE)

Goals: Raise baseline hemoglobin, treat iron deficiency, reduce infections/ parasites, and enable optimal spacing of pregnancies.

- *WASH (water, sanitation, and hygiene):*[9] Repeated enteric infections, soil-transmitted helminths, and environmental enteric dysfunction (EED)[10] Reduce nutrient absorption and cause chronic inflammation that worsens iron status. Studies and reviews show that better sanitation is associated with lower prevalence of anemia in women. Integrating WASH with nutrition programs, therefore, reduces anemia risk.
- *Scaling up global targets for nutrition:*[11] Nutritional counseling and provision of nutritious food using locally accessible diets. The global targets address a 50% reduction of anemia among WRA and increase exclusive breastfeeding for 6 months; a 30% reduction in low birth weight; a 40% reduction in childhood stunting; a reduction in wasting to <5% and no increase in childhood obesity.[12] Important to ensure the cultural habits are not aggravating the maternal anemia. Routine screening for anemia for women of reproductive age, where feasible; targeted iron supplementation for women with low Hb.
- Food fortification and dietary interventions (iron fortification of staple diets, avoidance of phytates, behavior change to increase iron absorption—e.g., combine Iron with vitamin C and avoid tea/coffee at meals).
- Deworming of women of reproductive age in endemic areas (WHO supports safe anthelminthic use in pregnancy after the first trimester and programs for WRA and community deworming to reduce hookworm burden.
- Malaria prevention in endemic areas (LLINs, community public health interventions); IPTp (intermittent preventive treatment in pregnancy) starts in pregnancy, but community malaria control helps preconception status.
- Family planning and pregnancy spacing reduce cumulative depletion of maternal nutrients, and it is recommended that the inter-pregnancy interval should be at least two years.
- *Agricultural practices:* Women are often the farmers and often do not benefit from nutritious foods even at the household level. Nutrition-sensitive agriculture (NSA), biofortification, homestead gardens, diversification, post-harvest preservation, and women's control of smallholder production improve

household diet quality and iron bioavailability. Reviews show agricultural interventions can improve food security and dietary diversity—essential long-term levers against anemia. Integrating multisector policies with nuanced Agri-ecological practices from biodiversity, food production to fork, avoidance of food wastage, and engaging in circular economies, i.e., NSA, reducing the carbon footprint, and with socio-cultural-behavioral change enhancing impact.

- *Multisector approach and programmatic implication:* ANC and community nutrition programs must partner with WASH, agricultural interventions, and public health strategies to shift population anemia prevalence before conception and during pregnancy and in the continuum of care.

THE CONTINUUM OF CARE

- Screen early and at entry to ANC; repeat in 2nd and 3rd trimester Hb measurement. Classify the anemia in pregnancy by WHO as mild (10.0–10.9 g/dL), moderate (7.0–9.9 g/dL), and severe (<7.0 g/dL).
- *Routine antenatal iron ± folic acid supplementation:* WHO recommends ironfolic acid to prevent anemia (daily oral iron is standard; in populations with lower baseline anemia, intermittent regimens may be used for better tolerance).[13] Dose and regimen depend on the setting; start as early as possible. Increasingly, there is recognition of the need for LMIC to provide multiple micronutrient supplementation (MMS). Additionally, it is recognized that in LMIC, adolescent pregnancies are high and often unplanned. Gynecological problems associated with increased blood loss, such as heavy menstrual bleeding (FIGO PALM–COIN classification)[14] Endometriosis and adenomyosis need to be addressed prior to pregnancy or the correction of anemia at the earliest opportunity in the prenatal period.
- *Treat iron deficiency anemia promptly:*
  - Oral iron is the firstline for many women. Note adherence may be compromised due to intolerance.
  - Intravenous (IV) iron is effective and increasingly used for moderate to severe anemia or when oral iron is not tolerated or too slow; recent large studies support safety and superiority for rapid correction in pregnancy in some settings. Cochrane reviews and RCTs support IV Iron in selected cases.

Address other causes: Test/treat malaria, WASH, and deworming where indicated, investigate for hemoglobinopathies or other causes of anemia that persist despite iron.

Anemia care plan for labor: Women with moderate to severe anemia should deliver in a facility with the capacity to prevent and manage PPH using the care bundles.

INTRAPARTUM (LABOR AND DELIVERY)

- *Place of delivery decision:* If Hb is low (moderate/severe), recommend planned delivery at a facility with emergency obstetric and neonatal care providing for PPH management capacity (skilled attendants, blood/transfusion capabilities, uterotonics) and a critical care unit for mother and neonate.
- Active management of the third stage of labor (AMTSL)—administer a prophylactic uterotonic (oxytocin 10 IU IM/IV) for all births to reduce PPH risk, and where inaccessible or poor-quality use of other uterotonic agents available, such as heat-stable carbetocin, misoprostol, ergometrine, or syntometrine (where indicated).[15] This is the cornerstone of PPH prevention worldwide.
- *Prepare for PPH:* Hemorrhage cart, clear protocols, team training, and rapid access to uterotonics and tranexamic acid (TXA) if needed. The care bundle of E-MOTIVE reduces the risk of PPH by 60%.
- *Recognize and respond appropriately and timely management of the underlying cause of PPH:* The 4 T's remain the practical clinical framework: Tone (atony), Trauma (lacerations/rupture), Tissue (retained placenta/clots), Thrombin (coagulopathy). However, there is an increase in placenta accreta spectrum as an underlying pathology for PPH.[16]

IMMEDIATE POSTPARTUM AND POSTNATAL CARE

- *Treat PPH early and aggressively with the care bundle: E-MOTIVE.* First-line: measurement of blood loss using the V-drape; bimanual uterine massage, uterotonics (oxytocin, or heat-stable Carbetocin (CHAMPION Trial),[17] or ergometrine or Misoprostol depending on context and contraindications, tranexamic acid (TXA) within 3 hours if clinically indicated, tranexamic acid reduces death from bleeding (WOMAN trial).[18] If medical measures fail, escalate to uterine balloon tamponade. In refractory PPH, re-evaluate the underlying pathology for the PPH. If uterine atony, administer parental fluids and blood transfusion, intravenous uterotonics or per rectal or sublingual misoprostol or prostaglandins; NASG for patient transfer, external/intermittent aortic compression, intraoperative hemostatic sutures (B-Lynch, Hayman, Pereira, Cho-suture, etc.), devascularization of the uterus, or hysterectomy as appropriate. All other causes provide definitive treatment accordingly.
- *Postpartum anemia management:* For women who have lost blood and are hemodynamically unstable or remain anemic postpartum, blood and blood product transfusion or IV iron as appropriate. Patient bloodmanagement protocols adherence.
- *Optimizing patient outcomes in addressing anemia and PPH health systems measures:* Skilled birth attendance, emergency setting for the maternal–neonatal dyad, inclusive of access to critical care units, diligent triage using

the MEOW chart, standardized PPH protocols, routine simulation drills, hemorrhage checklists, hemorrhage carts, and rapid transfusion pathways reduce their mortality.[19]

- *Postpartum breastfeeding:* Initiation of breastfeeding in the first golden hour accords a lot of benefits to the mother and newborn. Advantages include: a prevention strategy for PPH, a source of newborn nutrition, maternal warmth wards off hypothermia, maternal and newborn bonding may assist in the prevention of puerperal psychosis, immune factors—the first baby vaccine; a form of contraception—LAM, and must be supported to be initiated, continued, and exclusively done for the first 6 months.[20,21]

OUTSIDE PREGNANCY: POPULATION HEALTH APPROACHES

- *Women of reproductive age programs:* Iron supplementation/fortification, deworming, school-based Iron for adolescent girls, and school feeding programs; family planning to space pregnancies, vaccination, and infection control (malaria, etc.). These reduce baseline anemia before conception and improve pregnancy outcomes.
- *Social determinants and gender empowerment*[22,23] include women's education, food and nutrition security, and poverty alleviation, are long-term levers to reduce chronic anemia prevalence.[24] As far as possible, the importance of autonomy to decide when, if, timing, and how many children the women want (reproductive fecundity), giving her health rights with social and reproductive justice**.** This should be extended to girls/women with increased vulnerability, marginalized, hard to reach, and those in humanitarian crises.

Conclusion

Maternal anemia and PPH prevention and management need a multifaceted approach with clinical, social, and gender norms, systemic, and structural determinants addressed concurrently. The unified commitment, collaboration, and communication between obstetricians, midwives, pediatricians, and other health professionals is critical for the impactful delivery of care. When empowered by strong competency training and supported through multisector synergy, robust accountability mechanisms, system financing and technologies, community engagement, and continuous data-informed learning as essential to preventing and managing PPH, more lives are saved and move the needle towards healthy beginnings and hopeful futures as the maternal–neonatal dyad thrives and transforms positively societies.

References

1. International Federation of Gynecology and Obstetrics (FIGO). Recommendations on adolescent, preconception, and maternal nutrition: "Think Nutrition First". Int J Gynaecol Obstet. 2015;131(S4):S213-S253.
2. Reducing postpartum haemorrhage. Lancet. 2025;405(10485):1119.
3. Durocher J, Ononge S. Lessons for future implementation of the E-MOTIVE bundle. Lancet Glob Health. 2025;13(2):e187-e188.
4. Althabe F, Therrien MNS, Pingray V, et al. Postpartum hemorrhage care bundles to improve adherence to guidelines: A WHO technical consultation. Int J Gynaecol Obstet. 2020;148(3):290-9.
5. FIGO. Leadership Development Initiative—REACH. Available from: https://www.figo.org/news/ldireach-project-leads-knowledge-sharing-improve-effective-coverage-maternal-health
6. FIGO. AMPLI-PPH. Available from: https://www.figo.org/about-us/figo-programmes/accelerating-measurable-progress-and-leveraging-investments-postpartum
7. PMNCH. Healthy beginnings, hopeful futures: Global action for women and newborns. Available from: https://pmnch.who.int/news-and-events/events/item/2025/04/07/default-calendar/healthy-beginnings-hopeful-futures-global-action-for-women-and-newborns
8. End PPH. End PPH run. Available from: https://endpph.com/
9. Muriithi B, Wandera EA, Takeuchi R, et al. Impact of integrated WASH and maternal and child health interventions on diarrhea disease prevalence in a resource-constrained setting in Kenya. Trop Med Health. 2024;52(1):56.
10. Bushen G, Merga H, Tessema F. Effects of community-led total sanitation and hygiene implementation on diarrheal diseases prevention in children less than five years of age in South Western Ethiopia: A quasi-experimental study. PLoS One. 2022;17(4):e0265804.
11. World Health Organization. Global Targets 2025: To improve maternal, infant, and young child nutrition. Available from: https://www.who.int/teams/nutrition-and-food-safety/global-targets-2025
12. Global Nutrition Report. Nutrition Accountability Framework: Progress towards Global Nutrition Targets 2025. Available from: https://globalnutritionreport.org/resources/naf/naf-commitment-tracking/progress-towards-the-global-nutrition-targets/
13. World Health Organization. New guidelines on antenatal care for a positive pregnancy experience. 2016. Available from: https://www.who.int/news/item/07-11-2016-new-guidelines-on-antenatal-care-for-a-positive-pregnancy-experience
14. Munro MG, Critchley HOD, Broder MS, et al. FIGO classification system (PALM-COEIN) for causes of abnormal uterine bleeding in nongravid women of reproductive age. Int J Gynaecol Obstet. 2011;113(1):3-13.
15. World Health Organization. Uterotonics for the prevention of postpartum haemorrhage. Available from: https://www.ncbi.nlm.nih.gov/books/NBK535972/
16. Enste R, Cricchio P, Dewandre PY, et al. Placenta accreta spectrum Part II: Hemostatic considerations based on an extended review of the literature. J Perinat Med. 2022;51(4):455-67.
17. Ghosh R, Owa O, Santos N, et al. Heat-stable carbetocin or oxytocin for prevention of postpartum hemorrhage among women at risk: A secondary analysis of the CHAMPION trial. Int J Gynaecol Obstet. 2024;164(1):124-30.

18. Picetti R, Miller L, Shakur-Still H, et al. The WOMAN trial: Clinical and contextual factors surrounding the deaths of 483 women following postpartum haemorrhage in developing countries. BMC Pregnancy Childbirth. 2020;20:409.
19. Vogel JP, Nguyen PY, Ramson J, et al. Effectiveness of care bundles for prevention and treatment of postpartum hemorrhage: A systematic review. Am J Obstet Gynecol. 2024;231(1):67-91.
20. World Health Organization. Protecting, promoting and supporting breastfeeding in facilities providing maternity and newborn services: The Baby-friendly Hospital Initiative: Monitoring manual. Available from: https://www.who.int/publications/i/item/9789240103764
21. UNICEF. Countdown 2030 Kenya profile. Available from: https://data.unicef.org/countdown-2030/country/Kenya/1/
22. Souza JP, Day LT, Rezende-Gomes AC, et al. A global analysis of the determinants of maternal health and transitions in maternal mortality. Lancet Glob Health. 2024;12(2):e306-e316.
23. Frontiers in Public Health. Social determinants of women's health: Several Ethiopian publications. Available from: https://www.frontiersin.org/research-topics/52770/social-determinants-of-womens-health-in-low-and-middle-income-countries/articles
24. UNICEF. Global action plan on child wasting. Available from: https://www.unicef.org/media/96991/file/Global-Action-Plan-on-Child-Wasting.pdf

Chapter 3

Challenges and Interventions for Anemia in Pregnancy: The Indian Perspective from a Public Health Lens

Manya Prasad, Umesh Kapil

INTRODUCTION

Anemia in pregnancy remains a formidable public health challenge in India, contributing significantly to maternal morbidity, mortality, and adverse birth outcomes. Despite decades of targeted interventions, India continues to report one of the highest burdens of maternal anemia globally. According to the National Family Health Survey (NFHS-5), over 50% of pregnant women in India are anaemic, with little improvement seen over the past two decades.[1] The condition is not merely a reflection of iron deficiency, but a complex interplay of nutritional deficits, infections, social determinants, and systemic health delivery gaps.

Anemia in pregnancy has profound implications for both maternal and fetal health. It increases the risk of preterm birth, low birth weight, intrauterine growth restriction, and postpartum hemorrhage (PPH)—a leading cause of maternal death. From a physiological perspective, the increased blood volume during pregnancy places additional demands on maternal iron stores, making timely prevention and management essential. In the Indian context, the high prevalence of early marriage, adolescent pregnancy, poor dietary diversity, and limited access to quality antenatal care further compound the risk.

Over the years, the Government of India has launched multiple programs to combat maternal anemia, including the Intensified National Iron Plus Initiative (I-NIPI) and the Anemia Mukt Bharat (AMB) strategy.[2-4] These efforts have sought to expand coverage of iron and folic acid supplementation, deworming, and anemia screening through primary healthcare platforms. However, persistent implementation bottlenecks, poor adherence, and sociocultural barriers have limited the effectiveness of these interventions at scale.

This chapter aims to explore the burden, determinants, and consequences of anemia in pregnancy from an Indian perspective. It critically examines the existing policies and programmatic approaches, identifies key implementation challenges, highlights innovations and good practices, and outlines actionable strategies for achieving meaningful and sustained reductions in maternal anemia.

EPIDEMIOLOGY OF ANEMIA IN PREGNANCY IN INDIA

Anemia in pregnancy remains a widespread and entrenched public health issue in India, despite longstanding national programmes aimed at its reduction. According to the National Family Health Survey (NFHS-5, 2019–2021), 52.2% of pregnant women in India were found to be anaemic (Hb <11 g/dL), only marginally lower than the 50.4% reported in NFHS-4 (2015–2016). This stagnation in prevalence over time underscores a critical gap between programmatic coverage and actual health outcomes.[1]

Geographic and Sociodemographic Variation

There exists marked variation in the prevalence of maternal anemia across states, with high-burden states such as Bihar (63.1%), Rajasthan (58.4%), and Madhya Pradesh (54.7%) consistently reporting above-national-average figures. In contrast, some states like Kerala (19.9%) and Manipur (26.4%) show substantially lower prevalence, suggesting the role of broader socioeconomic determinants and health system performance.

The rural-urban divide is evident, with 55.8% of pregnant women in rural areas anaemic compared to 45.7% in urban areas (NFHS-5). Disparities are also seen by caste and tribe: Scheduled Tribes (58.8%) and Scheduled Castes (55.5%) bear a disproportionately higher burden, reflecting the interplay of poverty, dietary insufficiencies, and limited access to timely antenatal care.[1]

Age and Parity Trends

Adolescent pregnant women (15–19 years) are particularly vulnerable, with prevalence consistently higher in this subgroup. Early marriage and poor nutritional reserves contribute to a compounded risk. Multiparous women also exhibit higher rates of anemia, often reflecting cumulative nutritional depletion across successive pregnancies.

Disconnect Between Coverage and Outcomes

Despite near-universal registration of pregnant women for antenatal care and widespread distribution of Iron and folic acid (IFA) supplements under national programmes, anemia rates have not declined as expected. The Anemia Mukt Bharat (AMB) dashboard data, though showing high reported IFA distribution, does not consistently translate into reduced anemia prevalence. This disconnect is likely driven by poor adherence due to side effects, inadequate counselling, variable quality of hemoglobin estimation methods, and limited follow-up of moderate to severe anemia cases.

Overall, the epidemiological profile of anemia in pregnancy in India is shaped by a mix of biological, social, and systemic factors. A nuanced understanding of these patterns is crucial for designing targeted, context-sensitive interventions that go beyond supplement distribution and address the root causes of anemia.

ETIOLOGY AND RISK FACTORS

Anemia in pregnancy in India arises from a complex interplay of nutritional deficiencies, infections, genetic disorders, and sociodemographic determinants. While iron deficiency remains the predominant cause, a substantial proportion of pregnant women suffer from multifactorial or mixed etiology anemia, which necessitates a comprehensive approach to prevention and treatment.[5]

Nutritional Deficiencies

The primary driver of anemia in Indian pregnant women is iron deficiency, which accounts for over half of all cases. Pregnancy increases iron requirements threefold, and most women enter pregnancy with inadequate iron stores due to chronic dietary inadequacy, menstrual losses, and prior pregnancies. Deficiencies in folate and vitamin B12 are also common, especially among women consuming predominantly cereal-based, vegetarian diets with low intake of animal-sourced foods and green leafy vegetables. These micronutrients are critical for erythropoiesis and DNA synthesis, and their deficiency contributes to megaloblastic anemia, often underdiagnosed in clinical settings.[5]

Infections and Parasitic Infestations

Chronic and acute infections further exacerbate anemia. Helminthic infestations, particularly hookworm, lead to chronic intestinal blood loss and iron depletion. Malaria, though declining, remains a relevant cause in endemic pockets, especially among tribal and forest-dwelling populations. Urinary tract infections, chronic inflammation, and other infectious comorbidities can also cause or worsen anemia through mechanisms such as impaired iron absorption or anemia of inflammation.

Hemoglobinopathies and Genetic Disorders

Hemoglobinopathies are an important but under-addressed cause of anemia in India. Conditions such as sickle cell disease, beta-thalassemia trait, and HbE disease are prevalent in certain tribal and eastern states. These disorders may coexist with nutritional anemia, complicating diagnosis and management. Universal antenatal screening for hemoglobinopathies is not yet fully implemented, and counselling services for carriers are limited, especially in low-resource settings.

Reproductive and Obstetric Factors

Closely spaced pregnancies, high parity, and adolescent pregnancies contribute significantly to anemia through cumulative nutritional depletion and inadequate time for maternal nutrient repletion. Unplanned pregnancies, often occurring without preconception care or nutritional supplementation, further compound the risk. Inadequate use of contraception, high unmet need for family planning, and early marriage continue to be contributing factors.

Socioeconomic and Gender-related Determinants

Poverty, food insecurity, and low educational attainment are major structural drivers of anemia. Women from low-income households often lack access to iron-rich and diverse foods and are more likely to delay seeking antenatal care. Gender norms and cultural practices play a key role: dietary taboos (e.g., avoiding certain foods during pregnancy), lower intra-household food allocation for women, and limited decision-making power affect maternal nutrition and care-seeking behaviour. Anemia is often accepted as "normal" in pregnancy, leading to under-recognition and delayed treatment.

Health System-related Contributors

Late registration for antenatal care, inconsistent screening, inadequate counselling, and stock-outs of iron-folic acid (IFA) tablets contribute to missed opportunities for prevention. Poor follow-up of women with moderate or severe anemia, lack of early detection of micronutrient deficiencies other than Iron, and variable quality of point-of-care haemoglobin estimation all limit the effectiveness of current strategies.

By addressing both the biomedical and sociostructural determinants of anemia in pregnancy, programmatic interventions can move beyond the traditional "pill-based" approach and offer more comprehensive, sustainable solutions.[6]

CHALLENGES IN PREVENTION AND MANAGEMENT

Despite decades of programmatic focus and the availability of low-cost interventions, the prevention and management of anemia in pregnancy in India face persistent systemic and structural challenges. These barriers span across the continuum of care—from preconception to delivery—and hinder the translation of high coverage into improved outcomes **Figure 1**.[7]

Delayed Antenatal Registration and Missed Early Screening

A significant proportion of pregnant women in India seek antenatal care only in the second trimester, thereby missing the critical window for early detection and management of anemia. First-trimester registration remains suboptimal, particularly among women in rural, tribal, and underserved urban areas. This delay reduces the time available for effective intervention before haemodilution peaks in the second trimester.[5]

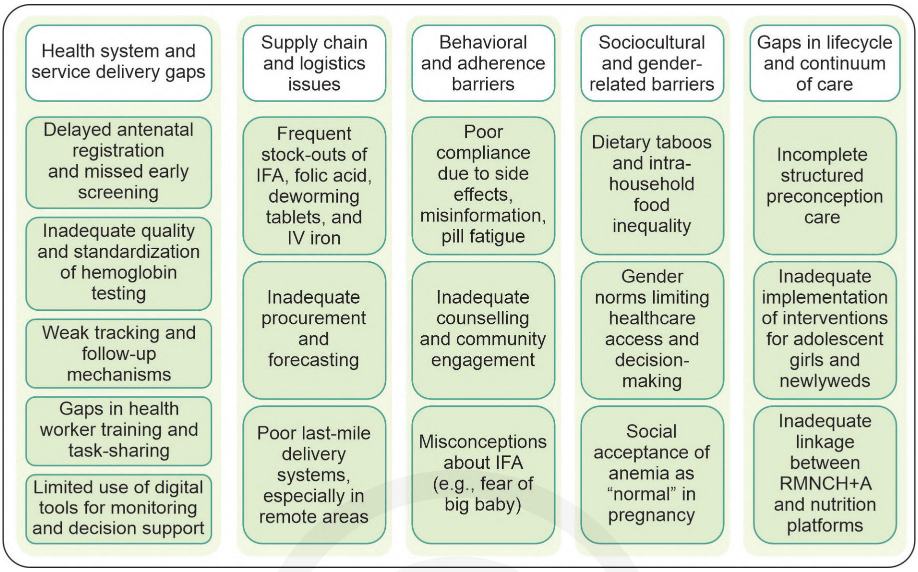

Fig. 1: Challenges in Prevention and Management

Poor Adherence to Iron and Folic Acid (IFA) Supplementation

While national surveys report high IFA distribution rates, actual consumption remains limited. Common reasons for poor adherence include gastrointestinal side effects, misinformation, pill fatigue, and lack of counselling on the importance of compliance.

Frequent Stock-outs and Supply Chain Gaps

Interrupted supplies of IFA tablets, folic acid, deworming tablets, and intravenous iron formulations continue to affect service delivery in several states. Inadequate forecasting, delayed procurement, and poor last-mile logistics result in frequent stock-outs at sub-centres and primary health centres, especially in hard-to-reach areas.

Inadequate Quality and Standardization of Hemoglobin Testing

Point-of-care haemoglobin estimation using methods such as HemoCue® is widespread, but concerns remain regarding accuracy, calibration, and standardization. Variability in test results leads to underdiagnosis or misclassification of anemia severity, compromising clinical decision-making and appropriate referral.

Weak Tracking and Follow-up Mechanisms

Although digital systems such as the Mother and Child Tracking System (MCTS) and Reproductive and Child Health (RCH) portal have been developed to monitor service delivery, their use is inconsistent across districts. Tracking of anemia severity, follow-up testing, adherence to treatment, and escalation to parenteral therapy where needed is often lacking or inadequately documented.

Gaps in Health Worker Training and Task-Sharing

Frontline health workers, including ASHAs, ANMs, and staff nurses, play a pivotal role in screening, counselling, and supplement distribution. However, many lack sufficient training in managing anemia beyond IFA distribution, including recognising signs of severe anemia, identifying high-risk groups (e.g., hemoglobinopathies), and appropriately referring cases for intravenous iron or blood transfusion.

Sociocultural Norms and Intra-household Food Distribution

Cultural practices and food taboos during pregnancy, especially the avoidance of iron-rich foods like eggs, fish, or meat, restrict dietary iron intake. In many households, pregnant women eat last and least, further aggravating micronutrient deficiencies. Family members may discourage supplement use or restrict food intake due to myths around fetal growth and delivery complications.

Absence of Preconception Care

Anemia prevention often begins too late—after pregnancy is established. The lack of structured preconception care platforms, especially for adolescents and newlyweds, results in missed opportunities for early identification and correction of anemia before conception. This is particularly relevant given the high rates of early marriage and adolescent pregnancies in India.[8,9]

NATIONAL POLICY AND PROGRAM LANDSCAPE

India has long recognized anemia in pregnancy as a critical public health issue and has launched multiple policies and large-scale programmes to address it. Over time, these efforts have evolved from narrowly focused iron supplementation schemes to more integrated and lifecycle-based strategies embedded within reproductive, maternal, newborn, child, and adolescent health (RMNCH+A) and nutrition frameworks.

Intensified National Iron Plus Initiative (I-NIPI)

Launched in 2013, the Intensified National Iron Plus Initiative marked a shift towards a lifecycle approach, targeting six beneficiary groups including pregnant and lactating women, women of reproductive age, and adolescents. For pregnant women, I-NIPI mandated daily supplementation with 60 mg elemental iron and 500 μg folic acid for 180 days, continued postpartum. Deworming with albendazole was recommended during the second trimester.[2]

While the program succeeded in streamlining IFA distribution, challenges in ensuring adherence, maintaining stock availability, and monitoring consumption limited its effectiveness. I-NIPI set the foundation for the subsequent Anemia Mukt Bharat initiative.

Anemia Mukt Bharat (AMB) Strategy

Launched in 2018 under the POSHAN Abhiyaan, Anemia Mukt Bharat (AMB) is India's flagship strategy to reduce anemia prevalence among six target groups, including pregnant women.[3] AMB introduced the 6 × 6 × 6 strategy, comprising:

- *Six target beneficiary groups:* Children (6–59 months), adolescents (10–19 years), women of reproductive age (15–49 years), pregnant women, lactating women, and preschool-aged children.
- *Six evidence-based interventions:*
    1. Prophylactic iron and folic acid supplementation
    2. Deworming
    3. Behavior change communication
    4. Testing and treatment of anemia using digital methods and point-of-care diagnostics
    5. Mandatory provision of iron-fortified foods through public health programs
    6. Addressing non-nutritional causes such as malaria and hemoglobinopathies
- Six institutional mechanisms for convergence, coordination, and monitoring, involving key ministries (Health, WCD, Education, and Panchayati Raj).

AMB emphasized intensification, convergence, and community engagement. It introduced intravenous iron sucrose or ferric carboxymaltose for the management of moderate to severe anemia, especially in the second and third trimesters. The initiative also called for quarterly district-level reviews and the use of the Anemia Mukt Bharat Dashboard for monitoring progress.[9]

Role of Janani Suraksha Yojana (JSY) and Pradhan Mantri Surakshit Matritva Abhiyan (PMSMA)

While not anemia-specific, these programmes play a supportive role in improving antenatal care coverage and access to anemia interventions.

- JSY, launched in 2005, provides conditional cash transfers to incentivize institutional deliveries and antenatal care attendance. It has contributed to increased ANC registration and IFA coverage.
- PMSMA, launched in 2016, aims to provide comprehensive and quality antenatal care on the 9th of every month, including screening for anemia and

referral for high-risk pregnancies. However, implementation remains variable, especially in rural and low-resource settings.[10,11]

Integration with RMNCH+A and POSHAN Abhiyaan

The anemia control strategy is closely aligned with the approach proposed in the RMNCH+A program, which integrates maternal and child health across life stages. Additionally, the POSHAN Abhiyaan (National Nutrition Mission), launched in 2018, aims to improve nutritional outcomes for children, pregnant women, and lactating mothers through the convergence of services across ministries, behavior change communication, and community-based monitoring.[4,11]

Iron and folic acid supplementation and anemia screening are also supported through platforms such as Village Health and Nutrition Days (VHNDs) and Urban Health and Nutrition Days, which enable community-level outreach.

Innovations and Good Practices

Across India, several innovative approaches and localized initiatives have emerged to address persistent barriers in anemia prevention and treatment. These models demonstrate the potential of technology, decentralised service delivery, and state-led strategies to bridge gaps in coverage and impact.[12]

Digital Tools for IFA Tracking and Monitoring

Digital health platforms are increasingly being used to improve adherence and monitoring. Initiatives such as Anemia Tracking Modules integrated into the RCH Portal**,** e-RaktKosh for tracking blood availability, and mobile-based IFA consumption apps (piloted in states like Maharashtra and Gujarat) have helped monitor supplement distribution, identify defaulters, and enable data-driven supervision.

Food Fortification and Diversification

The scale-up of rice fortification in mid-day meals, the Public Distribution System (PDS), and ICDS has been a major step toward addressing dietary iron deficiency. Double fortified salt (iron and iodine) and fortified wheat flour have also been introduced in select states. These efforts aim to address micronutrient gaps at the population level, especially where dietary iron intake is low.

Community-based Interventions

Accredited Social Health Activists (ASHAs) play a pivotal role in community mobilisation, IFA distribution, and follow-up of pregnant women. Village Health and Nutrition Days (VHNDs) offer a platform for haemoglobin screening, counselling, and direct service delivery. Several states have incentivised

ASHAs to promote early ANC registration and monitor compliance with iron supplementation.

Parenteral Iron Therapy at Secondary Facilities

In response to poor oral iron adherence and limited impact on moderate to severe anemia, several districts have scaled up the use of intravenous iron sucrose or ferric carboxymaltose (FCM). The inclusion of FCM in the essential drug list and government procurement systems has facilitated its availability in high caseload facilities. Trained staff nurses now administer IV iron in CHCs and district hospitals under safe protocols.

State-level Innovations

- Anemia Free Rajasthan introduced Jan Andolans (people's movement) for community participation, mass testing, and counselling.
- Tamil Nadu piloted point-of-care digital hemoglobinometers for immediate classification and referral.
- Chhattisgarh and Odisha have integrated sickle cell screening into ANC services for tribal populations.

These practices, though scattered, highlight the potential for scaling context-specific, evidence-informed approaches with adequate policy and programmatic support.[13-15]

RESEARCH GAPS AND EVIDENCE NEEDS

Despite longstanding efforts, key evidence gaps limit the optimisation of anemia control strategies in India:

Evaluation of Intervention Effectiveness

There is limited high-quality implementation research evaluating the real-world effectiveness of large-scale IFA supplementation programmes, especially in terms of anemia reduction and maternal outcomes. Comparative studies assessing oral vs. intravenous iron therapy, dosing schedules, and integration with ANC services are needed.

Micronutrient Profiling Beyond Iron

Nationally representative data on folate, vitamin B12, and zinc deficiency are sparse. The lack of routine testing for these nutrients may result in inappropriate or incomplete management of megaloblastic and mixed-type anemia. Similarly, there is a dearth of granular data on hemoglobinopathies, especially in tribal regions.

Adolescent and Preconception Anemia

While much of the focus is on antenatal anemia, there is limited research on anemia trajectories from adolescence to pregnancy. Studies exploring preconception interventions, adolescent dietary habits, and social norms are essential for lifecycle-based prevention **Figure 2**.

Counseling and Behavior Change Strategies

Evidence on the effectiveness of various counselling approaches, including digital tools, peer support models, and family-centred strategies, remains limited. Understanding what works in improving adherence and reducing misconceptions can enhance intervention impact.

RECOMMENDATIONS AND WAY FORWARD

To accelerate progress in reducing anemia in pregnancy, a multi-pronged, lifecycle-based approach is needed—one that integrates biomedical, behavioural, and systemic strategies:

Strengthening of Early Screening and Risk Stratification

- Ensure universal first-trimester hemoglobin screening with quality-assured methods.

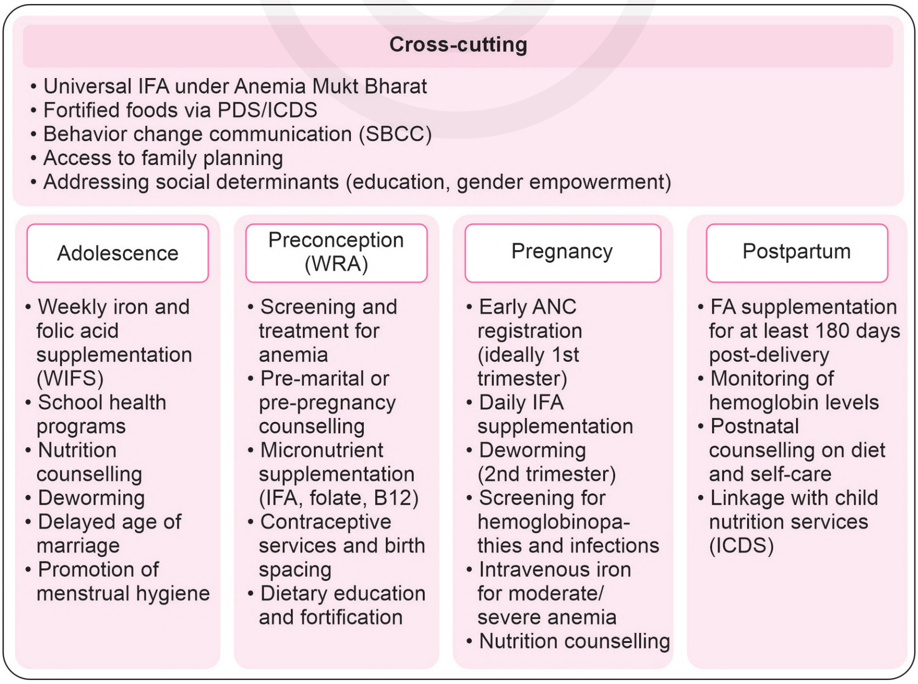

Fig. 2: Lifecourse approach to preventing anemia in pregnancy

- Implement risk-based management protocols, including prompt escalation to parenteral Iron in moderate/severe cases.

Expanding Preconception and Adolescent Interventions

- Integrate pre-marital and pre-pregnancy screening into RMNCH+A platforms.
- Strengthen the Weekly Iron and Folic Acid Supplementation (WIFS) programme and school health platforms.

Diversifying Strategies Beyond IFA

- Scale up iron-rich and fortified food distribution through PDS, ICDS, and mid-day meals.
- Promote dietary diversification and local food systems through community-based nutrition education.

Addressing Health System Bottlenecks

- Ensure uninterrupted IFA and IV iron supply, with improved forecasting and logistics.
- Train frontline workers in anemia classification, counselling, and referral protocols.

Promoting Community Engagement

Use social and behavioural change communication (SBCC) to address myths, enhance compliance, and encourage supportive household behaviours. Family members may be involved as participants in SBCC activities for greater impact.

Enhance Data Systems and Monitoring

- Integrate anemia tracking into digital health platforms with decision-support tools, similar to how it has been piloted in the NCD program.
- Use real-time data for microplanning and performance feedback at the district level.

KEY HIGHLIGHTS

- *High burden and disparities:* According to NFHS-5 (2019–2021), 52.2% of pregnant women in India are anaemic. Prevalence remains disproportionately high among rural populations, adolescents, women from Scheduled Castes and Tribes, and in certain high-burden states.
- *Multifactorial etiology:* While iron deficiency is the most common cause, anemia in pregnancy in India often results from a combination of nutritional deficits (iron, folate, B12), infections (hookworm, malaria), genetic disorders (hemoglobinopathies), and socioeconomic and gender-based determinants such as poor diet, early marriage, and limited access to healthcare.

- *Programmatic response:* National efforts have evolved from the Iron Plus Initiative (I-NIPI) to the Anemia Mukt Bharat (AMB) strategy, which adopts a comprehensive 6 × 6 × 6 approach, integrating supplementation, deworming, food fortification, and health system strengthening. Programmes such as PMSMA and JSY have further supported ANC coverage and service delivery.
- *Persistent challenges:* Gaps remain in early screening, adherence to iron-folic acid (IFA) therapy, supply chain reliability, accurate haemoglobin testing, and preconception care. Sociocultural norms and dietary practices continue to limit dietary iron intake and supplement compliance.
- *Innovations and good practices:* Promising approaches include the use of intravenous Iron in moderate to severe cases, digital tools for tracking IFA adherence, rice and salt fortification, and community-level interventions through ASHAs and VHNDs. Several states have demonstrated success with tailored strategies, such as Anemia Free Rajasthan and hemoglobinopathy screening in tribal areas.
- *Evidence gaps:* Key research needs include evaluation of the real-world effectiveness of interventions, micronutrient profiling beyond Iron, the impact of preconception strategies, and effective models of behaviour change communication.

Conclusion

Anemia in pregnancy is both highly prevalent and eminently preventable. Its persistence in India reflects not just biological deficiencies, but entrenched socioeconomic, cultural, and health system constraints. As a key risk factor for maternal mortality, postpartum hemorrhage, and adverse birth outcomes, addressing anemia is central to India's maternal health goals.

While national policies have evolved to embrace multi-sectoral, lifecycle-based approaches, their success hinges on effective implementation, community ownership, and data-informed strategies. A renewed focus on prevention before pregnancy, quality ANC, and context-sensitive innovations is vital. Combating anemia must remain a public health priority—one that unites the efforts of health, nutrition, education, and empowerment programmes to safeguard the health of India's mothers and their children.

References

1. International Institute for Population Sciences (IIPS), ICF. National Family Health Survey (NFHS-5), 2019-21: India. Mumbai: IIPS; 2021.
2. Ministry of Health and Family Welfare, Government of India. Intensified National Iron Plus Initiative (I-NIPI): Guidelines for Control of Iron Deficiency Anaemia. New Delhi: MoHFW; 2013.

3. Ministry of Health and Family Welfare, Government of India. Anemia Mukt Bharat: Intensified Iron Plus Initiative Operational Guidelines. New Delhi: MoHFW; 2018.
4. Ministry of Women and Child Development. POSHAN Abhiyaan: National Nutrition Mission Administrative Guidelines. New Delhi: MWCD; 2018.
5. Balarajan Y, Ramakrishnan U, Özaltin E, et al. Anaemia in low and middle-income countries. Lancet. 2011;378(9809):2123-35.
6. World Health Organization. The Global Prevalence of Anaemia in 2011. Geneva: WHO; 2015.
7. Rai RK, Fawzi WW, Barik A, et al. The burden of iron-deficiency anaemia among women in India: how have iron and folic acid interventions fared? WHO South-East Asia J Public Health. 2018;7(1):18-23.
8. Kalaivani K, Ramachandran P. Time trends in the prevalence of anaemia in pregnancy. Indian J Med Res. 2018;147(3):268-77.
9. Toteja GS, Singh P, Dhillon BS, et al. Prevalence of anaemia among pregnant women and adolescent girls in 16 districts of India. Food Nutr Bull. 2006;27(4):311-5.
10. Ministry of Health and Family Welfare. Pradhan Mantri Surakshit Matritva Abhiyan (PMSMA) Guidelines. New Delhi: MoHFW; 2016.
11. Rakesh PS. Anemia Mukt Bharat: A new strategy for control of Anemia in India. Indian J Community Med. 2018;43(4):266-9.
12. Kotecha PV. Nutritional Anemia in young children with focus on Asia and India. Indian J Community Med. 2011;36(1):8-16.
13. Bhutta ZA, Das JK, Rizvi A, et al. Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? Lancet. 2013;382(9890):452-77.
14. Government of India. Guidelines for Control of Iron Deficiency Anaemia: National Iron Plus Initiative for Pregnant and Lactating Women, Adolescents and Children. New Delhi: MoHFW; 2013.
15. World Health Organization. Guideline: Daily iron and folic acid supplementation in pregnant women. Geneva: WHO; 2012.

Chapter 4

Preconception Nutrition and Supplementation as a Shield Against Maternal Anemia

Mansi Kumar, Pikee Saxena

INTRODUCTION

Pregnancy is a unique window of opportunity and vulnerability for maternal and fetal health. As the maternal body adapts to support fetal growth and development, nutritional demands dramatically increase. Anemia in pregnancy, especially iron deficiency anemia (IDA), stands out as a major global public health concern, with repercussions on maternal wellbeing, fetal growth, and perinatal outcomes. Nutrition during pregnancy is a cornerstone of maternal and fetal health, influencing not only the immediate outcomes of pregnancy but also the long-term well-being of both mother and child. **Table 1** reflects that key micronutrients like Iron, folate, calcium, vitamin D, and iodine play critical roles in preventing maternal complications and supporting fetal development, including neural tube formation, bone growth, and cognitive function. Inadequate or imbalanced nutrition during this period can lead to adverse outcomes such as low birth weight, preterm delivery, congenital anomalies, and developmental delays. Therefore, ensuring a well-balanced, nutrient-dense diet is essential for optimising pregnancy outcomes and laying the foundation for a healthy start to life.

NUTRITIONAL NEEDS IN ANEMIC PREGNANCY

Anemia during pregnancy is a significant concern in developing nations, impacting both maternal and fetal health. A balanced diet focusing on iron-rich foods, coupled with proper supplementation and enhanced absorption strategies, forms the cornerstone of managing anemia in pregnant Indian women.

Prioritise Iron-Rich Foods

Dietary counselling and food-based strategies: Encourage a diverse, nutrient-dense diet, focusing on:

- *Vegetarian:*
    - *Dark leafy greens:* Spinach, fenugreek leaves, and amaranth are excellent sources of non-heme Iron.[1]

Table 1 Essential nutrients during pregnancy

Nutrient	***RDA in pregnancy***	***Function***	***Key food sources***
Protein	71 g/day	Fetal tissue growth, maternal tissue repair	Eggs, pulses, milk, meat, soy, nuts
Iron	27 mg/day	Hemoglobin synthesis, oxygen transport	Red meat, leafy greens, fortified cereals, legumes
Folic acid	600 µg/day	Neural tube development, cell division	Leafy greens, citrus fruits, beans, fortified grains
Calcium	1,000 mg/day	Bone and teeth development, nerve signaling	Milk, yogurt, cheese, tofu, sesame seeds
Vitamin D	600 IU/day	Calcium absorption, fetal bone health	Fortified milk, sunlight, and fish
Vitamin B12	2.6 µg/day	RBC formation, neurological development	Animal products, fortified cereals
Zinc	11 mg/day	DNA synthesis, cell division	Meat, nuts, seeds, whole grains
Iodine	220 µg/day	Fetal brain development, thyroid function	Iodized salt, dairy, fish
Omega-3 Fatty Acids	200–300 mg DHA/day	Brain and eye development	Fatty fish, walnuts, flaxseeds
Water	~3 liters/day	Amniotic fluid balance, nutrient transport	Water, juices, soups

- *Legumes:* Lentils (dal), chickpeas (chana), and kidney beans (rajma) are reliable sources of Iron and protein.[2]
- *Fortified cereals and whole grains:* Choose fortified oats, brown rice, and whole wheat products.[3]
- *Nuts and seeds:* Almonds, sesame seeds (til), and pumpkin seeds provide iron and healthy fats.[4]
- *Dried fruits:* Dates, raisins, and apricots offer a concentrated source of iron
- *Jaggery (gur):* A traditional sweetener rich in iron.[5]

▪ *Non-vegetarian (if preferred):*
  - *Lean meats:* Chicken, turkey, and lean red meat provide heme iron, which is more readily absorbed by the body.[6]
  - *Fish:* Salmon, sardines, and mackerel are excellent sources of Iron and essential fatty acids (omega-3).[7]
  - Eggs, especially their yolks, contain iron.[8]

Enhance Iron Absorption

- *Pair with vitamin C:* Consuming iron-rich foods with sources of vitamin C, like amla (Indian gooseberry), guava, tomatoes, lime juice, or oranges, can significantly boost iron absorption.[9]
- *Consider fermented foods:* Dishes like idlis and dosas may improve mineral absorption.[10]
- *Cooking in iron vessels:* This traditional practice can naturally increase the iron content of your meals[11]

Avoid or Limit Iron Absorption Inhibitors

- *Tea and coffee:* Avoid consuming these beverages with meals as they contain tannins that can hinder iron absorption.[12]
- *Excessive calcium intake with iron supplements:* Calcium can interfere with iron absorption, so it is advisable to avoid taking calcium supplements or calcium-fortified orange juice alongside iron supplements.[13]

Dietary Diversity and Balance

- *Include a variety of colorful fruits and vegetables:* This ensures a wide range of vitamins, minerals, antioxidants, and fiber.[14]
- *Choose whole grains over refined grains:* Opt for brown rice and millets instead of white rice for increased fiber and B vitamins.[15]
- *Incorporate protein sources:* Lentils, beans, eggs, and lean meats are vital for fetal growth and development.[16]
- *Healthy fats:* Include sources like avocados, nuts, seeds, and fatty fish for healthy brain and eye development.[17]

Hydration

- *Drink plenty of water:* Aim for at least 8–10 glasses of water daily to support amniotic fluid levels, digestion, and overall well-being.[18]
- *Consider coconut water and buttermilk:* These can help with hydration and digestion.[19]

Iron and Folic Acid Supplementation

- Prophylactic iron and folic acid (IFA) supplementation is a key public health strategy recommended by the World Health Organization (WHO) to prevent and treat anemia in pregnancy. WHO advises that all pregnant women receive a daily oral dose of 30–60 mg of elemental Iron and 400 µg (0.4 mg) of folic acid throughout pregnancy to reduce the risk of maternal anemia.[20]
- For anemic pregnant women, oral iron (usually ferrous sulfate or ferrous fumarate) remains the first-line treatment due to its effectiveness, affordability,

and safety. However, if the woman is unable to tolerate oral Iron, has severe anemia (Hb <7 g/dL in the second or third trimester), poor adherence, or poor response to oral therapy, parenteral iron (e.g., intravenous iron sucrose or ferric carboxymaltose) is recommended by WHO and national guidelines.

Intermittent (Weekly) Supplementation

Where daily supplementation is poorly accepted or anemia prevalence is below 20%, the WHO advises onceweekly IFA: 120 mg iron + 2.8 mg folic acid for better adherence in non-anemic pregnant women. However, this is not recommended for treating diagnosed anemia.[21]

Supporting Nutrients Beyond Iron: Multiple Micronutrient Supplementation (MMS)

In low-resource settings, multiple micronutrient supplements (MMS), which include iron, folic acid (IFA), and other vital nutrients, have shown potential to improve birth outcomes such as reduced low birth weight and preterm birth.[22] However, the World Health Organization (WHO) currently recommends MMS only within research settings, not as a routine replacement for IFA alone.[23]

While iron remains the cornerstone of anemia prevention in pregnancy, other micronutrients are also critical for maintaining hematological health and ensuring optimal red blood cell production, as mentioned in **Table 2**.

Table 3 outlines key micronutrient supplements commonly recommended for anemic pregnant women. In addition to *iron and folic acid,* which are central to managing anemia and preventing birth defects, other nutrients may be included based on individual deficiencies. These supplements play vital roles in improving hemoglobin levels, supporting immune function, and promoting healthy fetal development.

The Government of India uses the "Thali model" as a standardized dietary counselling tool for pregnant women under initiatives like POSHAN Abhiyaan and ICDS. Healthcare providers employ this model during antenatal care to demonstrate balanced meals, aiding in the management of maternal anemia and malnutrition.

Table 4 showcases how a traditional Indian thali can represent a nutritious and balanced meal for expectant mothers. It combines different food groups—such as cereals, legumes, vegetables, dairy, fruits, and healthy fats—into visually intuitive segments. This design approach aligns with government-endorsed guidelines and harnesses cultural familiarity to enhance comprehension and adherence.[24]

Cultural familiarity enables pregnant women and their families to grasp the nutritional concept with ease, particularly in communities where literacy levels are low. By emphasizing visual simplicity, the Thali model reduces confusion often caused by text-heavy nutrition guides, thereby helping healthcare workers

Table 2 Micronutrients and their role in anemia prevention

Micronutrient	*Role in anemia prevention*
Folate and vitamin B12	Crucial for red blood cell synthesis; B12 deficiency leads to megaloblastic anemia, especially in vegetarian diets.[25]
Vitamin C	Enhances non-heme iron absorption and supports immune and antioxidant functions.[26]
Vitamin A and E	Deficiencies may directly contribute to anemia; both support erythropoiesis and immune defense.[27]
Zinc	Required for iron metabolism and red blood cell production; pregnancy increases zinc needs by ~40% (~11 mg/day).[28]
Copper and magnesium	Help in iron mobilization and red blood cell development; their deficiencies worsen anemia.[29]
Riboflavin (B2)	Supports iron utilization and hemoglobin production.

provide more effective counselling. Its flexible and regionally adaptable layout—featuring more rice in southern diets and more rotis in northern—makes the model inclusive across India. Furthermore, this approach integrates seamlessly with interventions such as IFA supplementation, fortified staples, and nutrition education, offering comprehensive support to pregnant women.[30] **Table 5** provides an overview of global and national protocols for iron, folic acid, and micronutrient supplementation in anemic pregnant women.

Managing Side Effects and Enhancing Compliance

- Oral iron often causes nausea, constipation, dyspepsia, or metallic taste, affecting up to 70% of pregnant women, leading about 20% to discontinue therapy.
- Strategies include using ferrous salts with better tolerability, taking iron on an empty stomach or 1 hour after meals, starting with lower doses, or taking with vitamin C-rich juice; evening or bedtime dosing may help.
- Smartphone apps tailored to local food databases can help track daily iron intake and remind users about supplementation.

Additional Public Health Interventions

- *Deworming:* WHO recommends a single dose of albendazole (400 mg) or mebendazole (500 mg) in the second trimester for areas where hookworm prevalence is >20% and anemia prevalence in pregnancy is >40%, including many regions of India.
- In India, despite dietary diversity, typical staple foods often have low iron bioavailability, making it difficult to meet iron requirements through diet

Table 3 Common micronutrient supplements in anemic pregnant women

Supplement name	***Key components***	***Indications***	***Benefits***	***Typical dose in pregnancy***
Iron-folic acid (IFA)	Elemental iron (60–100 mg), folic acid (500 µg)	Mild to moderate IDA, prevention of neural tube defects	Improves hemoglobin, supports fetal neural development	1 tablet/day
Multiple micronutrient supplements (MMS)	Iron, folic acid, vitamin A, B12, zinc, copper, iodine, etc.	Moderate anemia, poor dietary intake, high-risk pregnancy	Improves birth weight, maternal micronutrient status, and hemoglobin	1 tablet/day
Iron + Vitamin C	Elemental iron (60–100 mg), vitamin C (100–200 mg)	Enhancing iron absorption	Increases the bioavailability of non-heme iron	1-2 tablets/day
Iron + Zinc	Iron (60-100 mg), zinc (10–15 mg)	Combined iron-zinc deficiency	Addresses anemia and growth/immune function in the mother and fetus	1 tablet/day
Iron + Vitamin B12 + Folic acid	Iron (100 mg), B12 (1–5 µg), folic acid (400–500 µg)	Macrocytic or mixed anemia	Supports RBC synthesis and nerve function	1 tablet/day
Folic acid alone	400–600 µg folic acid	Preconception and early pregnancy	Prevents neural tube defects, supports erythropoiesis	1 tablet/day
Vitamin B12 (cyanocobalamin)	250–500 µg/day (oral) or 1,000 µg (IM monthly)	Pernicious anemia, vegetarian mothers	Resolves megaloblastic anemia, supports fetal brain development	Oral or IM as required
Vitamin A + Iron	Vitamin A (5,000 IU) + Iron	Functional iron deficiency	Enhances iron utilization, immune function	Weekly or daily (per protocol)
Iron-fortified foods	Fortified wheat flour, rice, salt	Population-level anemia prevention	Easy compliance, safe for large-scale use	As per consumption

Table 4 Components and recommended portions of a balanced thali for pregnant women, as guided by Indian government nutrition initiatives

Food group	*Examples*	*Approximate portion/frequency*
Cereals and grains	Rice, roti (whole wheat), millets	4–6 servings/day (e.g., 2 roti + ½ cup rice per meal)
Pulses and legumes	Dal, beans, lentils	1–2 servings/day (e.g., ½ cup cooked dal)
Vegetables	Leafy greens, seasonal veggies	2–3 servings/day (1 serving ≈ ¼ Plate or ½ cup cooked)
Dairy and eggs	Milk (200 mL), curd, eggs (1-2/day)	Provides calcium and protein
Fruits	Seasonal varieties (banana, orange)	1–2 servings/day (1 serving ≈ 100 g)
Fats and oils	Ghee, vegetable oils, nuts	Use minimal healthy fats for cooking
Fortified items	Fortified staples via ICDS/ MDM	Provided as Take-Home Rations or Mid-Day Meals (CivilsDaily, 2022; Socio. Health, 2022)
Supplements	IFA syrup, nutrition mix (Telangana)	Per government kit (e.g., KCR Nutrition Kit) (UNICEF, 2022)

Table 5 Recent guidelines and recommendations on iron, folic acid, and micronutrient supplementation in anemic pregnant women

Organization/ guideline	*Year*	*Recommendation*	*Remarks*
WHO[33]	2020	Daily oral iron (30–60 mg) + folic acid (400 µg)	Recommended for all pregnant women to prevent maternal anemia, puerperal sepsis, LBW, and preterm birth
Indian Ministry of Health—National Iron+ Initiative[34]	Updated 2021	IFA tablets (60 mg elemental iron + 500 µg folic acid) once daily	For 180 days during pregnancy and 180 days postpartum
ICMR-NIN[35]	2020	Dietary diversification + Iron and folic acid supplementation	Encourages the use of fortified foods and regular deworming
Cochrane review[36]	2017	Multiple micronutrient supplementation (MMS) is more beneficial than IFA alone	Reduces the risk of LBW and maternal anemia better than IFA alone
FIGO recommendations[37]	2021	Use MMS in resource-limited settings where multiple deficiencies are common	Prioritize in low- and middle-income countries
UNICEF/UNU/ WHO (multiple micronutrient preparation)[40]	2020	UNIMAP formulation: 15 essential vitamins and minerals, including IFA	Endorsed as safe and effective during pregnancy

UNICEF: United Nations International Children's Emergency Fund, UNU: United Nations University, WHO: World Health Organization, UNIMMAP: United Nations International Multiple Micronutrient Antenatal Preparation alone.[31] Therefore, combining dietary diversification with iron-fortified iodized salt, known as double fortified salt (DFS).[32] This strategy has been shown to increase haemoglobin levels by 0.5–0.7 g/dL annually. The ICMR-National Institute of Nutrition's updated 17-point dietary guidelines (mid-2025) emphasise nutrient diversity with particular focus on Iron, folate, vitamin B12, and calcium during pregnancy, alongside recommending an added ~350 kcal/day in the second and third trimesters.[39]

- *Community education:* Engaging health workers and caregivers to educate on dietary diversity, iron-rich foods, supplementation adherence, cultural practices, and to encourage routine screening and follow-up.

Conclusion

The *Power of the Plate* offers a compelling, food-based approach to combating nutritional anemia by focusing on the value of everyday dietary choices. Rather than relying solely on supplements, it promotes the inclusion of iron-rich foods—such as meats, legumes, leafy greens, and fortified grains—alongside nutrients that enhance absorption, like vitamin C. This strategy not only supports the prevention of anemia but also empowers individuals and communities to take control of their health through culturally relevant, affordable, and sustainable nutrition. As part of a broader public health effort that includes supplementation and fortification where needed, the *Power of the Plate* can significantly contribute to reducing the global burden of anemia, especially among women, children, and other high-risk populations.

References

1. Hurrell RF. Influence of vegetable protein sources on iron absorption and status. Nutr Rev. 2002;60(7):220-5.
2. Food and Agriculture Organization of the United Nations, World Health Organization. Legumes in human nutrition. Rome: FAO; 1994.
3. Indian Council of Medical Research. Nutrient requirements and recommended dietary allowances for Indians. Hyderabad: National Institute of Nutrition; 2010.
4. Nzotta AO, Onabanjo RS. Evaluation of flaxseed, sesame and pumpkin seeds as an alternative source of functional feed ingredients. Niger J Anim Sci. 2021;23(3):55-66.
5. Food and Agriculture Organization of the United Nations. Dried fruits: Nutritional benefits. Rome: FAO; 2012.
6. Singh P, Singh V. Jaggery as a potential source of iron. Indian J Tradit Knowl. 2015;14(3):464-7.
7. Lynch SR. The effect of meat on iron absorption. Nutr Rev. 1997;55(5):122-6.
8. Calder PC. Omega-3 fatty acids and immune function. Nutrients. 2010;2(3):355-74.
9. Hurrell R. Egg yolk iron and bioavailability. Am J Clin Nutr. 2001;73(6 Suppl):1043S-9S.

10. Hallberg L, Hulthén L. Prediction of dietary iron absorption: an algorithm. Am J Clin Nutr. 2000;71(5):1147-60.
11. Siegel A, Gellert G, Godfrey K, et al. Iron cookware and dietary iron intake: A review of studies on iron leaching from cooking vessels. J Nutr Sci. 2017;6:e37.
12. Zimmermann MB, Hurrell RF. Nutritional iron deficiency. Lancet. 2007;370(9586):511-20.
13. Hallberg L, Brune M, Rossander L. The role of vitamin C in iron absorption. Int J Vitam Nutr Res Suppl. 1989;30:103-8.
14. Hallberg L, Brune M, Rossander L, et al. Calcium inhibition of iron absorption. Am J Clin Nutr. 1991;53(1):112-9.
15. World Health Organization. Healthy diet. Geneva: WHO; 2018.
16. Wu G, Bazer FW, Cudd TA, et al. Maternal nutrition and fetal development. J Nutr. 2004;134(9):2169S -72S.
17. Innis SM. Dietary omega 3 fatty acids and the developing brain. Brain Res. 2008;1237:35-43.
18. Innis SM. Essential fatty acids and pregnancy outcomes. Am J Clin Nutr. 2007;85(2 Suppl):S597-S604.
19. Thomas J, Weiner CP, Mitchell MD. Hydration in pregnancy: effects on amniotic fluid. Obstet Gynecol. 2004;103(4):742-7.
20. World Health Organization. WHO guidelines on daily iron and folic acid supplementation in pregnant women. Geneva: WHO; 2012. Reaffirmed 2020.
21. World Health Organization. Guideline: Intermittent iron and folic acid supplementation in non-anaemic pregnant women. Geneva: WHO; 2012.
22. Bhutto ZA, Das JK, Rizvi A, et al. Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? Lancet. 2013;382(9890):452-77.
23. World Health Organization. WHO recommendations on antenatal care for a positive pregnancy experience. Geneva: WHO; 2016.
24. Noora Health. Introducing the Thali Model [Internet]. 2023 [cited 2025 Aug 8]. Available from: https://noorahealth.org/thecompanion/introducing-the-thali-model-to-transform-maternal-nutrition/
25. Allen LH. Causes of vitamin B12 and folate deficiency. Food Nutr Bull. 2008;29(2 Suppl):S20-34.
26. Cook JD, Watson SS, Simpson KM, et al. The effect of high ascorbic acid supplementation on body iron stores. Blood. 1984;64(3):721-6.
27. West KP Jr. Extent of vitamin A deficiency among preschool children and women of reproductive age. J Nutr. 2002;132(9 Suppl):2857S-66S.
28. Hambidge KM, Krebs NF. Zinc deficiency: a special challenge. J Nutr. 2007;137(4):1101-5.
29. Osredkar J, Sustar N. Copper and zinc, biological role and significance of copper/zinc imbalance. Biochem Med (Zagreb). 2011;21(3):231-42.
30. Pathak P, et al. A comprehensive package of nutrition interventions in India. Nutrients. 2021;13(10):3534. Available from: https://www.mdpi.com/2072-6643/13/10/3534
31. The Times of India. Summary of new dietary guidelines. The Times of India [Internet]. 2024 [cited 2025 Aug 8]. Available from: https://timesofindia.indiatimes.com/

32. Ministry of Health and Family Welfare, Government of India. Anemia prevention initiatives [Internet]. New Delhi: MoHFW; 2024 [cited 2025 Aug 8]. Available from: https://www.mohfw.gov.in/
33. Ministry of Health and Family Welfare, Government of India. Double fortified salt program documents. New Delhi: MoHFW; 2024.
34. Sachdev HPS, Gera T, Nestel P. Effect of iron supplementation on physical growth in children: systematic review of randomized controlled trials. J Nutr. 2005;135(4):906-15.
35. World Health Organization. WHO recommendations on antenatal care for a positive pregnancy experience. Geneva: WHO; 2020.
36. Ministry of Health and Family Welfare. National Iron Plus Initiative: Guidelines for control of iron deficiency anaemia. New Delhi: MoHFW; 2021.
37. Indian Council of Medical Research—National Institute of Nutrition. Nutrient requirements for Indians. Hyderabad: ICMR-NIN; 2020.
38. Keats EC, Haider BA, Tam E, Bhutta ZA. Multiple-micronutrient supplementation for women during pregnancy. Cochrane Database Syst Rev. 2017;3(3):CD004905.
39. Rao BSN. Fortification of salt with iron and iodine to control anemia: Indian experience. Indian J Med Res. 2001;113:385-90.
40. UNICEF, UNU, World Health Organization. Composition of a multi-micronutrient supplement to be used in pilot programmes among pregnant women in developing countries. New York: UNICEF; 2020.

Chapter 5

Iron Deficiency Anemia in Pregnancy and Lactation: Delphi Consensus Statements

Hrishikesh Pai, Pikee Saxena, Ritu Sharma

The first round for Delphi consensus on Iron Deficiency Anemia (IDA) in Pregnancy and Lactation was conducted at the FOGSI South South conference on 10th of April 2025 in Gurgaon- New Delhi under the leadership of Dr. Hrishikesh Pai (Trustee for Asia Oceania), Dr. Blami Dao (Trustee for Africa and Eastern Mediterranean - FIGO), Dr. Sunita Tandulwadkar, Dr. Nandita Palshetkar,Dr. Rishmai Pai and Dr. Hema Divakar.

The convenor for the same was Prof. Dr. Pikee Saxena along with Dr. Ritu Sharma as the Co-Convener.

Expert panel for Round 1: Dr. Bhaskar Pal, Dr. Ajay Mane, Dr. Ashish Kale, Dr. Deepak Bhagde, Dr. Dilip Gadhvi, Dr. Hemang Shah, Dr. Madanjit Pasricha, Dr. Mahesh Gupta, Dr. Monika Gupta,

Dr. Priyankur Roy, Dr. Rajat Mohanty, Dr. Rajnikant Contractor, Dr. Rashmi Kahar, Dr. Shilpi Nain, Dr. Suman Yadav.

A second round was a global Delphi consensus which was held during FEMMTEK V at St. Regis on 3rd August 2025. Following were the participants for the discussion:

The convenor for the same was Prof. Dr. Pikee Saxena

Expert panel for Round 2: Dr. Hrishikesh Pai, Dr Rishma Pai, Dr. Nandita Palshetkar ,Dr Anju Soni, Dr Surpiya Jaiswal, Dr Priti Kumar, Dr. Hara Pattanaik, Dr Abha Singh, Dr. Sambit Mukhopadhyay (UK), Dr. Hani Fawzi (UK), Dr. Agnaldo Lopes da Silva (Brazil), Dr. Unnoop Jaisamrarn (Thailand), Dr. Isaimail Mete Itil (Turkey), Dr. Giuseppe Trojano (Italy), Dr. Maria Degollada (Spain), Dr. Pere Bresco (Spain), Dr. Stephen Rulisa (Rwanda), Dr. Nestor Garello (Argentina),
Dr. Kenneth B Ruzindana (Rwanda), Dr. Muna A Tahlak (UAE)

INTRODUCTION

Iron deficiency (ID) is the most common micronutrient deficiency worldwide and remains the leading cause of anemia.[1] The WHO recognizes iron deficiency anemia (IDA) as the most serious nutritional disorder of the twenty-first century, disproportionately affecting women.[2] During pregnancy, IDA prevalence ranges from about 14% in industrialized countries to an average of 56% (35–75%) in developing nations.[3]

In India, the NFHS-4 (2015–2016) reported anemia among 45.7% of pregnant women in urban areas and 52.1% in rural areas. In many developing countries, more than two-thirds of pregnant women are anaemic, with ID responsible for nearly 95% of cases. Additionally, up to 84% of women develop ID within the first postpartum week.[2]

Globally, IDA is a major contributor to maternal and fetal health risks, accounting directly for 20% of maternal deaths and indirectly for about 50% of maternal and feto-maternal morbidity. Oral iron therapy can increase haemoglobin by 0.3–1.0 g per week; however, its effectiveness is often limited by poor compliance (22–64%) due to gastrointestinal side effects. The development of IDA in pregnancy largely depends on maternal iron stores at conception and the amount of iron absorbed during gestation. In low-resource settings, pre-existing deficiencies and heightened physiological demands of pregnancy frequently exceed the maternal iron reserves, making supplementation an essential preventive strategy.[2]

The Delphi methodology is widely recognized as a qualitative approach for achieving consensus in areas where existing evidence is insufficient to resolve uncertainties. In light of the wide variation in clinical practice and the absence of uniform guidelines both in India and globally, a Delphi consensus exercise was undertaken with participation from gynaecologists and obstetricians. The objective was to formulate harmonized, evidence-informed recommendations for the screening, diagnosis, management, and prevention of anemia during pregnancy and lactation.

MATERIALS AND METHODS

Study Design and Expert Panel Selection

Given the limited high-quality evidence around diagnosis of ID/IDA, prevention, and management during pregnancy and lactation, a two-round Delphi technique was employed. The authors were provided adequate time to review the relevant literature and results of each Delphi round.

Members of the expert panel were selected based on the following criteria: practicing obstetrician–gynecologists with more than 15 years of experience; nationally and globally recognized experts in obstetrics and gynaecology; considerable experience in the diagnosis, evaluation, and management of ID/IDA; previous experience as an advisory board member; and an editorial board member for a reputable regional journal.

In Round 1, the expert panel consisted of 15 experts of national and regional repute with vast experience in obstetrics and gynaecology, whereas in Round 2, the panel comprised 10 internationally recognized experts. Experts were asked to provide their perspectives on a series of questions in a Delphi survey related to various challenges associated with managing anemia during pregnancy and lactation in different settings and rate their level of agreement. Topics included screening and diagnosis, prevention strategies, management during pregnancy, special populations and considerations, monitoring and follow-up, and patient education and compliance.

The Delphi survey questionnaires were administered to the panel between April and August 2025 using Google Forms.

To finalize the consensus during Round 1, a physical meeting was held on April 10, 2025, where a consensus was reached on the statements. The areas of consensus were identified, and any remaining differences in opinion were noted.

Similarly, to finalize the consensus during Round 2, a physical meeting was conducted on 4th August 2025, where consensus was reached for the statements.

Questionnaire Development for Round 1 of the Delphi Survey

The statements included in Delphi Round 1 were formulated based on a comprehensive review of the literature from the Medline via PubMed, Cochrane Database of systematic reviews, randomized controlled trials, non-randomized controlled trials, and cohort studies, and international guidelines were consulted. Full-text English-language articles published between 2018 and 2025 were retrieved from the databases using a combination of keywords such as: prevalence of iron deficiency anemia, IDA in pregnancy or pregnant women, anemia during pregnancy and lactation, prevention or prophylaxis, treatment or therapy, assessment or evaluation of iron status, iron supplementation or therapy, iron dose or dosage, guidelines, and consensus. Throughout the Delphi process and the drafting of this manuscript, the expert panel was provided with access to all related literature and materials.

All statements presented in Delphi Round 1 covered key domains such as screening and diagnosis, prevention strategies, management during pregnancy, special populations and considerations, monitoring and follow-up, and patient education and compliance. Each statement was accompanied by a free-text field, enabling panellists to elaborate on their responses and suggest additional statements for consideration in Round 2.

Questionnaire Development for Round 2 of the Delphi Survey

The outcomes of Round 1 were compiled and used to guide the development of the Round 2 survey. These results were also shared with panel members in Round 2, allowing them to revise their responses to statements that had not reached

Table 1 Grading system

Grade	Level of Agreement	Description
Grade U	100%	Unanimous consensus
Grade A	90–99%	Near-unanimous consensus
Grade B	78–89%	Strong agreement with minimal variance
Grade C	67–77%	Moderate agreement
Grade D	<67%	Below consensus threshold

consensus in the previous round. Free-text fields were also provided in Round 2 to allow panellists to justify and expand upon their responses.

GRADING OF STATEMENTS

After two Delphi rounds, the level of agreement for each statement was evaluated and categorized using a predefined grading scale **(Table 1)**.

A supermajority rule was applied to determine consensus, defined as agreement by more than 67% of the expert panel on a given statement.

Round 1 consisted of 40 questionnaire items, answered by 13 expert panel members. Over the course of the Delphi rounds and the subsequent in-person consensus meeting, the expert panel removed 15 statements due to redundancy or conceptual overlap.

Our iterative changes throughout the process yielded 21 final statements, all with >67% consensus, summarized in **Table 1**.

Results

A total of 40 statements were initially generated across domains of screening and diagnosis, prevention strategies, management, monitoring, patient education, and health system considerations. These statements were rated over two Delphi rounds.

In Round 1, all 40 statements were assessed, of which a few were carried forward for re-evaluation, and a few were newly added in Round 2. After structured discussion and re-rating, the statements that achieved unanimous consensus (Grade U, 100% agreement) were retained in the final set of recommendations.

Statements that did not reach the threshold of agreement were either omitted or dropped post-discussion, particularly those with moderate or conflicting evidence, operational challenges, or significant practice variability.

The progression of statements through each round of the Delphi process is presented in **Table 2**.

Table 2 Delphi results for statements on screening, prevention strategies, and management of IDA during pregnancy and lactation

Statements on screening and diagnosis	***Clarified statement***	***Round 1 rating***	***Round 2 rating***	***Grading***
Universal screening should be recommended in all women for anemia preconceptionally and during pregnancy	Retained	100%	100%	U
Screening for IDA should be performed during all trimesters of pregnancy	Omitted in round 2	60%	—	D
Hemoglobin thresholds of Hb <11 g/dL in the first and third trimesters, and Hb <10.5 g/dL in the second trimester should be used to diagnose IDA during pregnancy.	Omitted in round 2	40%		D
For detecting IDA in low-resource settings, clinical signs and symptoms, hemoglobin with peripheral smear, CBC, and a therapeutic trial of iron should be carried out.	Retained	70%	100%	U
Hemocue, Sahli's method, rapid diagnostic ferritin kits, and Smartphone-based hemoglobinometers are the available point-of-care tests for IDA.	Omitted in round 2	70%	—	C
Hemocue should be considered as the point-of-care testing method for hemoglobin estimation, as it has the highest accuracy and correlates best with laboratory standards.	Retained	70%	100%	U
Iron therapy can be started without ferritin levels based on clinical judgment and hemoglobin levels.	Omitted in round 2	80%	—	B
Statements on prevention strategies				
Treatment for IDA should be initiated at a serum ferritin level threshold of <30 μg/L in pregnancy.	Added in round 2	—	100%	U
All pregnant women should receive routine iron supplementation during pregnancy.	Omitted in round 2	90%	—	A

Contd...

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Statements on screening and diagnosis	***Clarified statement***	***Round 1 rating***	***Round 2 rating***	***Grading***
Effective preventive strategies to be considered for early detection and management of IDA are: • Community-based mass screening and awareness drives (e.g., schools, colleges) • Nutrition education on iron-rich food, enhancers during ANC • Public-private partnerships for supplementation and fortification • Mass deworming programs, malaria prevention and treatment • Micronutrient combinations (e.g., folic acid, B12 with iron) • Media-based awareness via celebrities and influencers, roadshows Train frontline workers in anaemia classification, counselling, and referral	Added in round 2	—	100%	U
To ensure uninterrupted iron supplement supplies, states should consider: • Implement logistics management information systems (LMIS) to track distribution from central warehouses to last-mile delivery points. • Establish buffer stocks • Decentralized distribution channels • Capacity building by training health workers on inventory management, timely requisitioning, reporting formats and quality assurance protocols. • Public–private partnerships (PPP) for bulk procurement and efficient transportation • Ensure budget and include iron supplements as essential medicines under public procurement frameworks. • Digital anemia dashboards and planning portals Mobile-based IFA consumption apps to monitor supplement distribution, identify defaulters, and enable data-driven supervision	Added in round 2	—	100%	U
The recommended dose of iron for prophylaxis in pregnancy for non-anaemic mothers in the Anemia Mukt Bharat initiative is 60 mg elemental iron + 500 µg folic acid	Omitted in round 2	60%	—	D
Routine supplementation of iron should be delayed until the second trimester.	Omitted in round 2	60%		D
Iron supplementation during the first trimester is associated with increased risk of nausea/ vomiting.	Omitted in round 2	50%		D

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Statements on screening and diagnosis	***Clarified statement***	***Round 1 rating***	***Round 2 rating***	***Grading***
Ganzoni's formula should be used to calculate the dose of iron requirement.		80%		B
The practical use of the Mentzer index is to differentiate IDA from thalassemia.		80%		B
Management during pregnancy				
The preferred route of iron replacement in moderate to severe anemia is IV iron.		50%	—	D
The recommended duration of iron therapy in the Anemia Mukt Bharat initiative is 180 days during pregnancy and 180 days postpartum.	Retained	80%	100%	U
IV iron should be considered when Hb <8 g/dL, the patient has a poor response to oral iron, is intolerant to oral iron, and is in late gestation with moderate anemia.	Omitted in round 2	90%	—	A
Contraindications to using IV iron in pregnancy are allergy to iron formulations, during the first trimester, and the presence of active infections.	Omitted in round 2	60%	—	D
Ferric carboxymaltose is the preferred IV iron preparation with respect to safety and compliance.	Omitted in round 2	90%	—	A
After IV iron therapy, oral iron can be initiated after 1 week.	Omitted in round 2	60%	—	D
The next Hb assessment should be repeated every 3-4 weeks until Hb > 11 g/dL, when the haemoglobin has increased from 7.8 to 9.8 in 3 weeks after giving IV.	Omitted in round 2	80%	—	B
Slower-than-expected rise in haemoglobin after oral iron therapy is usually due to vitamin B12/folate deficiency, haemoglobinopathy, or intake with calcium/phytates.	Omitted in round 2	80%	—	B
Blood transfusion in iron deficiency anemia is indicated when haemoglobin is <6 g/dL, <7 g/dl with symptoms, or <8 g/dL in late pregnancy.	Omitted in round 2	70%	—	C
The expected rise in haemoglobin after one PCV transfusion is approximately 1 g/dL.	Omitted in round 2	80%	—	B
Oral iron therapy should be stopped at least 24 hours before initiating intravenous iron therapy.	Omitted in round 2	70%	—	C

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Statements on screening and diagnosis	***Clarified statement***	***Round 1 rating***	***Round 2 rating***	***Grading***
Intravenous iron in pregnancy is indicated for women with moderate to severe anemia who are non-compliant with oral therapy, those with poor response or intolerance to oral iron, or those with malabsorptive conditions impairing gastrointestinal absorption.	Omitted in round 1	—	100%	U
Parenteral iron should not be administered in early pregnancy, in patients with prior allergic reactions, active infections, abnormal liver function, or anemia not caused by iron deficiency.	Omitted in round 1	—	100%	U
Pregnant women with severe anemia (Hb <7 g/dL) should be considered high-risk and promptly referred to higher-level care facilities.	Omitted in round 1	—	100%	U
Treatment for iron deficiency anemia in pregnancy should be initiated when serum ferritin is below 30 μg/L.	Retained	90%	100%	U
Combining multiple micronutrients, such as folic acid and vitamin B12, with oral iron is a rational treatment strategy for pregnant women with iron deficiency or iron deficiency anemia.	Retained	70%	100%	U
Special populations and considerations				
In women with pre-existing conditions, iron is avoided in thalassemia traits unless iron deficiency anemia exists, and referral to a specialist is required.	Omitted in round 2	40%	—	D
Oral iron therapy should be continued for 180 days during pregnancy and 180 days postpartum.	Omitted in round 1	—	100%	U
Postpartum CBC testing is indicated for women with moderate to severe anemia or those who had postpartum haemorrhage prior to discharge.	Omitted in round 2	80%	—	B
Women with moderate to severe postpartum anemia should be administered parenteral ferric carboxymaltose (FCM) before discharge, and haemoglobin should be reassessed after 6 weeks to confirm correction of anemia	Omitted in round 2	70%	—	C

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Statements on screening and diagnosis	***Clarified statement***	***Round 1 rating***	***Round 2 rating***	***Grading***
Monitoring and follow-up				
Successful treatment and therapeutic trial of oral iron is defined by haemoglobin rise >1 g/dl in 2–4 weeks, rise in reticulocyte count within 5–7 days, improvement in symptoms, and haemoglobin normalisation in 8 weeks	Omitted in round 2	80%	—	B
Reticulocyte response occurs post-therapy at 5–7 days with oral iron, 3–5 days with intravenous iron, and 2–3 days after blood transfusion.	Omitted in round 2	90%	—	A
Post therapy, haemoglobin should be monitored at 2–4 weeks and ferritin at 6–8 weeks.	Omitted in round 2	60%	100%	U
Patient education and compliance				
Strategies to improve adherence to oral iron therapy include counselling on benefits and side effects, splitting the dose, addressing gastrointestinal side effects, providing reminders or aligning with routine activities, and using adherence checklists.	Retained	100%	100%	U
Side effects of oral iron can be minimized by using lower doses (30–60 mg), taking tablets 1 hour after meals, avoiding interfering foods and medications (e.g., antacids, calcium, tea), alternate-day dosing, and changing formulation.	Retained	80%	100%	U
Deworming in pregnancy is done with a single dose of albendazole, preferably during the second and third trimester.	Omitted in round 2	80%	—	B
The first trimester poses the highest risk for irreversible neurodevelopmental effects in the fetus due to maternal iron deficiency anemia.	Omitted in round 2	80%	—	B
Among forms of iron, sodium iron EDTA (NaFeEDTA) is considered the most suitable for fortifying staple foods to prevent iron deficiency and iron deficiency anemia. Ferrous sulphate, ferrous fumarate, or elemental iron can also be used for fortification, and the choice may also depend on the food vehicle and population.	Omitted in round 2	60%	—	D
After correction of anemia, continuation of iron–folic acid (IFA) supplementation for 3 months is appropriate.	Omitted in round 2	60%	—	D

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Statements on screening and diagnosis	***Clarified statement***	***Round 1 rating***	***Round 2 rating***	***Grading***
Anemia prevention and management should be integrated into routine antenatal care, with hemoglobin assessed in each trimester.	Omitted in round 1	—	100%	U
After parenteral iron therapy, haemoglobin should be reassessed at 4 weeks and ferritin at 4–8 weeks.	Omitted in round 1	—	100%	U
Low-dose daily iron supplementation (30–60 mg elemental iron) is effective and better tolerated than high-dose regimens (100–200 mg) for preventing iron deficiency anemia in pregnant women.	Omitted in round 1	—	100%	U
Strengthening healthcare workforce capacity through training in screening, diagnosis, and management of iron deficiency anemia should be a national priority.	Omitted in round 1	—	100%	U
National anemia control programs should include measurable key performance indicators (KPIs), conduct quarterly reviews, and adopt adaptive strategies to enhance program outcomes.	Omitted in round 1	—	100%	U

SCREENING AND DIAGNOSIS

Consensus was reached on several key statements regarding screening and diagnostic approaches for anemia and iron deficiency anemia (IDA) in pregnancy:

- Universal screening for anemia was unanimously endorsed both preconceptionally and during pregnancy (100% agreement; Grade U).
- Although there was initial support for screening in all trimesters, this statement was omitted in Round 2 due to insufficient consensus (<67%; Grade D).
- For low-resource settings, experts achieved a unanimous consensus that clinical evaluation, hemoglobin measurement with peripheral smear, complete blood count (CBC), and therapeutic trial of iron should be used to detect IDA (100%; Grade U).
- Among point-of-care tests, HemoCue was retained as the preferred method due to its high accuracy and correlation with laboratory standards (100%; Grade U).
- Other proposed approaches, such as Sahli's method, rapid diagnostic ferritin kits, and smartphone-based hemoglobinometers, did not reach consensus and were omitted.

PREVENTION STRATEGIES

- Initiation of treatment for IDA at a serum ferritin threshold <30 μg/L during pregnancy achieved unanimous consensus when introduced in Round 2 (100%; Grade U).
- A comprehensive set of preventive strategies, such as community-based screening, nutrition education, deworming, micronutrient fortification, public–private partnerships, and media awareness campaigns, was strongly supported (100%; Grade U).
- Similarly, systems-based interventions such as logistics management information systems (LMIS), buffer stock maintenance, decentralized distribution, capacity building, digital dashboards, and mobile-based IFA monitoring apps were unanimously endorsed (100%; Grade U).
- Routine universal iron supplementation in pregnancy and trimester-specific recommendations (prophylaxis dose, timing of initiation) failed to reach consensus and were omitted.

MANAGEMENT IN PREGNANCY

- The recommended duration of iron therapy under Anemia Mukt Bharat, 180 days during pregnancy and 180 days postpartum, achieved unanimous consensus (100%; Grade U).

- Several statements related to intravenous iron use (indication at Hb <8 g/dL, preferred formulations, contraindications, and post-IV iron monitoring) did not retain consensus and were omitted in Round 2.
- The panel achieved a unanimous consensus on broader statements:
  - IV iron is indicated in women with moderate to severe anemia who are intolerant or non-compliant with oral therapy, or have malabsorptive conditions (100%; Grade U).
  - Parenteral iron should not be used in early pregnancy, in women with prior allergic reactions, active infections, abnormal liver function, or anemia not caused by IDA (100%; Grade U).
  - Pregnant women with severe anemia (Hb <7 g/dL) should be considered high-risk and referred to higher-level care (100%; Grade U).

MONITORING AND FOLLOW-UP

- The statements on reticulocyte response timelines, post-therapy monitoring schedules, and criteria for successful oral iron trial did not retain consensus beyond Round 1.
- A retained consensus statement emphasized that after parenteral iron therapy, Hb should be reassessed at 4 weeks and ferritin at 4–8 weeks (100%; Grade U).

PATIENT EDUCATION AND COMPLIANCE

- Strategies to improve adherence to oral iron therapy—including counselling, side effect management, reminders, and adherence tools—achieved unanimous agreement (100%; Grade U).
- Likewise, measures to minimize side effects of oral iron—such as lower doses, alternate-day dosing, and avoidance of interfering foods/medications—were retained with unanimous consensus (100%; Grade U).

SPECIAL POPULATIONS AND POSTPARTUM

- Several statements relating to thalassemia traits, postpartum testing, and parenteral iron use in the postpartum period did not reach consensus and were omitted in later rounds.
- Unanimous consensus was achieved on:
  - Continuation of oral iron therapy for 180 days postpartum (100%; Grade U).
  - Postpartum women with moderate to severe anemia should be prioritized for parenteral iron where oral therapy is not feasible (100%; Grade U).

HEALTH SYSTEMS AND POLICY

The panel reached a unanimous consensus on the need to strengthen healthcare workforce capacity, integrate anemia prevention into routine antenatal care, and include key performance indicators (KPIs) with quarterly program reviews to improve national anemia control programs (100%; Grade U).

DISCUSSION

This Delphi consensus exercise provides expert guidance on the screening, prevention, and management of IDA in pregnancy. From an initial pool of 40 statements, and after the addition of new statements, 21 reached unanimous consensus (Grade U, 100% agreement) after two iterative rounds. These retained statements highlight areas of strong agreement, while omitted statements reveal domains where evidence is insufficient, practices are diverse, or operational feasibility remains uncertain.

SCREENING AND DIAGNOSIS OF IDA

The consensus on universal screening for anemia preconceptionally and during pregnancy underscores the recognition that anemia remains highly prevalent among women of reproductive age in low- and middle-income countries (LMICs).[4,5]

This aligns with global strategies, including the WHO and Anemia Mukt Bharat guidelines, which advocate early detection as a cornerstone of prevention.[6]

While frequent screening may improve detection, resource limitations, competing priorities, and feasibility concerns may constrain its universal implementation. The retained recommendation supporting HemoCue as the preferred point-of-care diagnostic method is notable. HemoCue has consistently demonstrated high accuracy and reproducibility compared to laboratory standards, making it particularly valuable in decentralized or community-based settings. Older methods, such as Sahli's test, and newer but less validated approaches, such as smartphone-based hemoglobinometers or rapid ferritin kits, were omitted due to variable performance and lack of large-scale validation. This highlights a pragmatic preference for tools that combine accuracy with scalability.[7,8]

Another important retained recommendation was the emphasis on practical diagnostic algorithms in low-resource settings—including clinical evaluation, CBC, peripheral smear, and therapeutic trial of iron.[5]

This reflects recognition that while ferritin testing is the gold standard for diagnosing iron deficiency, it is not widely accessible in many primary care or rural facilities. The consensus, therefore, prioritizes feasible and context-sensitive approaches.

PREVENTION OF IDA

Initiating treatment when serum ferritin <30 μg/L in pregnancy ensures early correction of iron deficiency before progression to anemia.[9]

The panel focused on multi-level preventive strategies: community-based awareness, nutrition education, food fortification, micronutrient supplementation, deworming, and malaria prevention. The consensus also extended beyond clinical measures to systems-based interventions, such as logistics management information systems (LMIS), buffer stock maintenance, public–private partnerships, and digital dashboards. These interventions directly address supply-chain bottlenecks and ensure continuity of supplementation programs, which have been undermined by stock-outs and weak monitoring.[10]

Interestingly, trimester-specific supplementation strategies (delaying supplementation until the second trimester or highlighting first-trimester intolerance) failed to reach consensus. This divergence highlights the gap between global recommendations and the realities of implementation, underscoring the need for more tailored, context-specific approaches.

MANAGEMENT OF IDA IN PREGNANCY

The panel reached a clear consensus on the duration of therapy (180 days during pregnancy and 180 days postpartum), reinforcing national programmatic guidelines. This is significant, as adherence to prolonged supplementation has often been poor, and consensus highlights the need for reinforcing compliance through counselling and system-level supports.[10]

The role of intravenous iron (IV iron) was one of the more debated areas. IV iron should be considered for moderate to severe anemia where oral therapy is not feasible due to intolerance, non-compliance, or malabsorptive conditions, and it should be avoided in early pregnancy, allergy, infection, or non-IDA anemias. This balance reflects both safety considerations and operational realities, given the limited availability of IV formulations, inconsistent monitoring infrastructure, and cost differentials across health systems.[5]

Referral of women with severe anemia (Hb <7 g/dL) to higher-level facilities was another area of unanimous consensus, reinforcing the need for timely escalation of care to prevent maternal and fetal complications.[11]

MONITORING AND FOLLOW-UP, PATIENT EDUCATION, ADHERENCE, AND POLICIES

The statement—reassessment of Hb at 4 weeks and ferritin at 4–8 weeks post-parenteral iron therapy—achieved consensus. Proposals for reticulocyte monitoring or frequent Hb checks were not retained, likely reflecting variability in laboratory access and resource constraints. This highlights a critical evidence gap and implementation challenge: while monitoring is essential for treatment efficacy, standardizing protocols across diverse health systems remains difficult.

One of the strongest areas of consensus was around patient education and adherence strategies. Experts unanimously endorsed counselling on benefits and side effects, addressing gastrointestinal intolerance, using adherence checklists, and setting reminders. These strategies help with addressing adherence, which is considered a major barrier in anemia control.[9]

Consensus also emphasized practical strategies to minimize side effects of oral iron, including use of lower doses (30–60 mg), alternate-day dosing, and timing of intake to avoid food-drug interactions. This reflects an important shift from "high-dose supplementation" models toward tolerability-focused regimens, consistent with emerging evidence that lower, intermittent dosing may improve both adherence and absorption.[12]

Experts strongly emphasized integration of anemia care into routine antenatal services, training of health workers, and embedding accountability mechanisms such as KPIs, quarterly reviews, and adaptive program strategies. These recommendations align with a broader shift toward health systems strengthening in maternal health programs.[10]

The major strength of this Delphi process was the structured methodology that ensured only statements with unanimous consensus were retained, lending to a robust final set of recommendations. The involvement of multidisciplinary experts across clinical, public health, and programmatic domains ensured that the retained statements are evidence-based, supported by national and international guidelines, and implementable.

Conclusion

The findings from this Delphi consensus balance global evidence with local feasibility, emphasize patient-centerd care, and underscore the importance of systems strengthening. These consensus-based recommendations provide a practical framework for enhancing maternal anemia control programs.

References

1. International Federation of Gynecology and Obstetrics (FIGO). Iron deficiency and anaemia in women and girls. Published September 12, 2023. Accessed August 26, 2025. Available from: https://www.figo.org/news/iron-deficiency-and-anaemia-women-and-girls
2. Raut AK, Hiwale KM. Iron deficiency anemia in pregnancy. Cureus. 2022;14(9):e28918.
3. Khalafallah A, Dennis A. Iron deficiency anaemia in pregnancy and postpartum: Pathophysiology and effect of oral versus intravenous iron therapy. J Pregnancy. 2012;2012:630519.
4. Williams AM, Brown KH, Allen LH, et al. Improving anemia assessment in clinical and public health settings. J Nutr. 2023;153(Suppl 1):S29-41.
5. Kriplani A, Sharma AK, Radha GA, et al. FOGSI General Clinical Practice Recommendations: Management of Iron Deficiency Anemia in Pregnancy. 2016.

6. Ministry of Health and Family Welfare, Government of India. Anemia Mukt Bharat - Strategy and Guidelines. Available from: https://nhm.gov.in/index1.php?lang=1&level=3&sublinkid=1448&lid=797
7. An R, Huang Y, Man Y, et al. Emerging point-of-care technologies for anemia detection. Lab Chip. 2021;21(10):1843-65.
8. Nkrumah KN, Abdulai T, Asiedu-Bekoe F, Tagoe EA. Performance of point-of-care hemoglobinometers for screening and diagnosis of anaemia in field settings in Ghana. BMC Public Health. 2023;23:1234.
9. Pavord S, Daru J, Prasannan N, et al. UK guidelines on the management of iron deficiency in pregnancy. Br J Haematol. 2020;188(6):819-30.
10. Ministry of Health and Family Welfare, Government of India. Operational guidelines for programme managers: Intensified National Iron Plus Initiative (I-NIPI). 2018. Available from: https://www.fitterfly.com/site/pdf/anemia-mukt-bharat.pdf
11. FIGO Working Group on Good Clinical Practice in Maternal–Fetal Medicine. Good clinical practice advice: Iron deficiency anemia in pregnancy. Int J Gynaecol Obstet. 2019;144:322-4.
12. Jain G, Gupta A, Mishra A, et al. Low-dose iron is safer, tolerable, and equally effective to high-dose iron in improving iron status in mildly anemic female participants. Int J Pharmacol. 2024;20(3):352-60.

Chapter 6

Screening, Diagnosis and Comprehensive Management of Anemia in Pregnancy with Special Focus on Iron, Folic Acid and Vitamin B_{12} Deficiencies

Pikee Saxena, Alka Pandey, Triksha Gautam

INTRODUCTION

Anemia in pregnancy remains a major global public health challenge and significantly contributes to maternal and perinatal morbidity and mortality. According to the World Health Organization (WHO-2021),[1] the Global prevalence of anemia among pregnant women is approximately 36.5%, with the highest burden seen in low- and middle-income countries. In India, the prevalence of anemia among pregnant women is alarmingly high, up to over 50% (according to WHO-2021, around 52.2% and according to NFHS-5,[2] it is around 57%), despite the existence of targeted public health programs like Anemia Mukt Bharat (AMB, 2018) and the National Iron Plus Initiative (NIPI, 2013).[3,4]

Anemia in pregnancy is multifactorial, but nutritional deficiencies—particularly of iron, folic acid, and vitamin B_{12} are the leading causes. Iron deficiency accounts for approximately 50–60% of all anemia cases in pregnancy and often coexists with deficiencies in folate and B_{12}, especially in populations with poor dietary diversity and increased physiological demands.

Untreated anemia during pregnancy can lead to many fetal complications, ranging from intrauterine growth restriction and low birth weight to preterm birth and neonatal anemia. Early identification through screening, diagnosis, and comprehensive management is critical to ensure optimal maternal and fetal outcomes.

SCREENING

When to Screen

WHO recommends screening during the first prenatal visit and again at around 28 weeks of gestation. However, based on the prevalence of anemia in pregnancy,

Table 1 Timing of screening for anemia during pregnancy

Organization	***Timing***
WHO	At first ANC visit; repeat if high-risk
National Iron Plus Initiative (NIPI) – India/ Anemia Mukt Bharat (AMB)/FOGSI	At registration, then in 2nd and 3rd trimesters
ACOG[5]	At the first visit and the third trimester for high-risk women

different countries have recommended the timing of screening as shown in **Table 1**.

Screening Tests

- *Hb estimation (main test):*[6] Methods: Sahli's, HemoCue, Automated analyzers, Digital hemoglobinometers
- *Sample: Capillary or venous blood:* Hemoglobin (Hb) estimation via automated analyzer or Non-invasive hemoglobin monitoring is shown in **Table 2**.

CLASSIFICATION OF ANEMIA IN PREGNANCY[1,7] (TABLES 3 AND 4)

In pregnancy, plasma volume expansion lowers Hb physiologically, especially in the 2nd trimester. Therefore, trimester-specific cut-offs are important. Diagnosis should combine Hb value and clinical examination along with detailed history regarding diet, symptoms, comorbidities, and obstetric history.

WHO recommends prophylactic iron supplementation during pregnancy with a daily regimen of 30–60 mg elemental iron + 400 µg folic acid, starting early in pregnancy and continuing throughout. They recommend an intermittent regimen (if daily not tolerated and anaemia prevalence <20%) with 120 mg elemental iron + 2,800 µg folic acid once weekly. If anemia is diagnosed (Hb <110 g/L), 120 mg elemental iron + 400 µg folic acid daily is advised until Hb normalizes.[8,9]

In India, Anemia Mukt Bharat/NIPI—Prophylaxis Strategy recommends a daily iron + folic acid (IFA) tablet from the second trimester until delivery, totaling at least 180 days of supplementation. Each tablet contains 60 mg elemental iron + 500 µg folic acid.[3,4]

Patients with moderate to severe anemia or those with mild anemia not responding to empirical oral iron therapy should be investigated to determine the types of anemia, such as megaloblastic anemia, thalassemia, anemia of chronic disease, etc.

Investigations done are complete blood count with peripheral smear, red blood cell indices (mean corpuscular volume, mean corpuscular hemoglobin, and

Table 2 Methods for non-invasive hemoglobin monitoring

Pulse co-oximetry	Uses multi-wavelength light to estimate hemoglobin and related parameters through a sensor placed on a finger or earlobe	Masimo SpHb
Reflectance spectroscopy	Measures reflected light from skin/tissue to estimate Hb	Non-invasive hemoglobin meters
Near-infrared spectroscopy (NIRS)	Assesses tissue oxygenation and sometimes Hb concentration by analyzing near-infrared light	Medtronic INVOS
Photoacoustic imaging (research stage)	Combines laser and ultrasound to image blood and estimate Hb levels	Advanced clinical research tools

Table 3 Severity of anemia based on Hb level (FOGSI, WHO Standards and AMB)

WHO, FOGSI	
Severity	Hb level
Normal	≥11.0
Mild	10–10.9 g/dL
Moderate	7–9.9 g/dL
Severe	<7 g/dL
Very severe (FOGSI, AMB)	<4 g/dL

*Anemia Mukt Bharat classification is based on WHO standards, but is adopted in India under the Anemia Mukt Bharat strategy for targeted interventions.

Table 4 Based on Hb levels according to trimester of pregnancy and postpartum (ACOG)

ACOG	
Trimester	***Hb threshold for anemia***
1st trimester	<11.0 g/dL
2nd trimester	<10.5 g/dL
3rd trimester	<11.0 g/dL
Postpartum	<10.0 g/dL

mean corpuscular hemoglobin concentration), reticulocyte count, blood films for malaria parasites (particularly in endemic areas), and stool examination for ova, cysts, and occult blood.

Table 5 Comparison of IDA and megaloblastic anemia in pregnancy[7,10]

Intervention	***IDA***	***Megaloblastic anemia***
Key nutrients	Iron (heme & non-heme) + Vit C	Folate, vitamin B12
RDA (adults)	Women: 18–21 mg Men: 8–17 mg Pregnant: 27–35 mg	Folate: 400 ug (preg: 600 mg); B12: 2.4 ug (preg: 2.6 ug)
Dietary sources	Meat, fish, legumes, greens, fortified cereals	Leafy greens, legumes, animal products, fortified foods
Enhancers	Vitamin C, prebiotics and probiotics, liposomal iron, MFP factor, and iron cookware	–
Inhibitors	Phytates, tannins, calcium, oxalates	–
Fortification	Iron added to flour, salt, rice	Folate in staples; B12 in fortified foods
Clinical cues	Microcytic anemia, low ferritin	Macrocytic anemia; treat B12 first

Peripheral blood picture helps to differentiate IDA (microcytic hypochromic) from megaloblastic anemia (macrocytic) or anemia of chronic disease (normocytic normochromic) or a dimorphic anemia.

For microcytic and hypochromic type of anemia (low mean corpuscular volume), hemoglobin electrophoresis is done to rule out thalassemia trait. Serum ferritin is advisable to differentiate IDA from thalassemia trait and anemia of chronic disease.

In low-resource settings, RBC count and Mentzer index (mean corpuscular volume/RBC count) can be used to differentiate thalassemia from IDA. A Mentzer index of more than 13 indicates IDA, whereas a Mentzer index of less than 13 indicates thalassemia. In β-thalassemia, RBC count is more than $5 \times 10^6/mm^3$.[7]

Diagnosis of iron deficiency may further be confirmed by tests like total iron binding capacity, serum iron, transferrin saturation, soluble transferrin receptors, zinc protoporphyrin, and erythrocyte protoporphyrin.

Most common types of anemia in pregnancy are:[7,11,12]

- *Iron deficiency:* microcytic, low serum ferritin, high TIBC.
- *Folate/B_{12} deficiency (megaloblastic):* Macrocytic, low serum folate/B_{12}.
- In pregnancy, both deficiencies often coexist due to high demand.

Comparison of IDA and megaloblastic anemia is shown in **Table 5**.

Iron absorption is tricky because it depends on the type of iron consumed, the presence of enhancers/inhibitors in the diet, physiological and medical conditions, non-adherence due to gastrointestinal side effects of oral therapy, and the form of the supplement and its timing. Newer approaches for enhancing iron absorption are shown in **Table 6**.

Table 6 Approaches to enhance iron absorption in IDA and reduce GI side effects[4,7,12,13]

Method to enhance iron absorption	***Mechanism/benefit***
Vitamin C (ascorbic acid)	Converts ferric to ferrous iron
Ferrous bisglycinate	Amino acid chelate; well absorbed, fewer side effects
Enteric/sustained-release iron	Targeted duodenal delivery
Probiotics and prebiotics	Improve gut flora and iron uptake
Nano-iron formulations	Enhance absorption, reduce side effects
Liposomal iron	Encapsulation increases bioavailability
Heme iron polypeptides	Highly absorbable form from animal sources
Iron amino acid chelates	Stable and well-absorbed in the gut
Co-administration strategies	With enhancers, avoid inhibitors

Parenteral Iron[7,8]

Indications:

- Poor tolerance or inadequate response to oral iron by 2–4 weeks.
- Moderate anemia (Hb 7–9.9 g/dL), late Pregnancy, when the patient is symptomatic/heart failure, and there is some time for delivery
- *Preferred formulation:* Ferric carboxymaltose (FCM) or iron sucrose. Dosage: Single 1,000 mg dose administered under supervision.
- Ferrous isomaltoside is a third-generation intravenous (IV) iron preparation, used to rapidly replenish iron stores. Dose up to 20 mg/kg body weight in one sitting and is associated with negligible hypersensitivity risk.

Table 7 Contraindications to intravenous (IV) iron therapy in pregnancy

Category	***Details***
Hypersensitivity	Known hypersensitivity to any IV iron preparation (e.g., ferric carboxymaltose, iron sucrose, ferric gluconate)
First trimester	Routine use is avoided in the first trimester unless benefits outweigh risks (due to limited safety data)—per WHO, FOGSI, RCOG, and ACOG
Iron overload disorders	Conditions like hemochromatosis, hemosiderosis
Non-iron deficiency anemia	Anemia due to causes other than iron deficiency (e.g., thalassemia, aplastic anemia, B12/folate deficiency)
Acute or chronic infection	IV iron may worsen infections; caution or defer until infection resolves—emphasized by WHO and ACOG
Severe liver disease	Use with caution; iron can worsen hepatic dysfunction
Uncontrolled asthma or eczema	Higher risk of hypersensitivity reactions

- FOGSI/AMB promote FCM for faster Hb rise, single-dose infusion, fewer side effects, and cost-effectiveness
  Conditions where parenteral iron should be avoided are shown in **Table 7**.

Blood Transfusion[7]

Reserved for Hb <7 g/dL or severe symptomatic anemia, especially if hemodynamic compromise or urgent delivery is needed.

Management algorithm for microcytic anemia is given in **Flowchart 1**

Folic Acid Deficiency

- Standard daily dose: 0.5–1 mg folic acid.
- For those at high risk (prior neural tube defect): 4 mg/day started pre-conception to first trimester

Vitamin B_{12} Deficiency

- IM cyanocobalamin: 1,000 μg daily × 7 days, weekly × 4 weeks, then monthly maintenance.
- Mild deficiency may be managed with oral B_{12}.

Monitoring and Follow-up

Follow-up is essential for assessing the treatment efficacy. Hemoglobin levels should be reassessed four weeks after initiating therapy. A successful response is defined as a hemoglobin rise of ≥1 g/dL within 2–3 weeks **(Table 8)**. Management

Flowchart 1: Algorithm for microcytic anemia

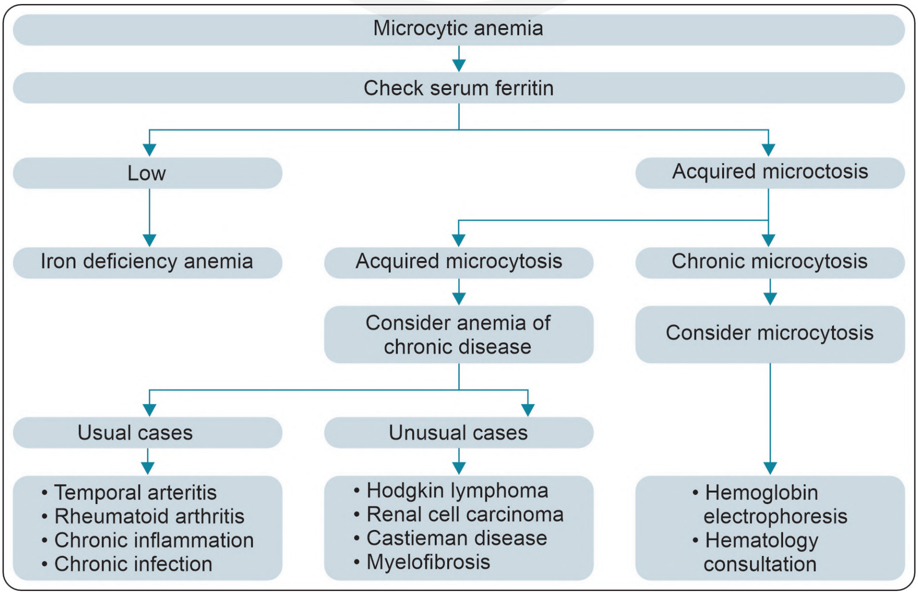


Table 8 Monitoring and follow-up

Intervention	*Expected Hb rise*	*When to check Hb*	*How to check*
Oral iron	1–2 g/dL in 2–4 weeks	2–4 weeks, then every 4–6 weeks	CBC (complete blood count) including Hb, HCT, MCV, MCH Reticulocyte count: May rise within 5–10 days, indicating marrow response If no Hb rise in 2–4 weeks: Evaluate for non-compliance, malabsorption, or ongoing blood loss
Parenteral iron	1–2 g/dL in 2–4 weeks	2–4 weeks, then as needed	CBC (complete blood count) including Hb, HCT, MCV, MCH Ferritin: To assess iron stores, especially before and after full repletion Reticulocyte count: Increases within days to a week
Blood transfusion	~1 g/dL per unit PRBC	1–2 hours, and 12–24 hours post-Tx	CBC (complete blood count) including Hb, Hct, MCV, MCH Note: Earlier checks (<1 hour) may not reflect equilibration; delayed checks (>24 hours) may be affected by ongoing bleeding or hemolysis

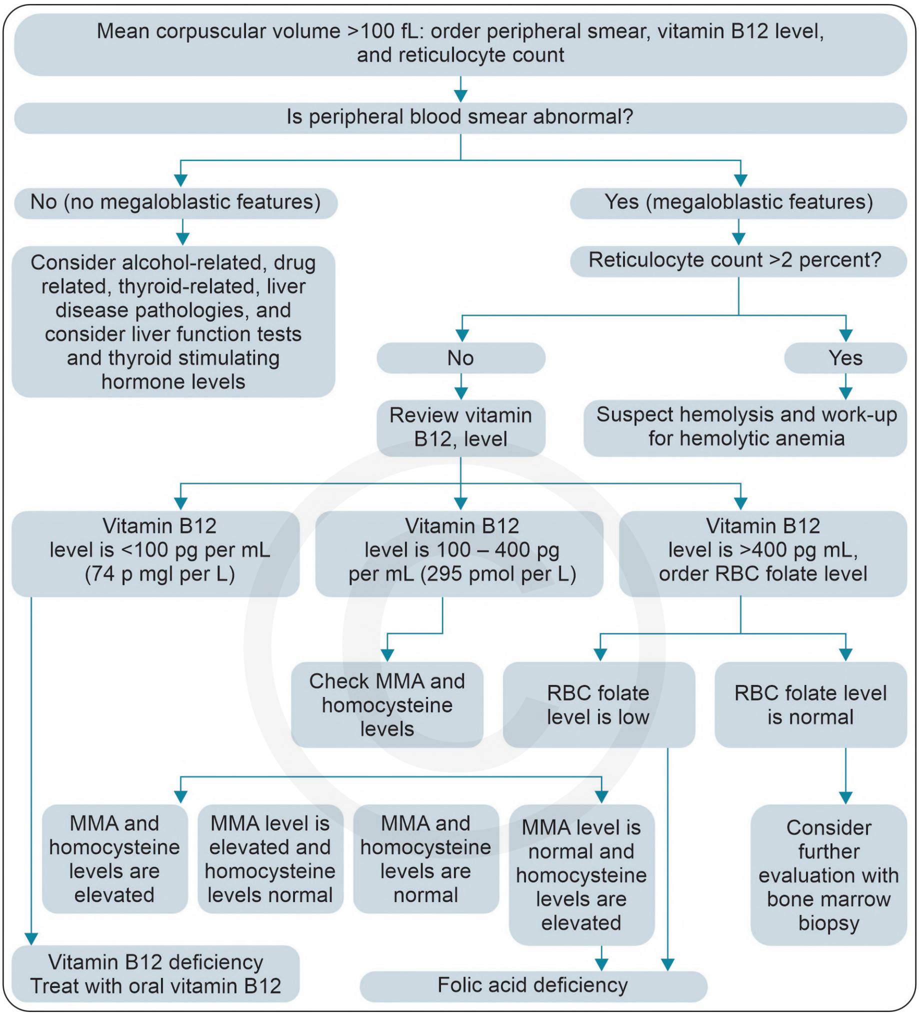
algorithm for macrocytic anemia is given in **Flowchart 2**. Folic acid and B_{12} therapy should be continued until both hemoglobin and MCV return to normal levels.[7]

NATIONAL PROGRAMMES: ANEMIA MUKT BHARAT AND NIPI[3,4,14]

Anemia Mukt Bharat Interventions

AMB incorporates a six-pronged strategy focused on improving iron and folate status among pregnant women. Key interventions include daily iron and folic acid (IFA) supplementation (60 mg iron + 500 μg folic acid) from the second trimester until delivery and for 180 days postpartum; bi-annual deworming with Albendazole (400 mg) during the second trimester; and the fortification of staple foods like rice, salt, wheat, and oil with iron, folate, and B_{12} in public distribution systems. Monitoring is strengthened through digital tracking of hemoglobin levels at each antenatal visit, with protocols in place for referral in cases of poor response. Behavioral change is encouraged via Information, Education, and Communication (IEC) and Behavior Change Communication (BCC) campaigns promoting

Flowchart 2: Algorithm for macrocytic anemia



supplement adherence, nutritious diets, deworming, delayed cord clamping, and early initiation of breastfeeding.

IMPLEMENTATION CHALLENGES AND BEST PRACTICES

Several barriers affect anemia control, including poor adherence to oral iron due to gastrointestinal side effects, lack of awareness, and health system gaps. IEC/BCC initiatives such as the “Solid Body, Smart Mind” campaign help improve compliance. Switching to IV iron (particularly FCM) is advised in all cases of poor oral tolerance.

National programs support equity through the fortification of staple foods in public schemes like the Targeted Public Distribution System (TPDS), Integrated Child Development Services (ICDS), and Mid-Day Meal (MDM) programs.

Regular monitoring of hemoglobin at ANC visits is extremely critical; therapy should be adjusted if Hb fails to rise by at least 1 g/dL per month. Additionally, non-nutritional causes of anemia, such as malaria and hemoglobinopathies, must be assessed as part of comprehensive antenatal care.

Conclusion

India's strategy for managing anemia in pregnancy includes WHO and FOGSI guidelines with national programs like Anemia Mukt Bharat and NIPI. Through early and universal screening, consistent supplementation, timely escalation to intravenous or transfusion-based therapy, and broad-based public health measures such as food fortification and deworming,

India presents a comprehensive model for anemia prevention and treatment. This integrated approach not only aims to reduce the burden of maternal anemia but also ensures safer pregnancies and better outcomes for mothers and newborns, further reducing morbidity and mortality.

References

1. World Health Organization (WHO). Guideline for the management of iron deficiency anemia in pregnancy. Geneva: WHO; 2024.
2. International Institute for Population Sciences (IIPS) and ICF. National Family Health Survey (NFHS-5), 2019-21: India. Mumbai: IIPS; 2021.
3. Ministry of Health and Family Welfare, Government of India. Anemia Mukt Bharat: Intensified National Iron Plus Initiative (I-NIPI) operational guidelines. 2018. Available from: https://anemiamuktbharat.info
4. UNICEF, Ministry of Health and Family Welfare. Anemia Mukt Bharat strategy document. New Delhi: UNICEF & MoHFW; 2018.
5. American College of Obstetricians and Gynecologists (ACOG). Practice Bulletin No. 233: Anemia in pregnancy. Obstet Gynecol. 2021;138(2):e55-64.
6. Kalaivani K, Ramachandran P. Time trends in prevalence of anaemia in pregnancy. Indian J Med Res. 2018;147(3):268-77.
7. Kriplani A, et al. FOGSI general clinical practice recommendations on management of iron deficiency anemia in pregnancy. New Delhi: Federation of Obstetric and Gynaecological Societies of India (FOGSI); 2021.
8. Bhutta ZA, Das JK, Rizvi A, et al. Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? Lancet. 2013;382(9890):452-77.

9. World Health Organization. Guideline: Daily iron and folic acid supplementation in pregnant women. Geneva: WHO; 2012.
10. Rai RK, Fawzi WW, Barik A, et al. The burden of iron-deficiency anaemia among women in India: how have iron and folic acid interventions fared? WHO South East Asia J Public Health. 2018;7(1):18-23.
11. Toteja GS, Singh P, Dhillon BS, et al. Prevalence of anemia among pregnant women and adolescent girls in 16 districts of India. Food Nutr Bull. 2006;27(4):311-5
12. Rakesh PS. Anemia Mukt Bharat: A new strategy for control of anemia in India. Indian J Community Med. 2018;43(4):266-9.
13. World Health Organization. The global prevalence of anaemia in 2011. Geneva: WHO; 2015.
14. Government of India. Guidelines for control of iron deficiency anaemia: National Iron Plus Initiative for pregnant and lactating women, adolescents and children. New Delhi: MoHFW; 2013.

Chapter 7

Low-dose Iron Supplementation: A Safe and Effective Strategy for IDA in Pregnancy

Alka Pandey, Pikee Saxena

INTRODUCTION

Iron deficiency anemia (IDA) is the most prevalent form of anemia in pregnancy, affecting nearly 75% of women in developing countries and contributing to 3.5–75% of all anemia cases worldwide.[1] In India, almost one in two pregnant women, or 7.5 million women annually, are anemic.[2] IDA causes are inadequate intake, poor absorption, impaired transport, and losses due to menstruation.[1]

Inadequate intake of iron and folic acid during pregnancy adversely impacts maternal health, pregnancy outcomes, and fetal development.[3] If left untreated, it increases the risk of complications such as postpartum hemorrhage, placental abruption, preeclampsia, and low birth weight, highlighting the importance of timely diagnosis and effective management[4]

SCREENING AND DIAGNOSIS OF IDA DURING PREGNANCY

Routine screening for IDA in pregnancy is essential for early diagnosis and effective management. The diagnostic approach combines clinical assessment, medical history, evaluation of risk factors, and laboratory investigations, with laboratory testing serving as the cornerstone. The World Health Organization (WHO) defines anemia in pregnancy as hemoglobin levels below 11 g/dL in the first and third trimesters and below 10.5 g/dL in the second trimester, providing trimester-specific thresholds for diagnosis. In addition to hemoglobin measurement, further laboratory tests are required to determine the type and severity of anemia.[5]

Serum ferritin is a sensitive marker of iron status under normal conditions; however, as an acute-phase reactant, it may be elevated in the presence of inflammation, which can complicate its interpretation. Patients with inflammation may have restricted iron availability for erythropoiesis despite normal or elevated ferritin levels. Therefore, the standard threshold of serum ferritin for ID (<30 µg/L) does not apply in such cases. Instead, a ferritin level <100 µg/L or transferrin saturation (TSAT) <20% is considered diagnostic of ID, as TSAT more accurately reflects iron bioavailability under inflammatory conditions.[6]

Incorporating these markers into routine diagnostic algorithms enhances diagnostic precision, particularly in populations with a high burden of infection and inflammation.

GUIDELINE RECOMMENDATIONS FOR THE DIAGNOSIS OF IDA DURING PREGNANCY

- The American College of Obstetricians and Gynecologists (ACOG) recommends that all pregnant women be screened for anemia with a complete blood count (CBC) in the first trimester and again between 24 weeks and 28 weeks of gestation. Anemia is defined as hematocrit levels <33% in the first and third trimesters and <32% in the second trimester. Women meeting these criteria should be further evaluated to identify the underlying cause. If ID is excluded, alternative etiologies should be investigated.[7]
- Centers for Disease Control and Prevention (CDC) recommends that all pregnant women undergo a CBC at their initial antenatal visit.[8]
- International Federation of Gynecology and Obstetrics (FIGO) advises that a full blood count should be assessed at least at booking and again at 28 weeks of gestation.[9]

ORAL IRON SUPPLEMENTATION: AN EFFECTIVE MANAGEMENT OF IDA IN PREGNANCY

Effective management of anemia in pregnancy is essential and should be individualized based on the cause and severity. Treatment strategies include dietary measures, iron supplementation, and, in severe cases, blood transfusion to restore hemoglobin and prevent complications.[10]

Oral iron supplementation is considered the first-line and only safe option for iron repletion during the first trimester of pregnancy, owing to its low cost, established efficacy, and the lack of safety data for alternative therapies during this critical period of fetal development and organogenesis.[4,11]

Ferrous formulations are generally better absorbed compared to ferric forms.[12] Commonly available ferrous preparations include ferrous sulfate, ferrous fumarate, ferrous ascorbate, and ferrous gluconate.[11] Ferrous sulfate is a commonly used salt, but its relatively poor absorption necessitates doses several times higher than the recommended dietary allowance. Such high dosing increases unabsorbed intestinal iron, which is associated with gastrointestinal side effects, including nausea, vomiting, constipation, and diarrhea, which reduces patient compliance. Additionally, excess unabsorbed iron has been shown to negatively influence the gut microbiota composition, promoting dysbiosis.[11]

A meta-analysis of 20 clinical trials reported a significantly higher incidence of gastrointestinal side effects with oral ferrous sulfate compared to placebo [odds ratio (OR)=2.32, 95% confidence interval (CI) 1.74–3.08, p<0.001], with 30–70% of symptomatic patients demonstrating poor adherence to therapy.[4,13]

To improve tolerability, formulations of ferrous sulfate are manufactured as enteric-coated tablets, designed to delay dissolution and minimize gastric irritation. However, these preparations are associated with impaired absorption compared to standard supplements.[14]

To overcome these limitations, alternative preparations such as ferrous fumarate, ferrous gluconate, and iron glycine amino acid chelate have demonstrated better absorption profiles and are less likely to cause gastrointestinal intolerance.[14]

These options merit consideration for women unable to tolerate standard ferrous salts, especially when long-term therapy is needed. A tailored approach considering individual tolerance, iron status, and gestational age is essential for optimizing outcomes in IDA during pregnancy.

IRON AMINO ACID CHELATES: AN EMERGING ALTERNATIVE FOR IDA

IAAC serves as an alternative iron supplement to reduce treatment-related adverse effects and improve adherence, particularly in pregnant women requiring long-term oral iron therapy **(Fig. 1)**.[14,15]

CLINICAL EVIDENCE FOR IAAC DURING PREGNANCY

A randomized controlled study compared the efficacy and tolerability of IAAC (15 mg elemental iron once daily) with ferrous fumarate (350 mg capsule containing 115 mg elemental iron once daily) in pregnant women (n=150) for the management of IDA over 12 weeks. The findings showed that the IAAC group experienced a significantly greater and faster rise in hemoglobin levels at 4, 8, and 12 weeks compared with the ferrous fumarate group (p≤0.001). Gastrointestinal side effects, including constipation (p=0.022) and abdominal colicky pain (p=0.031), were reported more frequently in women receiving ferrous fumarate than IAAC. Overall, IAAC demonstrated superior efficacy and better tolerability compared to ferrous fumarate in the management of IDA during pregnancy.[15]

A randomized controlled study of 150 pregnant women assessed the efficacy of IAAC versus ferrous fumarate in the management of IDA. Both treatment groups demonstrated significant hematological improvements, including rises in hemoglobin, red cell indices, serum iron, and ferritin levels at 4, 8, and 12 weeks. By week 12, however, the mean hemoglobin concentration was significantly higher in the IAAC group compared with the ferrous fumarate group (11.6 ± 0.8 g/dL vs. 11.3 ± 0.9 g/dL). Furthermore, IAAC treatment produced significantly greater increases in serum ferritin, packed cell volume (PCV), mean corpuscular volume

Ideal chelator	• Amino acids are ideal chelators, from both chemical and nutritional points of view.[15]
Neutral chelate structure	• IAAC forms a stable, charge-free bicyclic configuration via the carboxyl oxygen and a-amino group, enhancing absorption.[15]
Higher absorption	• Intestinal villi have strong affinity for amino acids, enabling up to 95% absorption. Well-formulated chelates cross mucosal cells intact with minimal resistance.[15]
Overcome absorption limitations	• IAAC bypasses the absorption challenges of inorganic iron salts.[14]
Enhanced bioavailability	• Its superior bioavailability supports effective iron repletion at lower daily doses, which reduces the gastrointestinal adverse effects commonly observed with conventional Iron therapy.[14]
Improved compliance	• Lower doses and reduced GI discomfort support better patient compliance and long-term adherence.[14]
Faster hemoglobin rise	• Accelerated improvement attributed to efficient assimilation through chelation.[14]

Fig. 1: Key advantages of IAAC[14,15]

(MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and serum iron levels after 12 weeks.[16]

IAAC demonstrated superior improvements in hemoglobin and iron parameters compared to ferrous fumarate in pregnant women with IDA.[16]

LOW-DOSE 30 mg IAAC: A BETTER TREATMENT APPROACH FOR IDA

- From a physiological and nutritional perspective, low-dose iron supplementation is sufficient to meet preventive requirements during pregnancy.[17]
- Minimizing interference with the absorption of essential divalent cations such as zinc, copper, chromium, molybdenum, manganese, and magnesium helps maintain overall micronutrient balance.[17]
- Lower doses also reduce the risk of oxidative tissue damage caused by excess iron and reactive oxygen species.[17]
- Furthermore, pregnancy-induced suppression of maternal hepcidin enhances iron absorption, making smaller doses adequate while preventing iron overload.[18]

- Importantly, low doses (30 mg/day) are better tolerated, with fewer gastrointestinal side effects, which in turn improve patient compliance, adherence, and more efficient iron utilization.[19]

COMPARATIVE EVIDENCE: LOW-DOSE VS. HIGH-DOSE IRON SALTS

An open-label, parallel, randomized, pilot clinical study assessed the efficacy and tolerability of low-dose IAAC (30 mg elemental iron daily) versus high-dose ferrous ascorbate (100 mg elemental iron daily) in women with mild anemia. The IAAC group experienced a 15.6% greater increase in hemoglobin levels, with fewer gastrointestinal adverse effects. Notably, 33.3% of participants in the ferrous ascorbate group developed gastrointestinal inflammation, whereas none in the IAAC group did. Side effects such as nausea, vomiting, metallic taste, and abdominal discomfort were mild in the IAAC group compared to moderate severity in the high-dose group. Overall, these findings suggest that low-dose IAAC (30 mg) is safer, better tolerated, and as effective as high-dose iron salts in the management of mild anemia.[20]

Hepcidin is the key regulator of systemic iron balance, inversely linked to iron bioavailability.[21] By inducing ferroportin degradation, it limits duodenal iron absorption, and elevated hepcidin levels consequently reduce systemic iron availability.[22] In iron-depleted young women, oral iron supplementation with doses of 60, 80, 160, and 240 mg administered in the morning led to an acute rise in plasma hepcidin, both on the same day and 24 hours later. This increase was strongly associated with reduced absorption of a subsequent iron dose given 24 hours after the first. Providing 60 mg twice daily further amplified the hepcidin response and lowered fractional absorption of both the afternoon dose and the following morning dose, such that the total iron absorbed from three doses (two mornings and one afternoon) was no greater than that absorbed from two morning doses alone.[21]

Overall, these findings indicate that a supplemental 60 mg dose elevates hepcidin after 24 hours, thereby impairing absorption of the next dose. Importantly, fractional absorption was highest at lower iron doses. Thus, low-dose iron supplementation may enhance absorption efficiency, reduce gastrointestinal exposure to unabsorbed iron, and improve overall tolerance and adherence to therapy.[21]

Elevated circulating hepcidin levels may serve as an early diagnostic indicator for gestational diabetes mellitus (GDM) and could be a useful marker for assessing iron balance in affected patients.[23]

Table 1 Recommendations for low-dose iron as prophylactic treatment during pregnancy[7,8,26,27]

Guidelines	***Recommendations***
ACOG	Recommends starting low-dose iron supplementation in the first trimester to reduce the prevalence of maternal anemia at the time of delivery.[7]
CDC	Advises initiating 30 mg of elemental iron per day from the first prenatal visit as a preventive measure.[8]
WHO	Suggests a daily intake of 30–60 mg of elemental iron for all pregnant women to prevent ID and ensure optimal maternal health.[27]
FOGSI GCPR	Recommends that once hemoglobin levels are normalized, prophylactic iron supplementation should continue for at least 6 months during pregnancy and be further extended for another 6 months postpartum to maintain iron stores and prevent recurrence of anemia.[26]

ACOG: American College of Obstetricians and Gynecologists, CDC: Centers for Disease Control and Prevention, WHO: World Health Organization; FOGSI GCPR, Federation of Obstetric and Gynaecological Societies of India Good Clinical Practice Recommendations

PROPHYLACTIC LOW-DOSE IRON SUPPLEMENTATION DURING PREGNANCY

During pregnancy, increased iron requirements often exceed what is achievable through diet alone, making prophylactic iron supplementation essential. Consequently, routine iron supplementation is strongly recommended to ensure adequate maternal and fetal iron status.[24] Initiating low-dose elemental iron supplementation (30–60 mg/day) by the 12th week of gestation when iron requirements begin to rise is effective.[25] Evidence indicates that prophylactic supplementation can reduce the risk of maternal anemia by up to 70% and decrease the incidence of ID and IDA at term by 57%. Leading health bodies, including ACOG, CDC, WHO, and FOGSI, endorse early and continued low-dose supplementation throughout pregnancy and postpartum **(Table 1)**. Lower doses not only maintain micronutrient balance but also minimize oxidative tissue injury and improve gastrointestinal tolerability, ultimately enhancing adherence. Furthermore, women who receive supplementation achieve higher hemoglobin levels both at term and postpartum, contributing to improved maternal health outcomes.[26]

Conclusion

Low-dose iron amino acid chelate (IAAC), delivering 30 mg elemental iron daily, has shown promise as a well-tolerated and effective alternative to traditional high-dose iron salts in the management of IDA during pregnancy. Higher iron doses are associated with hepcidin elevation, reduced subsequent absorption,

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and increased gastrointestinal intolerance, whereas low-dose supplementation optimizes fractional absorption, minimizes unabsorbed intestinal iron, and improves tolerability. Emerging clinical evidence suggests that IAAC may offer comparable or superior improvements in hematologic indices while reducing gastrointestinal side effects, thus enhancing patient adherence. While these findings are encouraging, larger-scale, multicenter studies are necessary to validate long-term efficacy, safety, and cost-effectiveness across diverse populations. Integration of IAAC into clinical practice should be considered within the context of national guidelines, resource availability, and patient-specific needs.

References

1. Kebede SS, Asmelash D, Duguma T, et al. Global prevalence of iron deficiency anemia and its variation with different gestational age: a systematic review and meta-analysis. Clin Nutr Open Sci. 2025;59:68-86.
2. Locks L, Bhaise S, Dhurde V, et al. The prevalence of anemia during pregnancy and its correlates vary by trimester and hemoglobin assessment method in Eastern Maharashtra, India. Matern Child Nutr. 2024;20(4):e13684.
3. Banerjee A, Athalye S, Shingade P, et al. Efficacy of daily versus intermittent oral iron supplementation for prevention of anaemia among pregnant women: a systematic review and meta-analysis. EClinicalMedicine. 2024;74:102742.
4. Benson AE, Shatzel JJ, Ryan KS, et al. The incidence, complications, and treatment of iron deficiency in pregnancy. Eur J Haematol. 2022;109(6):633-42.
5. Obeagu E. Anemia in pregnancy: causes, diagnosis, and management strategies. Lifel Nurs Healt Sci. 2024;2(1):31-41.
6. Dignass A, Farrag K, Stein J. Limitations of serum ferritin in diagnosing iron deficiency in inflammatory conditions. Int J Chronic Dis. 2018;2018:9394060.
7. ACOG practice bulletin 233. Anemia in pregnancy. Obstet Gynecol. 2021;138(2):e55-63.
8. Centers for Disease Control and Prevention. Recommendations to prevent and control iron deficiency in the United States. 1998.
9. Renzo G. FIGO committee report: good clinical practice advice: iron deficiency anemia in pregnancy. Int J Gynecol Obstet. 2019;144:322-4.
10. Agarwal A, Rets A. Laboratory approach to investigation of anemia in pregnancy. Int J Lab Hematol. 2021;43(Suppl 1):65-70.
11. Ebea O, Vidyasagar S, Connor R, et al. Oral iron therapy: current concepts and future prospects for improving efficacy and outcomes. Br J Haematol. 2024;204(3):759-73.
12. Pavord S, Daru J, Prasannan N, et al. UK guidelines on the management of iron deficiency in pregnancy. Br J Haematol. 2020;188(6):819-30.
13. Tolkien Z, Stecher L, Mander A, et al. Ferrous sulfate supplementation causes significant gastrointestinal side effects in adults: a systematic review and meta-analysis. PLoS One. 2015;10(2):e0117383.

14. Soliman G, Mhfouz M, Emara I. Effect of different types of oral iron therapy used for the treatment of iron deficiency anemia and their effects on some hormones and minerals in anemic rats. J Am Sci. 2010;6(6):109-18.
15. Abdel Moety G, Ali A, Fouad R, et al. Amino acid chelated iron versus an iron salt in the treatment of iron deficiency anemia with pregnancy: a randomized controlled study. Eur J Obstet Gynecol Reprod Biol. 2017;210:242-6.
16. Makled A, Abuelghar W, El-Shahawy A, et al. Amino acid chelated iron versus ferrous fumarate in the treatment of iron deficiency anemia with pregnancy: randomized controlled trial. Evid Based Women Health J. 2020;10(1):95-103.
17. Milman N, Bergholt T, Eriksen L, et al. Iron prophylaxis during pregnancy—how much iron is needed? A randomized dose–response study of 20–80 mg ferrous iron daily in pregnant women. Acta Obstet Gynecol Scand. 2005;84:238-47.
18. Sangkhae V, Fisher A, Ganz T, et al. Iron homeostasis during pregnancy: maternal, placental, and fetal regulatory mechanisms. Annu Rev Nutr. 2023;43:279-300.
19. Chandra S, Mohanty S, Gupta M, et al. Evaluation of safety and tolerability of iron amino acid chelate therapy in pregnant women. Int J Basic Clin Pharmacol. 2022;11:249-54.
20. Jain GK, Gupta A, Mishra A, et al. Low-dose iron is safer, tolerable, and equally effective to high-dose iron in improving iron status in mildly anemic female participants. Int J Pharmacol. 2024;20:352-60.
21. Moretti D, Goede J, Zeder C, et al. Oral iron supplements increase hepcidin and decrease iron absorption from daily or twice-daily doses in iron-depleted young women. Blood. 2015;126(17):1981-9.
22. Rosson S, Pavord S. Understanding hepcidin for iron management in pregnancy. J Br Blood Transfus Soc. 2025;35(2):109-15.
23. Meka S, Geddamuri B, Varghese B, et al. Circulatory hepcidin levels association with gestational diabetes mellitus: a meta-analysis of observational studies. Int J Pharm Pract. 2022;30:195-203.
24. Tandon R, Jain A, Malhotra P. Management of iron deficiency anemia in pregnancy in India. Indian J Hematol Blood Transfus. 2018;34(2):204-15.
25. Institute of Medicine (US) Committee on Nutritional Status During Pregnancy and Lactation. Nutrition during pregnancy: Part I, weight gain; Part II, nutrient supplements. 14. Iron nutrition during pregnancy. Washington (DC): National Academies Press (US); 1990.
26. FOGSI. General clinical practice recommendations: management of iron deficiency anemia in pregnancy. 2017.
27. World Health Organization. Guideline: daily iron and folic acid supplementation in pregnant women. 2012.

Chapter 8

Thalassemia and Sickle Cell Anemia: Prevention and Preconception Strategies

Abhilasha Shandaliya, Monika Anant

INTRODUCTION: GLOBAL AND INDIAN BURDEN OF HEMOGLOBINOPATHIES

Hemoglobinopathies—particularly **thalassemia** and **sickle cell disease (SCD)**—are among the most common monogenic disorders worldwide.

Global Burden

Approximately 7% of the global population carries a gene for a hemoglobin disorder.[1]

India's Burden

- Around 10,000–15,000 children are born annually with thalassemia major in India.[2]
- Sickle cell disease is highly prevalent in tribal and underserved communities, with carrier rates ranging from 10% to 35% in certain regions.

Adult hemoglobin (HbAA) is made up of two α and two β (α2β2) chains. Hemoglobinopathies, affecting the amino acid sequence of globin that alters the physical, chemical, or functional qualities of Hb or thalassemia, the disorder of biosynthesis of globin chains, are of obstetrical interest.

Together, these disorders of the Hb molecule are the most common human monogenic disease. Phenotypic diversity among these disorders is enormous; mutations can be asymptomatic or can be as severe as to cause intrauterine death.

For formulating prevention and preconception strategies for thalassemia and hemoglobinopathy, the genetics, mode of inheritance, symptomatology, diagnosis and management are of paramount importance.

Incidence

Approximately 7% of the global population carries a gene for a hemoglobin disorder.[3]

Hemoglobinopathies like sickle cell disease (SCD) can occur in any ethnic group, but are most common in African, Middle Eastern, Mediterranean and and Indian descent.

α-β thalassemia, once known as Mediterranean Anemia because of its occurrence in countries bordering the Mediterranean Sea, is common in areas of the world where malaria is endemic.

An effective program of screening, counselling, and antenatal diagnosis has reduced the birth of new cases in the Mediterranean region.

Because of effective screening programs in the Mediterranean, the number of affected individuals has decreased, whereas in Asian and India, the number of individuals of Indian origin is increasing. Around 10,000–15,000 children are born annually with thalassemia major in India. Sickle cell disease (SCD) is highly prevalent in tribal and underserved communities, with carrier rates ranging from 10% to 35% in certain regions.[1]

SCD is a single gene autosomal recessive disorder caused by substitution of valine for glutamine in position 6 in β globin chain of the Hb molecule, producing sickle cell Hb (HbSS); a heterozygous condition, sickle cell trait (HbSC) and combination with β thalassemia (HbS β thal) or combination with HbD, E.

THALASSEMIA

α thalassemia—two genetic loci in each 16 chromosome make a total of four alleles possible.

α thal trait		
	–α/αα	One deleted α geneqent -α^+ thal (α thal-2), both deleted genes α^0 thal (α thal-1) . Non-gene deletion thal α)
	–α/–α	
	– – / αα	
	$\alpha^T\alpha/\alpha\alpha$	
HbH	--/- α	Mild to moderate anemia As chains are in excess tetramer of is formed
	$\alpha^+\alpha$/- -	
	$\alpha^+\alpha/\alpha^+\alpha$	
Hb Bart	---/---	Fatal in utero or at birth, with rare survivors (hydrops fetalis)
α thal/Intellectual disability syndrome ATR-16 ATR-α	--/αα ---/-α in ATR 16 αα/αα in ATR x	
thal with myelodysplasia	αα/αα	Strikingly male preponderance

β-Thalassemia

Two genetic loci for β globin chain synthesis crest one on each chromosome 11. Depending on clinical features and degree of reduction in β chain synthesis, it is classified into three types.

Clinical	*Genotype*	*Features*	*Lab finding*
β thal minor (trait)	β^0/β β^+/β	Asymptomatic	HbA_2>3.5%
β thal major	β^0/β^+ β^0/β^0	The β chain severely affected will require lifelong blood transfusion (BT) Hence, the problem of Fe overload	
β thal intermedia	β^+/β^+	Moderate impairment of the β chain, occasional BT	

DIAGNOSIS

Sickle Cell Disease

Typical history of painful crisis, low Hb, and HPLC.

β-Thalassemia Trait

Red cell indicates (low MCV, MCH and normal MCHC), excluding iron deficiency anemia, excluding iron deficiency anemia, NESTROFT for osmotic fragility, are simple, cost-effective screening tests.

HPLC (high-performance liquid chromatography) finding elevated HbA2 and Hb F is sufficient to diagnose hetrogygous β thal.

β-thal major: Red cell indices and quantitation of HbA2 by HPLC along with features of hemolytic anemia.

MANAGEMENT

Screening, Counseling and Antenatal Diagnosis

All women planning pregnancy should be screened for disorders of Hb by blood count, red cell indices and HPLC analysis of Hb. Affected individuals should have their partners tested and genetic counseling offered. If a positive antenatal diagnosis using chorionic villus sampling or amniocentesis is indicated, it should be advised. Preimplantation genetic testing is also possible in couples undergoing IVF.

Pregnant women with hemoglobinopathy or thalassemia need a multidisciplinary team approach consisting of an obstetrician and hematologist.

SCD: Check for HBV, HCV, HIV and rubella. All SCD women should receive a high dose of folic acid 5 mg and penicillin prophylaxis.

Measures to reduce sickle cell crisis, e.g., keep warm, hydrated, oxygenated, and avoid infection, should be ensured. Transfusion may be necessary for severe anemia.

α-β thalassemia rait should be given oral iron and folate supplements during pregnancy. Blood transfusion may be required prior to delivery if hemoglobin is less than 7 g/dL. Though pregnancy is rare in women with β-thalassemia major, the major concern for patients is iron overload due to repeated blood transfusions.

Given the lifelong burden and the absence of a universal cure, prevention strategies—especially those implemented before conception—are critical to reducing the incidence of these diseases.

PRECONCEPTION PREVENTION STRATEGIES

NHM India

Awareness and education
- Educate adolescents and the community about genetic inheritance, dispel myths, reduce stigma, and promote voluntary testing.
- Focus on school-level programs with pre-screening education and post-screening non-directive genetic counselling.

Voluntary screening of adolescents
- Implement cost-effective carrier screening programs at schools, backed by awareness drives.
- Maintain confidentiality and informed consent to build trust and encourage participation.

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Pre-marital and preconception screening
- Offer screening to couples before marriage or pregnancy to identify "at-risk" couples (where both partners are carriers).
- Provide genetic counselling to explain reproductive risks and available options.

Extended family screening
- Once a carrier or affected case is detected, conduct cascade screening in their extended family to identify more carriers and provide timely counseling.

AWARENESS AND EDUCATION

Awareness and education form the cornerstone of any effective strategy for the prevention and control of genetic disorders such as thalassemia and sickle cell disease. It is essential to educate adolescents and the broader community about the fundamentals of genetic inheritance to foster informed decision-making and reduce the deep-rooted stigma associated with carrier status. School-level interventions play a pivotal role in this regard. Structured programs must incorporate pre-screening educational sessions that explain the purpose and implications of genetic testing in a clear and culturally appropriate manner. These sessions should be interactive, using age-appropriate tools such as workshops, visual aids, and peer discussions to ensure comprehension and engagement. Following the screening, non-directive post-screening genetic counselling should be offered to all participants, ensuring that results are conveyed sensitively and confidentially, with support for emotional and social concerns. Counselling must respect individual autonomy and reproductive rights, without any form of coercion or directive advice. In addition, broader community-based educational efforts should be undertaken through local health workers, school staff, and media channels to reinforce key messages and dispel common myths. Training programs for educators and healthcare providers can enhance the sustainability and impact of these initiatives. Ultimately, a well-rounded awareness and education strategy promotes voluntary testing, destigmatizes carrier status, and strengthens community participation in genetic screening programs.

ACOG Guidelines (USA)
Universal Hemoglobinopathy Screening: ACOG recommends offering universal hemoglobinopathy testing to all individuals planning pregnancy or at the first prenatal visit (if prior testing is unavailable), rather than using race/ethnicity as a proxy.
Test options Hemoglobin electrophoresis or molecular genetic testing (e.g., expanded carrier screening). Non-invasive prenatal diagnosis with cell-free fetal DNA remains experimental.
Genetic Counseling and Reproductive Planning: Helps couples understand risks and consider options like preimplantation genetic testing or prenatal diagnosis.

LABORATORY AND INFRASTRUCTURE SUPPORT (INDIA)

- *District testing facilities:* Hemoglobinopathy testing labs at district hospitals or DEICs for carrier identification.
  District-level testing facilities: To ensure early and widespread carrier identification, the National Health Mission recommends establishing dedicated hemoglobinopathy testing laboratories within every district hospital or District Early Intervention Centre (DEIC). Equipped to perform cost-effective hemoglobin electrophoresis or HPLC, these labs serve as the first line of screening for β-thalassemia and sickle-cell disease among antenatal women, school-age adolescents, and high-risk populations. Integration with existing district hospital services streamlines sample collection, reduces turnaround time, and facilitates prompt, non-directive genetic counselling for carriers and their families. Where complex cases or molecular confirmation are required, district labs act as referral nodes, forwarding specimens to regional centres with advanced DNA-based diagnostics, thereby creating a seamless, tiered network for comprehensive hemoglobinopathy control.

- *Regional centers for prenatal diagnosis (PND):* With NICU, obstetric care, and genetic lab support, these centres perform:
  - DNA analysis
  - CVS (10–12 weeks)
  - Amniocentesis (16+ weeks)
  - Cordocentesis (18–20 weeks)
- Regional Centres for Prenatal Diagnosis (PND) play a crucial role in the early detection and prevention of hemoglobinopathies in at-risk pregnancies. As per the NHM Guidelines, these centres are equipped with essential infrastructure, including obstetric care services, neonatal intensive care units (NICU), and advanced genetic laboratory facilities to ensure comprehensive diagnostic support. The centres offer a range of fetal sampling techniques to enable timely and accurate diagnosis. Chorionic villus sampling (CVS) is typically performed between 10 to 12 weeks of gestation and allows for early detection of genetic mutations. Amniocentesis, conducted after 16 weeks, involves the analysis of amniotic fluid for fetal DNA, while Cordocentesis or fetal blood sampling is carried out between 18 to 20 weeks of gestation when required. These procedures are supported by DNA analysis to detect β-thalassemia mutations and other hemoglobinopathies. The integration of high-quality obstetric care with advanced molecular diagnostics ensures that these centres provide critical support in informed decision-making for prospective parents and significantly reduce the likelihood of the birth of affected children.
- *Diagnostic strategy for thalassemia:*
  - Screen for 6 common β-thalassemia mutations using RDB/ARMS.
  - If inconclusive, test for 22 additional mutations.
  - Use DNA sequencing if needed.

The diagnostic approach for thalassemia follows a stepwise strategy aimed at accurately identifying genetic mutations responsible for the condition, particularly in at-risk couples or families with a history of hemoglobinopathies. As per the National Health Mission (NHM) guidelines, initial screening involves testing for the six most common β-thalassemia mutations using molecular techniques such as Reverse Dot Blot (RDB) or Amplification Refractory Mutation System (ARMS). These methods are cost-effective and efficient for detecting prevalent mutations within the population. If the results of this primary screening are inconclusive, a second tier of testing is undertaken to detect an additional panel of 22 less common β-thalassemia mutations, thereby increasing diagnostic sensitivity. In cases where the expanded mutation panel still does not yield a definitive result, advanced genetic analysis through DNA sequencing is recommended. DNA sequencing enables the identification of rare or novel mutations and provides comprehensive insight into the genetic profile of the individual. This tiered diagnostic strategy ensures both precision and feasibility in clinical and community settings, aligning with national public health priorities.

ETHICAL PRINCIPLES (AS PER WHO 1999 GUIDELINES)

- All genetic testing must be voluntary, based on informed consent.
- Programs must respect cultural diversity, individual dignity, and reproductive autonomy.
- Avoid coercion, discrimination, or stigmatization of carriers or affected individuals.

Conclusion

Hemoglobinopathies (Thalassemia & SCD) are among the most common monogenic disorders globally, with a heavy burden. Prevention through screening, counselling, and prenatal diagnosis is more effective than lifelong management. Adolescent. premarital, and preconception screening are key strategies to identify carriers early.

Universal hemoglobinopathy screening (ACOG) and voluntary, culturally sensitive programs (NHM India, WHO) are essential in strengthening district labs and regional PND centres ensures timely diagnosis and reproductive planning.

Awareness, ethical practices, and multidisciplinary care together form the cornerstone of reducing disease incidence.

References

1. WHO Genetics Disorders and Birth Defects. 1999.
2. NHM Guidelines for Prevention and Control of Hemoglobinopathies in India, MoHFW India.2016.
3. Gestational Hypertension and Preeclampsia: ACOG Practice Bulletin, Number 222. Obstet Gynecol. 2020;135(6):e237-60.

Chapter 9

Clinical Approach to Rare Acquired Hemolytic Anemia in Pregnancy

Ritu Sharma, Pikee Saxena, Vaishali

INTRODUCTION

Anemia may result if there is decreased red blood cell production, increased red blood cell destruction, or increased blood loss. Hemolytic anemias are associated with increased destruction of RBC, which may occur intravascular or extravascular; and they are broadly classified into two types—inherited and acquired, where RBC integrity is affected. Inherited hemolytic anemias include sickle cell anemia, thalassemia major, and hereditary spherocytosis. Acquired hemolytic anemias are further classified into micro-angiopathic hemolytic anemia (MAHA) and non-micro-angiopathic hemolytic anemia, with further subclassification in both **(Table 1)**.[1,2]

The overall incidence of autoimmune hemolytic anemia (AIHA) is 1–3 cases per 100,000 per year, while the prevalence of AIHA in pregnancy is around 1 in 50,000. AIHA can be either primary or secondary to certain causes like SLE, malignancies, infections, or immunodeficiency. AIHA is classified as warm (65%), cold (30%), and mixed (5%) type based on direct antiglobulin test (DAT). Allo-immune hemolytic anemia results from transfusion reactions.[1-5]

Though rare, acquired hemolytic anemia is also associated with adverse fetomaternal outcome; hence, an evidence-based clinical approach is essential. Obstetricians should opt for a multidisciplinary approach involving a hematologist, a physician, a geneticist, an immunologist, an infectious diseases specialist, a nephrologist, a pharmacologist, and a laboratory medicine specialist, depending on the suspected clinical diagnosis.[5,6]

In this chapter, we will focus mainly on acquired hemolytic anemia and clinical approach to a patient presenting with hemolytic anemia.

PATHOPHYSIOLOGY[2]

Hereditary hemolytic anemia may result from defects in the red cell membrane, or globin synthesis, or due to enzyme deficiency. Acquired hemolytic anemia may result secondary to immunological causes, infections, drugs, and fragmentation syndromes like hemolytic uremic syndrome (HUS), thrombotic thrombocytopenic purpura (TTP), and disseminated intravascular coagulation(DIC). Sequestration

Table 1 Classification of hemolytic anemia

Inherited hemolytic anemia	***Acquired hemolytic anemia***	
• Sickle cell anemia • Thalassemia • Hereditary spherocytosis	*Micro-angiopathic hemolytic anemia (MAHA)* • Thrombotic thrombocytopenic purpura (TTP) • Hemolytic uremic syndrome (HUS) • HELLP syndrome • Infections (malaria) • Drug induced	*Non-micro-angiopathic hemolytic anemia (non-MAHA)* • Autoimmune • Alloimmune

and phagocytosis are responsible for extravascular destruction of RBCs, while direct cellular destruction caused by toxins, trauma, fragmentation, and oxidative damage is responsible for intravascular destruction. Intravascular destruction occurs mainly in micro-angiopathic hemolytic anemia (MAHA), trauma, alloimmune causes, and enzyme deficiencies, while hemoglobinopathies, hereditary spherocytosis, and paroxysmal nocturnal hemoglobinuria (PNH) show extravascular destruction. In the rest, RBC destruction occurs at both sites.

CLINICAL APPROACH TO PREGNANCY WITH SUSPECTED HEMOLYTIC ANEMIA[2,7-9]

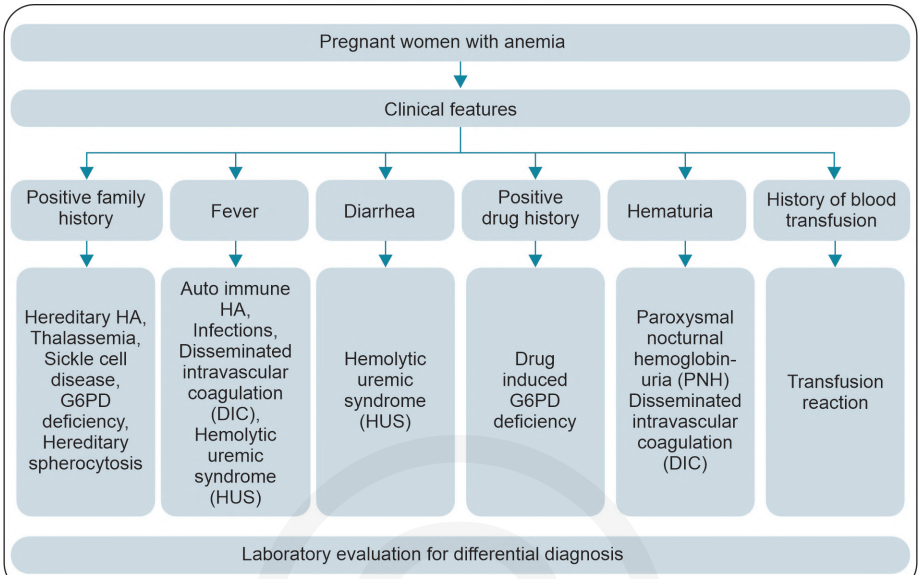
The presence of jaundice, hematuria, fever, and positive drug history in a pregnant patient with anemia should raise suspicion of hemolytic anemia. CBC may reveal normocytic or macrocytic RBCs. The clinical approach is similar to that of a non-pregnant patient. A detailed medical, drug, personal, and family history should be taken along with a thorough examination. Depending upon the severity and duration of hemolysis, the patient may present with varying degrees of pallor, jaundice, splenomegaly, cholelithiasis, neurological symptoms, skeletal abnormalities, and leg ulcers.

Certain clinical findings are specific and may suggest the underlying cause for hemolytic anemia **(Flowchart 1)**.

LABORATORY WORKUP (FLOWCHART 1)[2,7-9]

For confirmation of hemolysis, the initial laboratory investigations include LDH, unconjugated bilirubin, reticulocyte count (RCC), haptoglobin, and urine examination. Presence of hemoglobinuria, urobilinogen, and proteinuria in urine examination; low haptoglobin levels with increased levels of rest investigations will suggest hemolytic anemia. The negative findings should prompt an investigation for alternative causes.

Flowchart 1: Suspected underlying cause for hemolytic anemia (HA) based on clinical features



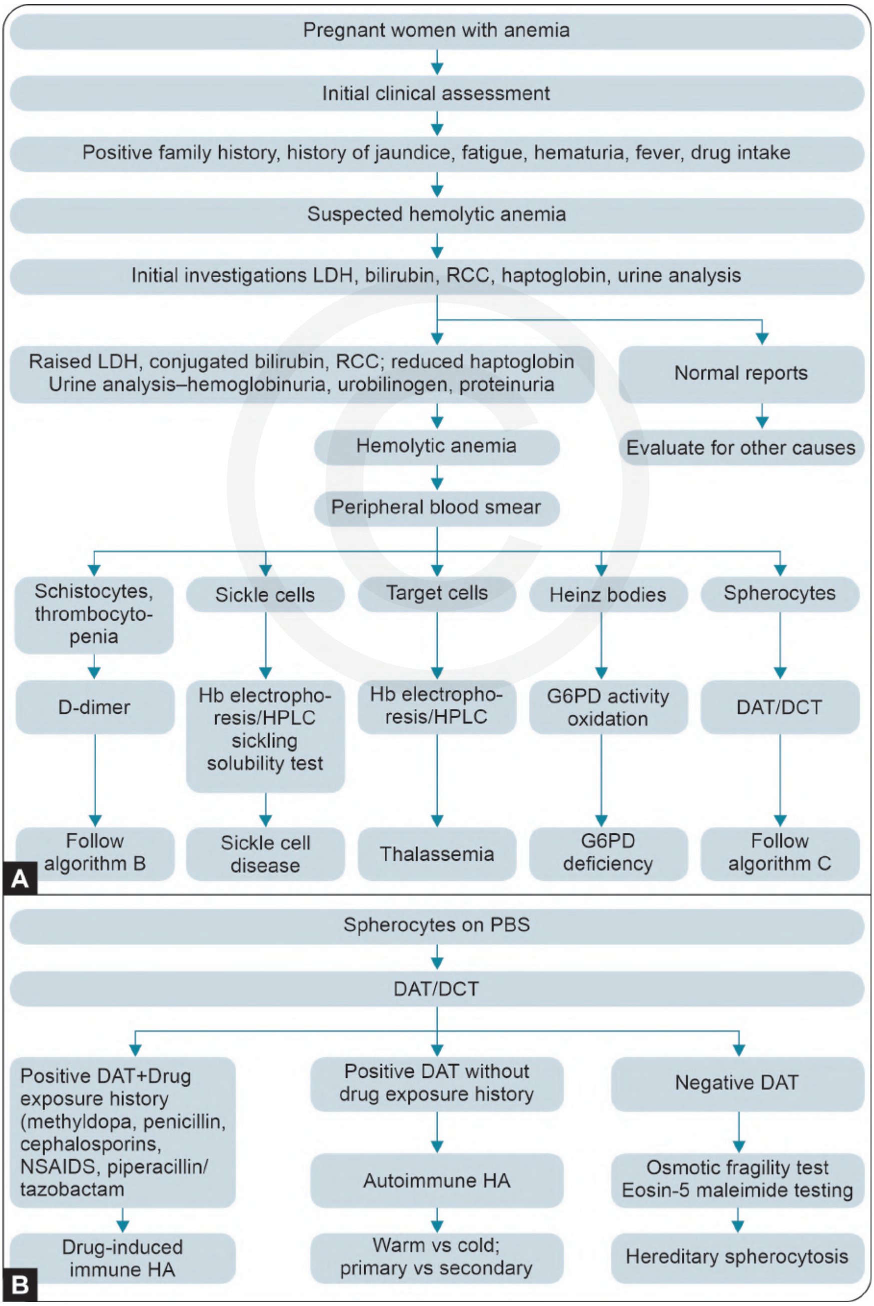
The next step includes a peripheral blood smear to identify different RBC abnormalities, which will direct further investigations to confirm the diagnosis. The tests include liver function test (LFT), D-dimer, HPLC, G6PD activity, stool culture, tests to detect various infections, Shiga toxin, and ADAMTS 13 activity. Positive direct antiglobulin (Coomb) test (DAT/DCT) will help in diagnosing autoimmune hemolytic anemia (AIHA); if positive with IgG, C3d or both, it refers to warm agglutinin disease; and if in presence of IgM antibodies, DAT is positive only with C3d, it refers to cold agglutinin disease.

In G6PD deficiency, ferric iron (Fe^{3+}) is not reduced to ferrous form (Fe^{2+}), leading to methemoglobinemia and the formation of Heinz bodies due to ferric haemoglobin multimers. Depending upon the results, various types of haemolytic anemia will be diagnosed **(Fig. 2)**.

MICRO-ANGIOPATHIC HEMOLYTIC ANEMIA (MAHA)[7]

This is rare but a serious condition adversely affecting both the mother and the foetus, in which there is formation of microthrombi in the capillaries and blood vessels, which leads to non-immune intravascular haemolysis. MAHA is the key feature in a diverse group of clinical entities with thrombotic microangiopathies (TMAs), which will ultimately progress to end-organ damage. MAHA, AIHA, and PNH may exacerbate in pregnancy. In pregnancy, MAHA can be associated with hemolysis, elevated liver enzymes, and low platelet count (HELLP) syndrome, thrombotic thrombocytopenic purpura (TTP), and hemolytic uremic syndrome (HUS), which is complement-mediated.

Flowchart 2A and B: Clinical approach to a suspected case of pregnancy with hemolytic anemia (RCC, reticulocyte count; DAT, direct antiglobulin test; DCT, direct Coomb's test; PBS, peripheral blood smear; HA, hemolytic anemia; DIC, disseminated intravascular coagulation; MAHA, micro-angiopathic hemolytic anemia; TMA, thrombotic microangiopathies; HUS, haemolytic uremic syndrome; ADAMTS, a disintegrin and metalloprotease with a thrombospondin type I motif, member 13; TTP, thrombotic thrombocytopenic purpura; LFT, liver function test; HELLP, hemolysis elevated liver enzymes low platelet count)



In *TTP*, the activity of the ADAMTS13 enzyme, responsible for cleavage of Von-Willebrand factor aggregations, is reduced, leading to microthrombi formation.[8] Apart from MAHA, the characteristic features include fever, thrombocytopenia, renal injury, and neurological dysfunction. Since the laboratory diagnosis via reduced ADAMTS13 enzyme activity takes time, considering the severity of the situation and to initiate timely treatment, the PLASMIC score (platelets, lysis, active cancer, stem cell or solid organ transplant, MCV, INR, and creatinine score) is recommended to predict the enzyme activity and assess the likelihood of TTP **(Table 2)**.[9,10]

HUS can be either typical HUS (90% cases) caused by Shiga toxin–producing Escherichia coli (STEC-HUS) or atypical HUS caused by complement dysregulation (CM-HUS); generally, CM-HUS arises in pregnancy/postpartum. Apart from MAHA, the characteristic features of HUS include thrombocytopenia, renal injury, and neurological dysfunction. Classic prodrome of abdominal pain and diarrhoea precedes MAHA by 5–10 days in typical HUS, which is absent in atypical HUS.

HELLP syndrome is associated with deranged liver function tests, which differentiates it from TTP and HUS. Since among the thrombotic microangiopathies (TMAs), liver function tests are more deranged in HELLP syndrome and hemolysis is more in other TMAs, lactate dehydrogenase–to–aspartate transaminase ratio helps in diagnosis as the ratio will be low in HELLP.

Disseminated intravascular coagulation (DIC) can be diagnosed by positive D-dimer test results, decreased fibrinogen levels, and prolonged coagulation studies.

Infections, viral, bacterial, and parasitic, can lead to haemolytic anemia. The important viruses responsible include Plasmodium falciparum, CMV, parvovirus B19, HIV, HBV, EBV; the important bacterial cause includes *Clostridium perfringens*; and parasitic infections include helminths, schistosomiasis, and rickettsial disease.

Table 2 PLASMIC score for predicting ADAMTS13 enzyme activity

Parameter	***PLASMIC score***	***Interpretation***
Platelet count <30 × 10^3 per µL (30 × 10^9/L)	1	0–4: Low risk (4.3%) 5–6: Intermediate risk (56.8%) 7: High risk (96.2%) *Low ADAMTS13 enzyme activity is defined as ≤10%*
Hemolysis	1	
No cancer history	1	
No transplantation history	1	
Mean corpuscular volume <90 µm^3 (90 fL)	1	
Creatinine <2.0 mg per dL (177 µmol/L)	1	
International normalized ratio <1.5	1	

Drug-induced hemolytic anemia can be immune-mediated, or due to thrombotic microangiopathies (TMA), or occur via oxidative lysis. Dapsone, nitrofurantoin, primaquin, rifampin can cause haemolytic anemia via oxidative lysis; nitrofurantoin, primaquin, sulphonylurea, pyridium, metronidazole, tacrolimus, trimethoprim/sulfamethoxazole can cause haemolytic anemia via thrombotic microangiopathies; methyldopa, cephalosporins, NSAIDS, penicillin, piperacillin/tazobactum can cause immune-mediated hemolytic anemia.

CLINICAL FEATURES[2,5,6,12]

The incidence of *pre-eclampsia/HELLP* is 1,000 per lac pregnancies; it occurs beyond 20 weeks of gestation, most commonly in the third trimester between 27–37 weeks (70%) and in the immediate postpartum period (30%). Blood pressure is raised ≥140/90, and in severe cases it is ≥160/110. The patient may develop right quadrant pain due to liver involvement, and neurological symptoms like seizures, posterior reversible encephalopathy (PRES) syndrome, and stroke. It is associated with the classic triad—moderate MAHA and thrombocytopenia, along with markedly deranged LFT. The KFT are mildly deranged.

Thrombotic thrombocytopenic purpura (TTP) is a rare form of hemolytic anemia with an incidence of 1 per 1,000 pregnancies; it may be congenital/hereditary (cTTP) or acquired/immune-mediated (iTTP), the former being more common in pregnancy. cTTP may occur at any time during pregnancy, being most common at term and in the postpartum period, while iTTP occurs before 24 weeks. Blood pressure remains normal. Patient may develop classic pentad in 50% cases—severe neurological symptoms like seizures, and stroke in 30% cases, severe MAHA, thrombocytopenia, renal failure, and fever. There are mildly deranged LFTs.

CM-HUS is a rare form of hemolytic anemia in pregnancy; it may occur at any time during pregnancy, most commonly in the postpartum period. Blood pressure remains high, but there are no neurological symptoms. It is associated with the classic triad of moderate MAHA and thrombocytopenia, along with severely deranged KFT. The LFTs are normal.

COMPLICATIONS IN PREGNANCY[2,5,6,12]

Due to their rare prevalence, the full spectrum of disease complications remains ill-defined.

Maternal complications: MAHA, AIHA, and PNH may exacerbate in pregnancy, predisposing the mother to increased risk of HELLP, pre-eclampsia, and preterm delivery; life-threatening thrombosis, jaundice, heart failure, renal failure, seizures, neurological complications, infections, antepartum hemorrhage (APH), and postpartum hemorrhage (PPH). A patient with AIHA presents with symptoms generally in the third trimester, recovers post-delivery, and recurs in subsequent pregnancies. Compared to primary AHA of pregnancy, obstetrical outcomes are less favourable in secondary AIHA.

Fetal complications: Hemolytic anemia increases the risk of fetal anemia, hydrops fetalis, fetal growth restriction (FGR), and intrauterine death (IUD).

TREATMENT (TABLE 3)[1,2,11,12]

Pregnancy with rare acquired hemolytic anemia should always be considered high risk. Preconception counselling is of utmost importance in hereditary anemia and immune-mediated hemolytic anemia, focusing on potential fetomaternal risks; if missed, counselling may be done during pregnancy. Once the diagnosis of acquired hemolytic anemia is made, treatment has to be initiated promptly, addressing the cause identified and associated potential complications, and providing supportive care. Supportive care includes maintaining vitals, SPO_2, and hydration. In case of severe anemia or impending heart failure, blood transfusion should be given, with plasma exchange reserved for severe cases. Due to the concerns related to cross-matching, careful monitoring is warranted to address transfusion reactions at the earliest.

High-dose folic acid, 5 mg, is recommended to prevent megaloblastic anemia. Glucocorticoids are the first-line treatment for warm autoimmune hemolytic anemia (prednisone given in the dose of 1.0–1.5 mg/kg/day); the response appears

Table 3 Management of acquired hemolytic anemia

Acquired hemolytic anemia	***Management***
Micro-angiopathic hemolytic anemia (MAHA)	
Thrombotic thrombocytopenic purpura (TTP)	Immediate glucocorticoids (prednisolone), immunosuppression (rituximab), plasma exchange, cryoprecipitates, and fresh frozen plasma infusion
Hemolytic uremic syndrome (HUS)	STEC-HUS—supportive care, avoid antibiotics in STEC-EC diarrhea as it may increase HUS risk, strict evaluation of renal function tests; CM-HUS-anti—complement therapy (eculizumab, complement C5 inhibitor)
HELLP syndrome	Glucocorticoids, termination of pregnancy
Infections-related	Infection-specific treatment, avoidance, and splenectomy
Drug induced	Drug withdrawal, supportive care
Non-micro-angiopathic hemolytic anemia (non-MAHA)	
Autoimmune	Corticosteroids, avoid triggers, supportive measures, treatment of underlying diseases Prednisone is given at the initial dose of 1.0–1.5 mg/kg/day
Alloimmune (acute transfusion reaction)	Supportive care, stop blood transfusion

in two weeks in about 80% cases. After stabilization of haemoglobin, gradually taper prednisone.

The management in TTP should be prompt and include daily plasma exchange that eliminates autoantibodies and supplies ADAMTS13. Cryoprecipitates and fresh frozen plasma may also benefit the patient. Corticosteroids are given to suppress antibody formation. For immunosuppression, rituximab, a monoclonal antibody targeting CD20, is recommended; caplacizumab, an anti-vWF that attacks the A1 domain of vWF, may also be used. There is delayed improvement in the postpartum period.

The management in CM-HUS includes anti-complement therapy—Eculizumab, a complement C5 inhibitor, though it is still in the experimental phase.Trimethoprim/sulfamethoxazole and lactams have both been associated with an increased risk of HUS, hence need to be avoided. Fosfomycin and macrolides suppress the production of toxins and may reduce the risk of HUS.

We need to monitor CBC, LFT, KFT, LDH, PBS, and urine examination at regular intervals. Fetal surveillance includes serial ultrasounds with color dopplers from 20 weeks, done at 4-week intervals.

The definitive management for HELLP is termination of pregnancy with improvement in 24–36 hours postpartum. Vaginal delivery is preferred over caesarean. During delivery, a strict watch for heart rate, and for PPH is recommended. Blood and components are to be kept arranged.

Conclusion

Acquired HA in pregnancy is associated with fetomaternal adverse outcomes. The clinical approach begins with a high index of suspicion, followed by assessment for hemolysis; step-by-step evaluation to reach a definitive underlying cause, and finally initiating the treatment at the earliest. Management includes addressing the cause identified and associated potential complications, and providing supportive care in the form of oxygen, transfusion, and maintaining hydration.

References

1. ACOG. ACOG Practice bulletin No 233. Anemia in Pregnancy. Obstetrics and Gynecology. 2021; 138(2): e55-e64.
2. Loriamini M, Cserti-Gazdewich C, Branch DR. Autoimmune Hemolytic Anemias: Classifications, Pathophysiology, Diagnoses and Management. Int J Mol Sci. 2024;25(8):4296.
3. Garratty G. Immune haemolytic anaemia associated with negative routine serology. Sem Haematol. 2005;42:156–64.
4. Sokol RJ, Hewitt S, Stamps BK. Erythrocyte autoantibodies, autoimmune hemolysis and pregnancy. 1982;43(4):169–76.

5. Maroto A, Martinez-Diago C, Tio G, et al. Autoimmune hemolytic anemia in pregnancy: a challenge for maternal and fetal follow-up. J Matern Fetal Neonatal Med. 2020;25:1-3.
6. Taher AT, Iolascon A, Matar CF, et al. Recommendations for Pregnancy in Rare Inherited Anemias. Hemasphere. 2020;4(4):e446.
7. Agarwal AM, Rets A. Laboratory approach to investigation of anemia in pregnancy. Int J Lab Hematol. 2021;43 Suppl 1:65-70.
8. Sanchez-Luceros A, Farias CE, Amaral MM, et al. von Willebrand factor-cleaving protease (ADAMTS13) activity in normal non-pregnant women, pregnant and post-delivery women. Thromb Haemost. 2004;92(6):1320-6
9. Bendapudi PK, Hurwitz S, Fry A, et al. Derivation and external validation of the PLASMIC score for rapid assessment of adults with thrombotic microangiopathies:a cohort study. Lancet Haematol. 2017;4(4):e157-64
10. Kim CH, Simmons SC, Williams LA III, et al. ADAMTS13 test and/or PLASMIC clinical score in management of acquired thrombotic thrombocytopenic purpura: a cost-effective analysis. Transfusion. 2017;57(11):2609-18.
11. Pande A, Kumar A, Krishnani H, et al. Recent Advances in the Management of Microangiopathic Hemolytic Anemias (MAHA): A Narrative Review. Cureus. 2023;15(10): e47196.
12. Neave L, Scully M, Microangiopathic Hemolytic Anemia in Pregnancy, Transfus Med Rev (2018);32(4):230-6

Chapter 10

Postpartum Anemia: A Neglected Component of Maternal Health

Vidhi Chaudhary, Pikee Saxena

INTRODUCTION

Postpartum anemia (PPA) is a widespread global issue affecting 50–80% of women after childbirth. It is primarily attributed to blood loss during delivery, which typically ranges around 300 mL, but can involve significant hemorrhage (>500 mL) in 5–6% of cases, or insufficient iron intake throughout pregnancy and postpartum.[1]

PREVALENCE

The prevalence of PPA is especially high in developing nations, impacting up to 80% of women, while in developed countries it affects up to 50%. In healthy women who delivered normally and received iron supplementation, the prevalence of anemia (hemoglobin <110 g/L) one week postpartum is reported at 14%, compared to 24% in non-supplemented women. India faces a particularly severe burden of anemia, with approximately 60% of pregnant women affected, contributing to 20–40% of maternal deaths, with about three-quarters of anemia-related maternal deaths in South Asia occurring in India. Further studies highlight that anemia is even more prevalent among postpartum women (63%) than pregnant women (59%) and non-pregnant non-lactating women (53%).[2] Postpartum anemia (PPA) is common in women after childbirth and affects about 50–80% of all women worldwide.[3] This is often caused by blood loss during delivery or inadequate iron intake during pregnancy and postpartum. Normal peripartum blood losses are approximately 300 ml, but hemorrhage >500 mL occurs in 5-6% of the women.[4]

DEFINITION

The WHO defines PPA as a Hb value defined as <11 g/dL at 1week postpartum and <12 g/dL at 8weeks postpartum. If the Hb value is <7 g/dL, PPA should be considered severe.[3] Grading of PPA severity as mild, moderate, and severe with Hb levels of 10–10.9, 7–9.9, and below 7 g/dL, respectively, has been proposed by FOGSI Consensus Recommendations on postpartum anemia.[5]

ETIOLOGY

The postnatal period is a crucial time for both mothers and newborn babies. The primary contributors to postpartum anemia (PPA) are iron deficiency anemia (IDA) before delivery and severe obstetric hemorrhage. Other less common causes of anemia include folate and vitamin B12 deficiencies, as well as inflammatory or infectious disorders. Moreover, iron deficiency anemia during pregnancy can exacerbate its effects in the postpartum period, leading to a prolonged recovery time.[6]

PATHOGENESIS

Anemia, marked by low hemoglobin (Hb) levels, compromises the blood's capacity to transport oxygen, hindering the body's ability to meet physiological needs. In the postpartum period, this deficiency significantly affects both the physical and mental health of the mother.[3]

EFFECTS ON MOTHER[5,7,8]

Postpartum anemia (PPA) can lead to a range of adverse outcomes for mothers, significantly impacting their physical and mental well-being.

Physical Consequences

- *Easy fatigability and lower work performance:* Women with PPA may experience persistent tiredness and reduced energy levels, making it difficult to carry out daily tasks and impacting their overall productivity.
- *Palpitations and breathlessness:* The body's efforts to compensate for low oxygen-carrying capacity can lead to an increased heart rate and shortness of breath, particularly with physical exertion.
- *Higher chances of infections and venous thromboembolism:* Anemia can weaken the immune system, increasing susceptibility to infections, and may also elevate the risk of blood clot formation.

Mental and Emotional Consequences

- *Emotional instability and decline in cognitive abilities:* PPA has been linked to mood swings, irritability, difficulty concentrating, and impaired memory, impacting mental clarity and emotional regulation.
- *Postpartum depression (PPD):* Studies have consistently shown a strong association between PPA and an increased risk of developing PPD. A recent meta-analysis by Moya et al. (2022) revealed that women with postpartum iron deficiency or anemia were 1.66 times more likely to experience symptoms of depression compared to non-anemic or iron-replete women. Furthermore, studies have demonstrated that intravenous (IV) iron therapy can significantly reduce depression scores in women with PPA compared to oral iron or placebo, according to a 2022 meta-analysis.[7,8]

Impact On Mother-child Interaction and Infant Development

- *Poor interaction between mother and child:* PPA can negatively affect a mother's energy levels and emotional state, leading to difficulties in bonding and responding to her infant's needs.
- *Delay in developmental milestones in infants:* Maternal anemia can have adverse effects on the infant's development, potentially leading to delays in cognitive, motor, and social-emotional skills.

Exacerbation in Disadvantaged Populations

It's important to note that these adverse outcomes tend to be more pronounced in women from disadvantaged communities and developing countries, highlighting the need for improved access to care.

PREVENTION[3,6]

- Antenatal optimization of Iron deficiency anemia with iron supplementation. Securing an adequate iron status during pregnancy is the first step to preventing PPA.
- Good nutrition with high high-protein diet and iron-rich foods
- Deworming
- Estimation of hemoglobin levels—Universal hemoglobin (Hb) screening should be conducted within 24–48 hours of delivery, prior to discharge, for all postpartum women (PPW) as recommended by guidelines like those from the Network for the Advancement of Patient Blood Management, Hemostasis and Thrombosis (NATA) and the Federation of Obstetric and Gynaecological Societies of India (FOGSI).

This initial screening, ideally performed alongside a complete blood count (CBC) to include hemoglobin, mean corpuscular hemoglobin, mean corpuscular volume, and mean corpuscular hemoglobin concentration, offers a simple, economical, and quick method for early prediction of iron deficiency anemia (IDA). Given the inflammatory response associated with childbirth, which can elevate serum ferritin levels, experts advise against measuring serum ferritin in the first 6 weeks postpartum to avoid false elevations. A repeat Hb estimation should be performed at 6 weeks post-delivery. All detected low hemoglobin levels must be aggressively corrected.[9,10]

TREATMENT

Oral Therapy

The NATA Network recommends 80–100 mg elemental iron daily for 3 months in women with mild to moderate PPA (Hb 9.0–11.0 g/dL) who are hemodynamically stable, asymptomatic, or mildly symptomatic. In case of oral iron treatment, Hb concentration should be determined after 2–4 weeks in order to evaluate the efficacy of the treatment. For severe PPA, intolerance to oral iron or failed oral iron treatment, IV Iron is considered.[10]

Parenteral Therapy

Recent guidelines have advocated the superiority of parenteral preparations over oral iron preparations due to poor patient compliance, intolerability, insufficient treatment response, and long duration of treatment associated with the latter.[11] In addition, IV injections are preferred over intramuscular injections as these preparations are associated with pain, chances of permanent skin staining, and the occurrence of gluteal sterile abscesses. Absorption of iron following IM therapy is slow and variable, and multiple injections are required to achieve a therapeutic result. Though it has similar side effects and safety profile as that of intravenous injections, the enumerated disadvantages preclude its usage as a first choice to treat PPA in PPW.[12]

A meta-analysis by Sultan et al., compared oral and IV iron therapy and reported that IV therapy is associated with raised Hb levels at 1, 2, and 3 weeks, and higher serum ferritin levels at 1, 2, 4, and 6 weeks in the postpartum period. At 6 weeks, the rise in Hb level was around 1 g/dL more with the IV compared to the oral. Simultaneously, the adverse events such as dyspepsia and constipation were significantly less with the IV therapy. Therefore, IV iron is a superior choice for postpartum anemia.[13]

Iron Sucrose or Ferric Carboxymaltose (FCM)

The Anemia Mukt Bharat Programme (AMB), a crucial initiative by the Government of India, recognizes the importance of effective and timely treatment for anemia, especially in vulnerable populations like pregnant women and postpartum women. It recommends ferric carboxymaltose (FCM) or iron sucrose (IS) as the first choice for pregnant women diagnosed with anemia in late pregnancy or those with low compliance.[11]

However, recent consensus recommendations from the Federation of Obstetric and Gynaecological Societies of India (FOGSI) advocate the superiority of ferric carboxymaltose (FCM). They emphasize that all postpartum women should be discharged with a single dose of FCM after an informed decision, as the entire required dose can be administered in one visit, reducing the need for frequent visits and fostering better compliance and clinical outcomes. FCM has demonstrated a superior and sustained effect on hemoglobin (Hb) levels compared to iron sucrose (IS), showing an improvement of ≥1 g/dL within a week that is maintained for at least 6 weeks. Furthermore, FCM does not necessitate a test dose, unlike iron sucrose. Moreover, FCM infusions are reportedly more economical than IS infusions, leading to 30–44% savings per patient per treatment cycle.[5,14]

Recognizing that postpartum women (PPW) in India are usually discharged 48 hours post-delivery, administering a single dose of FCM within 24–48 hours postpartum presents a significant logistical advantage for treating PPA. This strategy minimizes follow-up appointments, making it more convenient for both patients and healthcare facilities. Oral iron therapy is not required during or following FCM administration.

DETERMINATION OF IRON NEED

Hemoglobin level (g/dL)	***Patient body weight***		
	<35 kg	***35–70 kg***	***≥70 kg***
<10	500 mg	1,500 mg	2,000 mg
10–14	500 mg	1,000 mg	1,000 mg

FCM Dosage

1 mL of solution of ferric carboxymaltose contains 50 mg of iron.

Calculation and Maximal Individual Iron Dose

A single administration should not exceed:
- Undiluted—15 mg iron/kg body weight (for administration by IV injection) or
- Diluted—20 mg iron/kg body weight (for administration by IV infusion; FCM must only be diluted with sterile 0.9% m/V sodium chloride solution)
  Both should not exceed 1,000 mg per single administration per week.

Conclusion

Postpartum anemia, a common condition linked to various comorbidities impacting the mother's physical and mental health, can be effectively treated with iron therapy. Therefore, it is crucial to prioritize the management of iron deficiency anemia in women after delivery. Universal Hb screening should be performed within 24–48 hours of delivery, prior to discharge. Injection FCM is superior to oral and other IV iron therapies, and all patients with anemia should be discharged with a single dose of FCM after the informed decision.

References

1. Moya E, Phiri N, Choko AT, et al. Effect of postpartum anaemia on maternal health-related quality of life: a systematic review and meta-analysis. BMC Public Health 2022;22:364.
2. Ministry of Health and Family Welfare. National Iron+ Initiative: Guidelines for Control of Iron Deficiency Anaemia. Adolescent Division. Adolescent Division, Ministry of Health and Family Welfare, Government of India, New Delhi; 2013. Available at: http://www.nhm.gov.in/images/pdf/programmes/child-health/guidelines/Control-ofIron-Deficiency-Anaemia.pdf. Accessed on: 4 August 2025

3. Neef V, Choorapoikayil S, Hof L, et al. Current concepts in postpartum anemia management. Curr Opin Anaesthesiol. 2024;37(3):234-8.
4. Milman N. Postpartum anemia I: definition, prevalence, causes, and consequences. Ann Hematol. 2011;90(11):1247-53.
5. Sekaran SK, Mukherjee B, Sharma JB, et al. Federation of Obstetric and Gynecological Societies of IndiaConsensus Recommendations for the Management of Postpartum Anemia with Specific Reference to Usage of Ferric Carboxymaltose. J South Asian Feder Obst Gynae 2024;16(Suppl 1): S43-9.
6. Kofie P, Tarkang EE, Manu E, et al. Prevalence and associated risk factors of anaemia among women attending antenatal and postnatal clinics at a public health facility in Ghana. BMC Nutr 2019;5:40.
7. Selvaraj R, Ramakrishnan J, Sahu SK, et al. High prevalence of anemia among postnatal mothers in urban Puducherry: A community-based study. J Family Med Prim Care 2019;8(8):2703-7.
8. Wemakor A, Ziyaaba A, Yiripuo F. Risk factors of anaemia among postpartum women in Bolgatanga Municipality, Ghana. BMC Nutr 2022;8(1):58
9. Mintsopoulos V, Tannenbaum E, Malinowski AK, et al. Identification and treatment of iron-deficiency anemia in pregnancy and postpartum: A systematic review and quality appraisal of guidelines using AGREE II. Int J Gynaecol Obstet. 2024;164(2):460-75.
10. Muñoz M, Peña–Rosas JP, Robinson S, et al. Patient blood management in obstetrics: Management of anaemia and haematinic deficiencies in pregnancy and in the postpartum period: NATA consensus statement. Transfus Med 2018;28(1):22–39.
11. Anemia Mukt Bharat. Anemia management protocol for pregnant women. Available from: https://anemiamuktbharat.info/home/ interventions/.
12. Api O, Breyman C, Çetiner M, et al. Diagnosis and treatment of iron deficiency anemia during pregnancy and the postpartum period: Iron deficiency anemia working group consensus report. Turk J Obstet Gynecol 2015;12(3):173–81.
13. Sultan P, Bampoe S, Shah R, et al. Oral vs intravenous iron therapy for postpartum anemia: A systematic review and meta-analysis. Am J Obstet Gynecol 2019;221(1):19.e3–29.e3.
14. Sharma N, Thiek JL, Natung T. Comparative study of efficacy and safety of ferric carboxymaltose versus iron sucrose in postpartum anaemia. J Obstet Gynecol India 2017;67(4):253–7.

Chapter 11

Postpartum Hemorrhage: Current Global Trends and Indian Context

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INTRODUCTION

Current Global Trends in Postpartum Hemorrhage

Postpartum hemorrhage (PPH) continues to be a major cause of maternal mortality and morbidity worldwide, particularly in low- and middle-income countries (LMICs). Rearranged maternal care systems, global health investments, and improvements in clinical practice have reshaped PPH trends in recent years.

INCIDENCE AND GEOGRAPHIC VARIATION

Postpartum hemorrhage (PPH) remains the leading cause of maternal mortality globally and continues to be a major contributor to maternal deaths in low- and middle-income countries (LMICs), including India. It is defined as blood loss of ≥500 mL following vaginal delivery or ≥1,000 mL after cesarean section within the first 24 hours, and can rapidly escalate into a life-threatening emergency.[1] Severe PPH, particularly in settings with limited access to skilled care, remains a critical driver of maternal morbidity and mortality.

Globally, PPH affects approximately 6–10% of all deliveries and accounts for nearly a quarter of maternal deaths;[2] with 2–3% classified as severe, involving blood loss ≥1,000 mL.[1,3] A landmark systematic review highlights significant regional disparities: Africa reports the highest prevalence (27.5%), followed by intermediate rates in Europe and North America (~13%), and the lowest in Oceania (7.2%).[1,4] The global average for severe PPH is around 2.8%, with the highest burden observed in Sub-Saharan Africa (5.1%).[1,4] These variations are attributed to differences in obstetric risk factors, diagnostic thresholds, and access to timely interventions.

In India, despite notable improvements in maternal healthcare infrastructure, PPH remains responsible for an estimated 12,000 maternal deaths annually, accounting for nearly 20% of all maternal fatalities.[5] Contributing factors include delays in recognition, limited access to timely treatment, and systemic inadequacies in emergency obstetric care. Although the country has achieved a decline in its maternal mortality ratio to 103 per 100,000 live births (2017–2019), hemorrhage—alongside hypertensive disorders and sepsis—continues to be the leading cause of maternal death, particularly in rural and underserved regions.[4]

This chapter contextualises current international guidelines within the Indian healthcare setting, with a focus on scalable, resource-sensitive strategies and innovations.

National Incidence and Reporting

Hospital-based studies in India report PPH incidences of 3–6%, while multicenter data suggest rates as high as 7–27%.[6,7] Significant oversight exists in peripheral facilities and home births, where underestimation of blood loss results in delayed management along with poor documentation, which clouds the actual incidence figures.

MORTALITY BURDEN

An estimated 14 million PPH cases occur annually, equating to one maternal death approximately every 4 minutes.[2] It remains one of the leading contributors to global maternal mortality, accounting for 25–52% of all maternal deaths in LMICs.[6] While high-income countries have seen PPH-related maternal deaths decline dramatically—now estimated at 1 per 100,000 deliveries—low-income nations still experience rates as high as 1 per 1,000 deliveries.[2] It is notable that current maternal mortality estimates may underestimate the true burden due to underdiagnosis and reporting gaps.[2]

EVOLVING CAUSES AND RISK FACTORS

The aetiology of PPH can primarily be classified into four T's: Tone—uterine atony remains the primary cause of PPH worldwide (70%), followed by Trauma (20%), retained placental Tissue (10%), and coagulopathy or Thrombosis (<1%).[8] At the same time, several key demographic and clinical risk factors for an increase in PPH prevalence have been identified:

- Rising maternal age and obesity.[9]
- Cesarean deliveries, labor induction/augmentation, and multiple gestations.[8]
- Additionally, challenges with dosing and uterotonic fatigue—such as uterine desensitization due to prolonged oxytocin infusions—have been observed to increase atony-related bleeding.[8]
- A hospital-based study in Oslo reported a doubling in the incidence of severe PPH (from 17.1 to 34.2 per 1,000 deliveries) between 2008 and 2017, along with increased transfusion rates. The authors attributed this trend partly to improved recognition and early intervention, rather than worsened outcomes.[10] This suggests refined diagnostic awareness, rather than purely worsened clinical burden.

The "Four Ts" paradigm holds true for India also:

- Uterine atony (~65–70%) is the most frequent cause.
- Trauma and retained tissue contribute ~30%, including high rates of genital tract lacerations and retained placenta.[3,7]
- Coagulopathies, while less common, escalate severity, especially in anemic or preeclamptic women.[7]

MATERNAL AND OBSTETRIC CONTRIBUTORS FOR PPH IN INDIA

- *Anemia is a critical risk enhancer:* With the high prevalence of moderate/severe anemia amongst reproductive age women in India, the incidence of PPH nearly doubles, with Hb <10 g/dL linked to 7–11% PPH incidence.[7]
- Other factors such as high parity, prolonged labor, macrosomia, sepsis, pre-eclampsia, and rising C-sections—all contribute to elevated risk.[4]

IMPORTANT INTERVENTIONS TO REDUCE MATERNAL MORBIDITY/MORTALITY DUE TO PPH

Assessment of Blood Loss

Visual assessment of blood loss leads to underestimation; hence, quantitative methods such as blood collection drapes for vaginal deliveries, weighing of soaked swabs, active periodic estimation, and a written and pictorial guide to aid visual estimation in labor wards may improve the accuracy of the estimation of blood loss.[11]

Shifts in Management Practices (Fig. 1)

Uterotonics and Tranexamic Acid

- Active Management of the Third Stage of Labor (AMTSL) is recognized as an important step for the prevention of PPH.
- Oxytocin remains the first-line uterotonic therapy for low-resource settings.[12]
- WHO endorses carbetocin as comparable to oxytocin and advantageous where cold chains are inconsistent.[13]
- Misoprostol plays a vital role in both the prevention and management of PPH. It does not require temperature storage and can be self-administered.[14]
- Tranexamic acid (TXA) has emerged as a lifesaver: large randomized trials and implementation data support 1 g IV within 3 hours postpartum, reducing bleeding-related mortality by ~20% (13). Usage of TXA in obstetric bleeding increased sharply in the US after 2017, from rare implementation to nearly 1% of deliveries.[13] However, most TXA administration still occurs after cesarean sections and in higher-resource centers.[14]

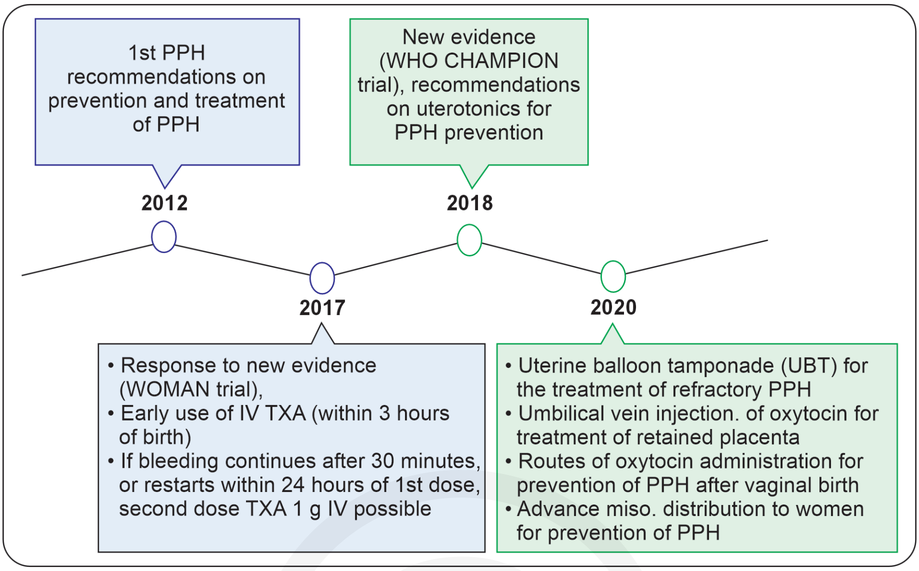


Fig. 1: WHO recommendations on PPH[15]

Mechanical Devices

- Uterine balloon tamponade (UBT), including the Bakri balloon and low-cost condom-catheter variants, has gained traction as an effective second-line intervention with success rates of 80–90%. WHO and FIGO strongly recommend UBT for refractory atonic hemorrhage.[15,16]
- Non-pneumatic anti-shock garments (NASG) reduce mortality, shock duration, and surgical need, particularly in transport-delayed or low-resource settings.[17]

Surgical and Radiological Interventions

- Surgical techniques—B-Lynch compression suture, uterine or internal iliac artery ligation, aortic compression, and hysterectomy are crucial in refractory cases.
- Uterine artery embolization is increasingly used where interventional radiology infrastructure exists, showing strong efficacy in fertility preservation.
- Compression sutures, artery ligation, hysterectomy, and embolization remain critical for refractory PPH.[7]

SYSTEMS STRENGTHENING AND CARE BUNDLES

Global momentum toward standardized PPH protocols continues. WHO, FIGO, and national bodies have endorsed "PPH care bundles," which emphasize:

- Universal uterotonic prophylaxis
- Immediate TXA
- Early mechanical tamponade
- Prompt escalation to surgical options.[15,16]

Implementation of such bundles in regions including South Asia and Sub-Saharan Africa has demonstrated reductions of up to 60% in severe PPH requiring transfusion, hysterectomy, or ICU admission.[18]

The E-MOTIVE initiative **(Fig. 2)** is a multi-country, cluster-randomized trial led by the University of Birmingham in collaboration with the WHO, aiming to standardize and speed up the treatment of PPH in low-resource hospitals located in Kenya, Nigeria, South Africa, and Tanzania. This intervention involves early detection of blood loss with a calibrated drip drape, coupled with an immediate "first-responder" bundle (uterine massage, oxytocics, tranexamic acid, IV fluids, and prompt escalation) supported by dedicated training, PPH kits, local champions, audits, and feedback, resulting in a 60% reduction in severe PPH during the trial.[18]

National Initiatives

India has made strides with LaQshya, DAKSHATA, JSY/JSSK to bolster infrastructure, referral systems, and labor-room quality.[3] However, PPH management packages—including UBT, TXA, and NASG—are still underutilized at peripheral facilities.

Institutional Protocols and Training

Evidence supports implementation of AMTSL, PPH-response kits, and multidisciplinary drills, which lead to improved outcomes.[20]

mHealth and AI Supports

Projects like Kilkari engage more than 3 lakh users; pilot AI systems (e.g., CHAHAK) aim to improve PPH risk recognition and response.[21] Integration platforms can streamline early detection and referral systems.

Innovation, Research, and Future Directions

Rising trends spotlight India's growing engagement in PPH innovation:

- Heat-stable carbetocin budget-impact models underscore cost-effectiveness and adaptability.
- TXA introduction studies reveal health-economic viability, prompting policy calls.
- UBT and NASG deployment across district-level centres has gained momentum, with early evaluations demonstrating improved survival outcomes.
- AI-based oxytocin dosing regimes are under active investigation.

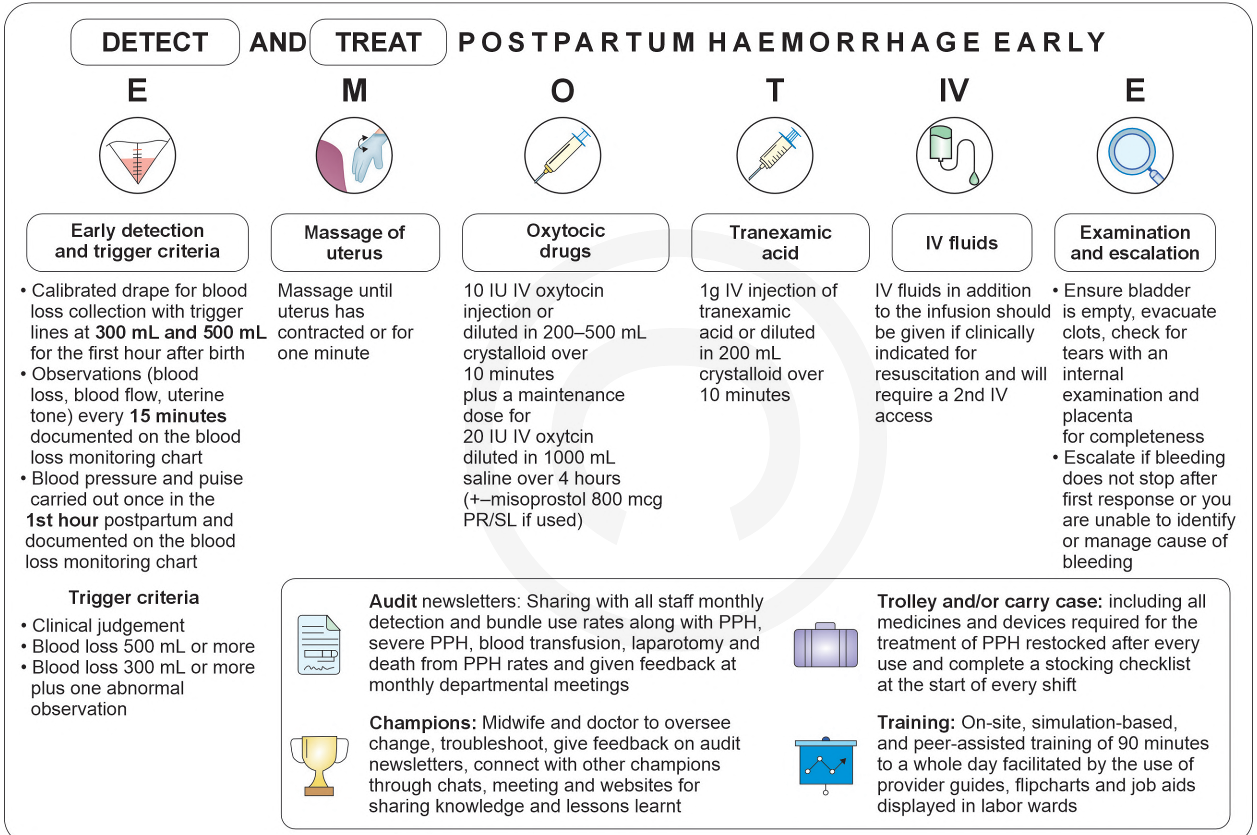


Fig. 2: E-MOTIVE Project[19]

Market Expansion

The medical device market for PPH continues to grow, reaching an estimated USD 808 million in 2023 and projected to exceed USD 1.2 billion by 2033.[21] UBT devices account for about 45% of this market, underlining their increasing global adoption.[21] Low-cost, widely deployable mechanical interventions now appear in over 60% of hospitals across diverse regions.[22] Furthermore, there are early trials of AI-driven oxytocin dosing and smart vital signs monitoring aimed at earlier hemorrhage detection.[23]

Challenges and Gaps

Despite advances, systemic issues remain:

- *PPH definitions lack standardization:* The commonly used ≥500 mL threshold is often decoupled from clinical severity signs, creating measurement and reporting inconsistencies.[1,4] WHO has recently initiated a global reappraisal of PPH definitions to refine clinical relevance and comparability.[1]
- *Access inequities:* The majority of PPH mortality burden remains concentrated in sub-Saharan Africa and South Asia (>80%), where barriers to skilled personnel, devices, uterotonic quality control, and blood products remain stark.[1,2,12]
- *R&D shortfalls:* Surprisingly few novel pharmacologic agents for PPH have emerged in the past two decades—underscored by the fact that only 29 new maternal health drugs/devices addressing PPH have entered the pipeline between 2000 and 2021.[12]
- *Training and implementation:* Successful clinical trials have yet to be uniformly translated into practice. Variations in clinician training, emergency planning, and local infrastructure hinder broad adoption.[12]

Conclusion

Recent global trends in PPH reflect both positive and negative signals. While incidence and recognition are rising—potentially due to better reporting and physiological shifts—mortality rates have declined in many high-resource settings. India has made significant strides in addressing PPH—including scaled access to uterotonics, care bundles, and high-impact tools like UBT and NASG. However, persistent hurdles remain:

- Anemia as a modifiable risk requiring systemic improvement
- Add TXA and heat-stable uterotonics to PPH kits at all frontline facilities
- Strengthen provider training, documentation, and drills in community centers
- Adopt mHealth and AI tools for early detection and triage

By integrating evidence-based medical interventions with systemic readiness and technological innovation, India can continue reducing PPH morbidity and mortality—thereby progressing toward SDG maternal health targets.

References

1. World Health Organization (2024). Second global call for data on postpartum haemorrhage. World Health Organization. Retrieved June 24, 2025.
2. Aimagambetova G, Bapayeva G, Sakhipova G, et al. Management of Postpartum Hemorrhage in Low- and Middle-Income Countries: Emergency Need for Updated Approach Due to Specific Circumstances, Resources, and Availabilities. J Clin Med. 2024;13(23):7387.
3. Bláha J, Bartošová T. Epidemiology and definition of PPH worldwide. Best Pract Res Clin Anaesthesiol. 2022;36(3-4):325-39.
4. Calvert C, Thomas SL, Ronsmans C, et al. Identifying regional variation in the prevalence of postpartum haemorrhage: a systematic review and meta-analysis. PLoS One. 2012;7(7):e41114.
5. Joshi BN, Shetty SS, Moray KV, et al. Cost-effectiveness and budget impact of adding tranexamic acid for management of post-partum hemorrhage in the Indian public health system. BMC Pregnancy Childbirth. 2023;23(1):9.
6. Say L, Chou D, Gemmill A, et al. Global causes of maternal death: a WHO systematic analysis. Lancet Glob Health. 2014;2(6):e323-33.
7. Shivappa Marabasannanavar S, Tankasali M, Nagaraj M. Study of causes and various modalities of management in postpartum hemorrhage at a tertiary care centre. Int J Reprod Contracept Obstet Gynecol. 2024;13(12):3702–6.
8. Anderson JM, Etches D. Prevention and management of postpartum hemorrhage. Am Fam Physician. 2007;75(6):875-82.
9. Yunas I, Islam MA, Sindhu KN, et al. Causes of and risk factors for postpartum haemorrhage: a systematic review and meta-analysis. Lancet. 2025;405(10488):1468-80.
10. Pettersen S, Falk RS, Vangen S, et al. Exploring trends of severe postpartum haemorrhage: a hospital-based study. BMC Pregnancy Childbirth. 2023;23(1):363.
11. British Committee for Standards in Haematology; Stainsby D, MacLennan S, Thomas D, et al. Guidelines on the management of massive blood loss. Br J Haematol. 2006;135(5):634-41.
12. Gallos ID, Williams HM, Price MJ, et al. Uterotonic agents for preventing postpartum haemorrhage: a network meta-analysis. Cochrane Database Syst Rev. 2018;4(4):CD011689.
13. Raghavan S, Abbas D, Winikoff B. Misoprostol for prevention and treatment of postpartum hemorrhage: what do we know? What is next? Int J Gynaecol Obstet. 2012;119 Suppl 1:S35-8.
14. Alsumadi M, Basha A, AlSumadi A, et al. Tranexamic Acid Use in Obstetric Hemorrhage: Knowledge and Attitude Among Jordanian Obstetricians and Gynecologists. Cureus. 2024;16(3):e57360.
15. World Health Organization (2012). "WHO recommendations for the prevention and treatment of postpartum haemorrhage" (PDF). World Health Organization. Retrieved June 24, 2024.
16. International Federation of Gynecology and Obstetrics (January 13, 2020). "Save Mothers, Stop PPH". FIGO. Retrieved June 24, 2024.
17. Miller S, Fathalla MM, Ojengbede OA, et al. Obstetric hemorrhage and shock management: using the low technology Non-pneumatic Anti-Shock Garment in Nigerian and Egyptian tertiary care facilities. BMC Pregnancy Childbirth. 2010;10:64.

18. Gallos I, Devall A, Martin J, et al. Randomized Trial of Early Detection and Treatment of Postpartum Hemorrhage. N Engl J Med. 2023;389(1):11-21.
19. World Health Organization (2023). Lifesaving solution dramatically reduces severe bleeding after childbirth. World Health Organization. Retrieved June 24, 2025.
20. McDougall ARA, Goldstein M, Tuttle A, et al. Innovations in the prevention and treatment of postpartum hemorrhage: Analysis of a novel medicines development pipeline database. Int J Gynaecol Obstet. 2022;158 Suppl 1(Suppl 1):31-9.
21. LeFevre A, Agarwal S, Chamberlain S, et al. Are stage-based health information messages effective and good value for money in improving maternal newborn and child health outcomes in India? Protocol for an individually randomized controlled trial. Trials. 2019;20(1):272.
22. Global Postpartum Hemorrhage Treatment Devices Market Size, Share, and Trends Analysis Report—Industry Overview and Forecast to 2032. Retrieved June 24, 2025.
23. Hu T, Chen JJ, Zhao X, et al . Research progress in intelligent control of intrapartum oxytocin (unrevised version). J Matern Fetal Neonatal Med. 2023;36(2):2230512.

Chapter 12

From Crisis to Control: Revolutionizing Postpartum Hemorrhage Care

Pikee Saxena, Alka Pandey

INTRODUCTION

Postpartum hemorrhage (PPH) continues to be one of the most critical challenges in maternal health care, contributing significantly to maternal mortality and morbidity worldwide. In low- and middle-income countries (LMICs), PPH is particularly devastating, contributing to over 30% of maternal deaths. In India alone, PPH is responsible for approximately 47% of maternal fatalities, particularly in rural regions with inadequate health infrastructure. Uterine atony, where the uterus fails to contract effectively after childbirth, is the most common cause, accounting for about 80% of PPH cases.

Despite global efforts to address this preventable cause of death, PPH remains a leading challenge due to delayed recognition, suboptimal management, and lack of access to timely and appropriate interventions. The situation is further complicated by social and systemic barriers such as transportation difficulties, limited blood storage facilities, and disparities in rural healthcare access. Strengthening emergency obstetric care (EmOC) systems remains a vital priority.[1,2]

Addressing PPH requires a multifaceted approach, including early detection, prompt management, and the availability of effective interventions. Enhancing training for healthcare providers, ensuring the availability of essential medications and devices, and strengthening healthcare infrastructure are vital steps toward reducing PPH-related maternal mortality.

DEFINITION AND DIAGNOSIS OF PPH

According to WHO guidelines, PPH is defined as blood loss exceeding 500 mL after vaginal delivery or more than 1,000 mL after a cesarean section. The American College of Obstetricians and Gynecologists (ACOG) further refines this definition to include cumulative blood loss ≥1,000 mL accompanied by signs or symptoms of hypovolemia, such as hypotension, tachycardia, and pallor, occurring within 24 hours postpartum. Uterine atony is the most common cause, responsible for 70–80% of PPH cases.

FIRST-LINE MANAGEMENT STRATEGIES

Active management of the third stage of labor (AMTSL) using uterotonics remains the cornerstone of prevention. Initial management of PPH[3-7] involves conservative, non-invasive techniques, often applied in sequence:

- *Uterotonics:* Medications like oxytocin, misoprostol, ergometrine, and carboprost are used to stimulate uterine contractions. Newer agents like carbetocin are increasingly recommended for their longer half-life and reduced need for cold-chain storage.
- *Uterine massage:* Helps in promoting uterine tone and is effective in an immediate response.
- *Bimanual compression:* Mechanical pressure applied manually to reduce blood flow and encourage uterine contraction.
- *Tranexamic acid:* Antifibrinolytic agent shown to reduce death due to bleeding if administered within three hours postpartum. WHO strongly recommends its inclusion in all PPH protocols.

These interventions are most effective when applied promptly.

SECOND-LINE INTERVENTIONS

If first-line measures fail, innovative second-line interventions before going for surgical options are discussed below.

Emerging/Innovative approaches[8-10]

Oxytocin in Uniject

Uniject system: A small **(Fig. 1)**, plastic, single-use, auto-disable injection system that comes *prefilled with 10 IU of oxytocin* (the standard prophylactic dose). *Developed by* PATH, in collaboration with WHO and pharmaceutical partners, to address the logistical barriers of oxytocin administration.

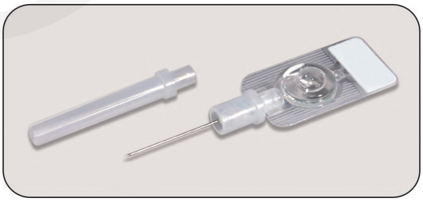


Fig. 1: Oxytocin in Uniject

Parameter	***Value***
Drug	Oxytocin (10 IU)
Delivery system	Uniject prefilled injection
Use	PPH prevention (third stage of labor)
Target settings	Home births, rural clinics, LMICs
Key benefit	Simplicity + safety + timely administration
WHO recommendation	Specially where injection-trained providers are limited

Packing Devices Revisited

Uterine packing with plain gauze was the earliest method of tamponade for postpartum hemorrhage, first described in the 19th century. While some early reports showed up to 100% success in controlling hemorrhage, concerns about infection and insufficient tamponade effectiveness led to its decline by the 1950s. However, with advancements in materials, there has been renewed interest in uterine packing, now showing comparable outcomes and complication rates to modern balloon tamponade.

Plain Gauze Sponges

Sterile cloth gauze is used for uterine packing in cases of atony and placental pathology, with a maximum use of 24 hours. It is low-cost and widely available. Limitations include risk of infection and inadequate tamponade.

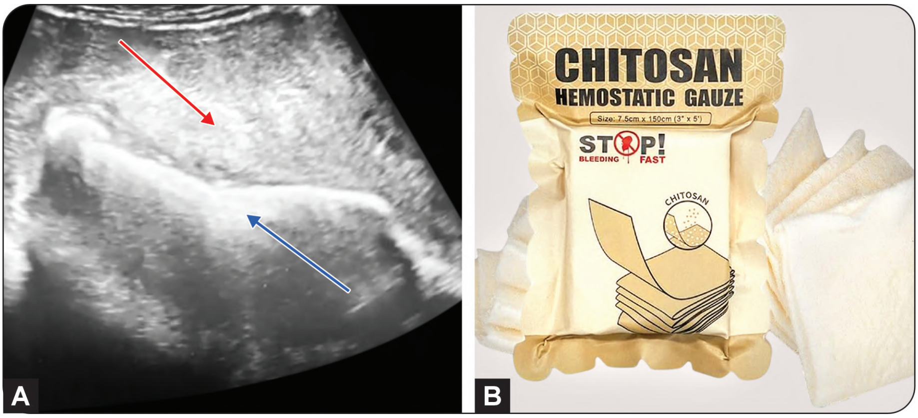
Chitosan-Covered Gauze (Fig. 2)

Chitosan-coated gauze is used for atony and placental pathology. It promotes hemostasis by forming a plug, effective even in hypothermia and without depending on clotting. The maximum indwelling time described is 48 hours.

Uterine balloon tamponade (UBT) devices are specially designed to control postpartum hemorrhage by exerting intrauterine pressure. They are sterile, easy to use, allow quick inflation, and often include drainage ports to monitor bleeding—offering safer and more effective management than improvised methods.

Bakri Balloon (Cook Medical) (Fig. 3A)

- The *bakri balloon* (Cook Medical) is a silicone balloon catheter with a central lumen, used for managing postpartum hemorrhage due to atony or placental



Figs. 2A and B: Chitosan-covered gauze depicted by the arrows

Fig. 3A and B: (A) Bakri balloon; (B) BT-Cath (Utah Medical)

issues. It holds up to 500 mL, is latex-free, has a drainage port, and allows rapid inflation. It can be used for up to 24 hours. Limitations include the possible need for vaginal packing and port protrusion. Contraindications include active bleeding needing surgery, infection, uterine anomaly, DIC, and ongoing pregnancy.

BT-Cath (Utah Medical) (Fig. 3B)

The device features a soft silicone balloon with an intrauterine drainage lumen, used for atony and placental pathology. It holds up to 500 mL and is used for a maximum of 24 hours. Key features include a flush port, rapid inflation, and a latex-free design. Limitations include the possible need for vaginal packing and limited supporting data. Contraindications are similar to the Bakri balloon.

Ellavi Balloon (Fig. 4)

This single balloon system connects to IV tubing and is used for uterine atony. It holds up to 1,000 mL and can be used for up to 24 hours. It is low-cost, preassembled, and maintains constant pressure. Limitations include limited outcome data. Contraindications are uterine tears, anomalies, rupture, and retained placenta.

Sengstaken–Blakemore Tube (Fig. 5)

The Sengstaken–Blakemore tube is a latex dual-balloon catheter used off-label for atony and placental pathology. It holds up to 250 mL and includes drainage. Dual balloons aid placement, but the tip often needs trimming for uterine use.

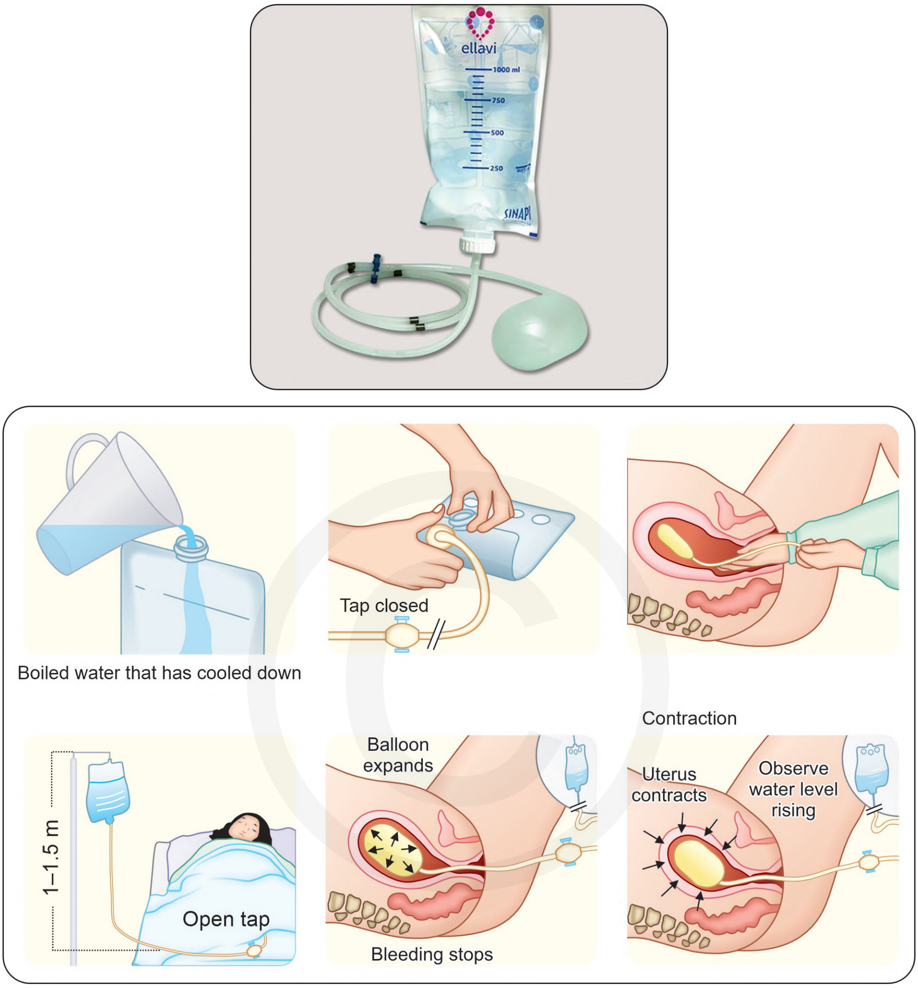


Fig. 4: Ellavi balloon

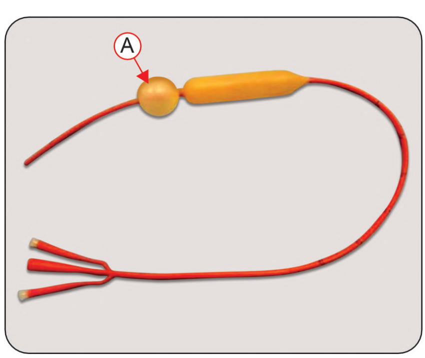


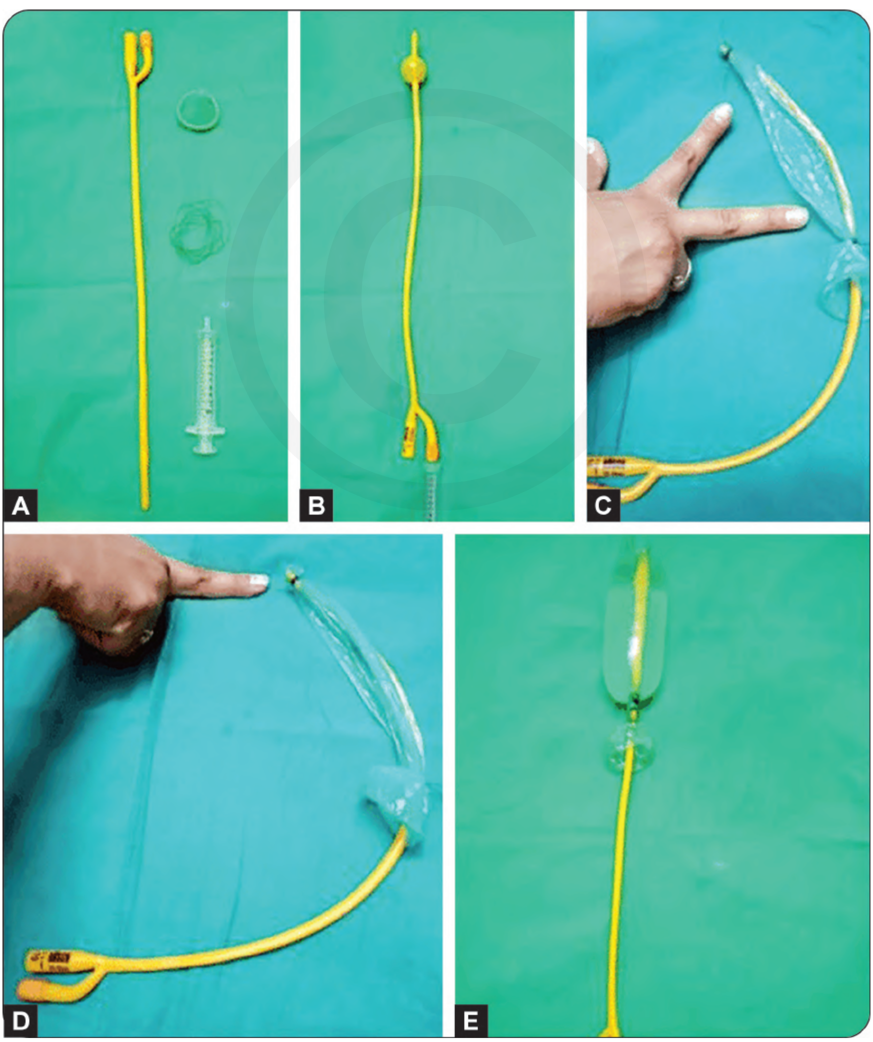
Fig. 5: Sengstaken–Blakemore tube

Condom Catheter (Fig. 6)

The condom catheter balloon, made by tying a condom to a urinary catheter, is used for atony and placental pathology. It holds up to 500 mL, is low-cost, and ideal for low-resource settings. Limitations include manual assembly and the absence of a drainage lumen.

Chhattisgarh Condom Balloon (CG Balloon)

The *Chhattisgarh Condom Balloon (CG Balloon)* is a low-cost, improvised uterine tamponade device tailored for resource-limited settings. Made from a Foley



Figs. 6A to E: Condom catheter

catheter and condom secured with tubing rings, it features a central drainage lumen for real-time monitoring. Used as a second-line treatment for atonic PPH, it showed a 98.3% success rate in a 2014–2016 study of 60 women, outperforming standard condom tamponades with lower blood loss, faster assembly (~1.2 min), and no leakage or expulsion. Its affordability, ease of use, and drainage capability make it a practical and effective option.

COMPARISON OF THE AVAILABLE UBT DEVICES FOR THE MANAGEMENT OF PPH (TABLE 1)

Mechanical Pressure → Hemostasis

- The inflated balloon applies *inward pressure on the uterine wall*, compressing *spiral arteries* and other bleeding vessels.
- This mimics the natural process of uterine contraction that stops bleeding after delivery.

Bridge to Definitive Care

UBT provides *time* for:

- Resuscitation and stabilization of the patient.
- Preparation for transfer to higher-level care.

Table 1 Comparison of various UBT available for the management of PPH

Device name	*Reusable*	*Volume capacity*	*Resource setting*	*Special features*
Bakri balloon	No	Up to 500 mL	All	FDA-approved; drainage port; high success in hospitals
BT-cath	No	Up to 500 mL	All	Dual lumen; commercial quality
Ellavi balloon	No	~500 mL	Low-resource	Gravity-filled; no syringe needed
ESM-UBT	No	Variable	Low-resource	Pre-packaged condom-catheter kit
Condom catheter	No	Variable	Low-resource	Improvised; low-cost
Sengstaken-Blakemore	Yes	Variable	Low-resource	Off-label use; multiple balloons
Chhattisgarh balloon	No	Variable	Low-resource	Central drainage port for monitoring; quick to assemble; 98.3% success reported
BakriOne UBT	No	~500 mL	All	Preassembled; simplified transparent, multiport, multipurpose

- Avoiding or delaying invasive procedures like a hysterectomy.

Simple, Rapid, and Effective

- It can be inserted in minutes by trained healthcare workers (even midwives).
- Requires minimal surgical skill and minimal equipment.
- Most studies report success rates between *75% and 95%,* especially in cases of *uterine atony,* retained placenta, or trauma-related bleeding.

Fertility Preservation

Unlike a hysterectomy, UBT *preserves the uterus*, which is critical for young women who desire future pregnancies.

Evidence-Based and Guideline-Supported

- Endorsed by WHO, FIGO, ACOG, and RCOG as a *second-line intervention* for PPH when medical management fails.
- Shown to *reduce maternal mortality and surgical intervention rates*, particularly in low-resource and rural settings.

INTRAUTERINE VACUUM SYSTEMS

Vacuum-assisted intrauterine devices are a novel addition to the PPH toolkit. These work by drawing negative pressure within the uterus to contract the myometrium and control bleeding.

Rationale for Uterine Vacuum Devices

Recently, intrauterine vacuum-induced hemorrhage control devices have been developed with the goal of rapid and effective control of PPH. The rationale for such devices is to use negative pressure within the uterine cavity to promote contraction, thus allowing coiling of the spiral arteries and reduced blood flow.

Panicker's Device (Fig. 7A)[12]

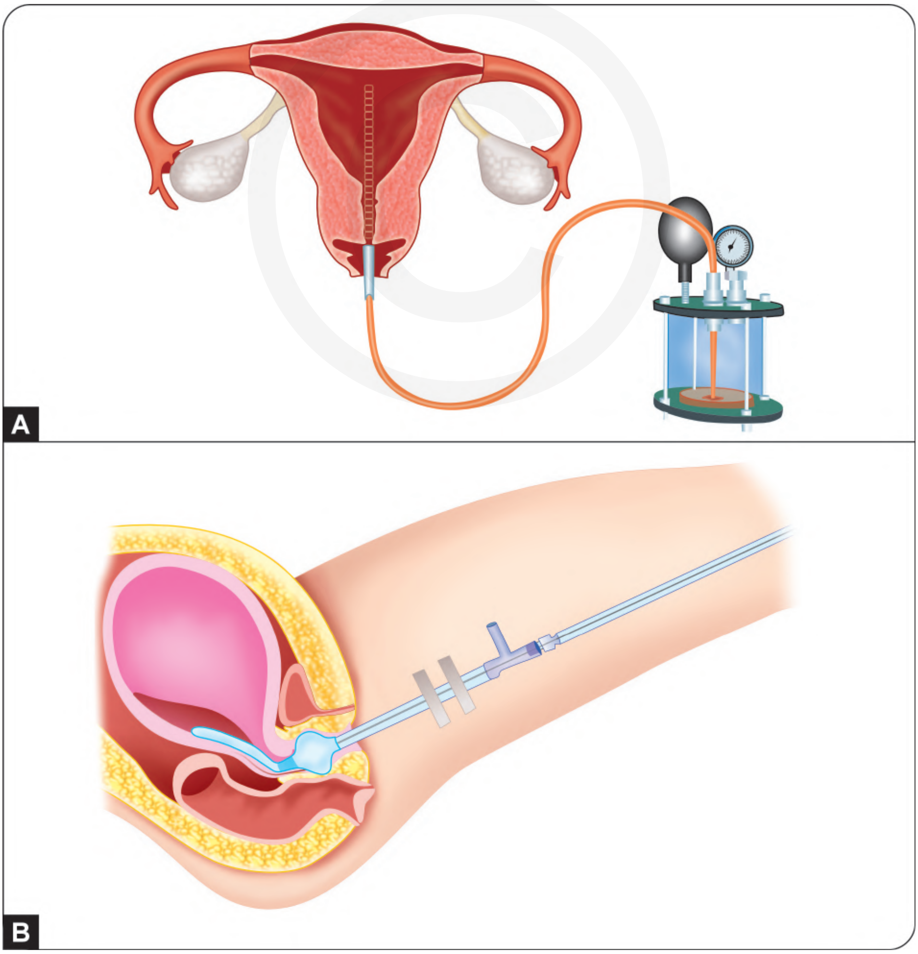
This low-cost, reusable intrauterine suction cannula controls atonic PPH by creating negative pressure within the uterus, promoting contraction and rapid bleeding control—often within 4 minutes. Studies show it is faster, more effective, and less painful than balloon tamponade devices. Ideal for low-resource settings, it requires a suction source and is not recommended in cases of uterine trauma or retained tissue.

Jada System (Fig. 7B)

FDA-approved in 2020, the vacuum-induced uterine tamponade device is made of soft silicone with an intrauterine loop featuring vacuum pores and a cervical seal balloon. It applies gentle suction (80 ±10 mm Hg) to control atonic postpartum hemorrhage and promote uterine contraction. Used for 1.5–24 hours and requires ≥3 cm cervical dilation. The RUBY trial (800 patients) showed success rates of 95.8% after vaginal and 88.2% after cesarean births, with bleeding controlled within 5 minutes on average. Contraindications include retained products, placenta accreta, infection, abnormal anatomy, pregnancy, inversion, and rupture.

Suction Tube Uterine Tamponade (STUT)

Affordable (<$1), novel device for postpartum hemorrhage management. It uses a flexible, round-tipped, wide-bore Levin tube with large pores connected to suction at 100–200 mm Hg. Suction is applied for 1 hour, followed by 20 minutes of



Figs. 7A and B: Paniker's device; (B) Jada system monitoring without suction before removal. Indicated for atony, it is low-cost and readily available but requires manual stabilization due to its improvised design.

Modified Bakri with Suction

This combines a Bakri balloon (50–100 mL) with external suction at 60–70 kPa (450–525 mm Hg) for managing atony and placental pathology. Used for 1–24 hours, it offers a lower-cost alternative to the Jada system by leveraging a familiar balloon device. It is off-label with limited outcome data.

Evidence from India: Panicker versus Chhattisgarh Balloon[12]

A 2025 comparative study from GSVM Medical College, Kanpur, assessed 140 patients with atonic PPH and found that Panicker's device outperformed the Chhattisgarh balloon tamponade on multiple parameters like faster control of hemorrhage, rapid uterine contraction, less overall blood loss, reduced patient discomfort, shorter recovery and hospitalization times. These findings support the wider implementation of Panicker's vacuum device, particularly in settings where affordability, durability, and ease of use are crucial.

COMPARISON OF AVAILABLE SUCTION DEVICES FOR MANAGEMENT OF PPH (TABLE 2)

Negative Pressure Promotes Uterine Contraction

- Applying *intrauterine vacuum* collapses the uterine walls inward.
- This *stimulates the natural contraction reflex* of the uterus (myometrial recoil), compressing spiral arteries and reducing bleeding.
- This mimics the uterus's physiological response to delivery more effectively than passive methods.

Evacuates Retained Blood and Clots

- Blood or clots inside the uterus can *prevent effective contraction* (uterine atony).
- Suction devices *remove this content rapidly*, allowing better contraction and reducing the risk of ongoing hemorrhage.

Faster Hemostasis Compared to Tamponade

- Many suction devices (e.g., Jada, NIPSD, Panicker cannula) have shown *bleeding cessation within 2–4 minutes*, compared to longer times for balloon tamponade.
- This speed is critical when every minute of bleeding increases the risk of maternal morbidity and mortality.

Table 2 Comparison of available suction devices for management of PPH

Device	***Mechanism***	***Pressure***	***Bleeding control time***	***Evidence base***	***Pros***	***Cons***
Panicker cannula	High-pressure suction	~700 mm Hg	~4 minutes (case series)	55-case series; 20-case recent cohort	Simple, reusable, low-cost, effective	Seal issues, blockage risk, and limited large-scale trials
NIPSD suction cannula	High-pressure suction	~650 mm Hg	2–4 minutes (small studies)	QI: n=1,324; small RCTs	Reduces PPH rate significantly in LMICs	Clogging, small study scale
Jada VHCD	Moderate vacuum + seal	~80 mm Hg	~3 minutes (registry data)	Registry data, n=107	Physiologic, fast, moderate vacuum	Vacuum dependence, no RCTs

Minimal Training and Equipment

- Devices like the *Panicker cannula or NIPSD* are simple, inexpensive, and can be used *without surgical skill or high-end equipment*.
- Ideal for *primary care settings or resource-limited hospitals*.

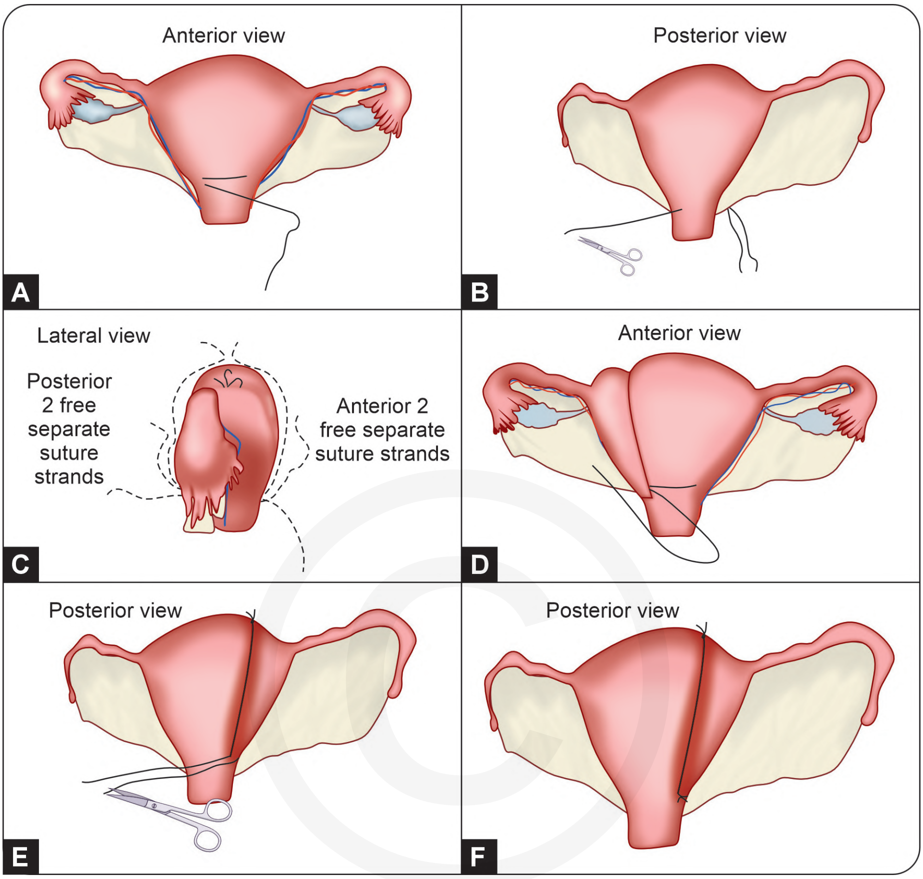
Preserves Fertility

- Like UBT, suction devices *avoid hysterectomy*, preserving fertility.
- Particularly beneficial in young, multiparous, or nulliparous women.

NON-PNEUMATIC ANTI-SHOCK GARMENT (NASG) (FIG. 8)

- It is a life-saving, first-aid medical device used to stabilize women suffering from obstetric hemorrhage and shock, especially in low-resource settings. It is made of neoprene with Velcro straps and is divided into six segments that wrap tightly around the lower body (legs, pelvis, and abdomen). It applies external pressure to shunt blood from the lower extremities to vital organs (heart, lungs, brain).
- Mostly used during *transport to referral centres by reducing blood loss, improving perfusion*, and buying time for definitive care. *Advantages are that it is r*eusable after cleaning and inexpensive.

Fig. 8: Non-pneumatic anti-shock garment (NASG)

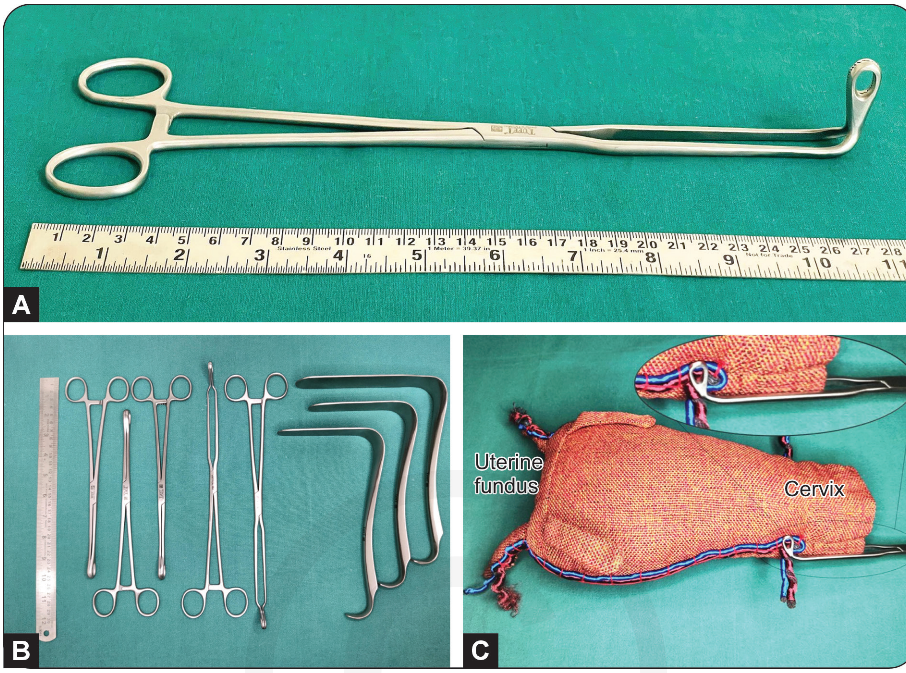


Figs. 9A to F: Compression of myometrium and occlusion of the uterine artery—MG (after mahesh gupta)

COMPRESSION OF MYOMETRIUM AND OCCLUSION OF THE UTERINE ARTERY—MG (AFTER MAHESH GUPTA) (FIGS. 9A TO F)

It is a modified *B-Lynch uterine suture* that uses a specialized *double-ended suture* (straight needle one end, curved needle the other) to compress the uterus and occlude uterine artery branches. It acts by combin*ing mechanical compression* (like B-Lynch) with *artery occlusion,* creating a dual hemostatic effect.

Can be placed in ~4–10 minutes after uterine closure. It can help to avoid a hysterectomy. Requires only standard suture and minimal specialized needles.Low rates of infection or uterine damage; fewer transfusions or surgical interventions needed.



Figs. 10A to C: Transvaginal uterine artery clamp (TVUAC)

TRANSVAGINAL UTERINE ARTERY CLAMP (TVUAC) (FIGS. 10A TO C)

TUVAC is applied to the uterine arteries at the cervico-isthmus via the vaginal route to *directly occlude arterial blood flow* quickly without laparotomy. A recent RCT evaluated the effectiveness of three interventions—transvaginal uterine artery clamp (TVUAC), vacuum-assisted uterine contraction using a suction cannula (SC), and condom tamponade (CT)—in the management of atonic PPH. It was noted that *TVUAC and SC were more effective and faster* than condom tamponade in atonic PPH. Both present *novel, less invasive options* for bleeding control in tertiary settings. It was suggested that more research and replication studies are needed to assess long-term outcomes and scalability.

PPH BUTTERFLY

It is an innovative device designed to *replicate bimanual uterine compression* without needing to insert a fist, making the process *less invasive and more acceptable* during postpartum hemorrhage. It is made from a *single-piece plastic platform* with *foldable wings* and a handle. It is inserted vaginally in a streamlined form, then opened to provide a *stable compression platform beneath the cervix.* The clinician applies pressure against the uterus via the abdomen; the butterfly handles

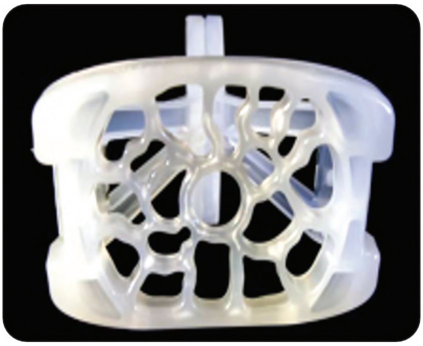


Fig. 11: PPH Butterfly

can be *wedged against the bed*, allowing one-handed compression over time. It has a *perforated or mesh surface*, which allows blood and clots to drain through while compression is maintained **(Fig. 11)**.

It is a clinically effective (~98% success in Phase II) UK-based model. More comparative trials are required.

SYSTEMIC CHALLENGES IN RURAL AND RESOURCE-POOR AREAS

India's maternal care system continues to face obstacles:
- Shortage of trained personnel in rural and peripheral regions.
- Inconsistent supply chains for critical medications and blood products.
- Lack of efficient transportation and referral mechanisms.
- Socio-cultural delays in seeking care and poor birth preparedness.

Affordable and user-friendly tools like Panicker's vacuum system and condom catheter UBTs can help bridge these gaps. To ensure effectiveness, their incorporation into state and national guidelines is essential after multicentric, adequately powered clinical trials.

Conclusion

Postpartum hemorrhage remains a leading cause of preventable maternal deaths worldwide, particularly in LMICs such as India. Despite advancements in pharmacologic and mechanical interventions, significant gaps remain in equitable access, training, and emergency response. Emerging technologies like intrauterine vacuum devices offer promising solutions, especially in underserved regions. The integration of newer innovations into mainstream maternal care protocols represents a low-cost, high-impact strategy. Moving forward, a multi-pronged approach combining education, infrastructure, technology, and policy reform is essential to ensure that no woman dies from preventable bleeding after childbirth.

References

1. Second global call for data on postpartum haemorrhage [Internet]. Geneva: WHO; 2024. Available from: https://www.who.int/news-room/articles-detail/second-global-call-for-data-on-postpartum-haemorrhage
2. Aimagambetova G, Bapayeva G, Sakhipova G, et al. Management of Postpartum Hemorrhage in Low- and Middle-Income Countries: Emergency Need for Updated Approach Due to Specific Circumstances, Resources, and Availabilities. J Clin Med. 2024;13(23):7387.
3. Global health sector strategy on viral hepatitis 2016–2021: towards ending viral hepatitis. Geneva: WHO; 2016. Available from: https://iris.who.int/bitstream/handle/10665/75411/9789241548502_eng.pdf
4. Save Mothers, Stop PPH [Internet]. London: International Federation of Gynecology and Obstetrics; 2020. Available from: https://www.figo.org/news/save-mothers-stop-pph
5. Bláha J, Bartošová T. Epidemiology and definition of PPH worldwide. Best Pract Res Clin Anaesthesiol. 2022;36(3-4):325-39.
6. Joshi BN, Shetty SS, Moray KV, et al. Cost-effectiveness and budget impact of adding tranexamic acid for management of post-partum hemorrhage in the Indian public health system. BMC Pregnancy Childbirth. 2023;23(1):9.
7. Yunas I, Islam MA, Sindhu KN, et al. Causes of and risk factors for postpartum haemorrhage: a systematic review and meta-analysis. Lancet. 2025;405(10488):1468-80.
8. McDougall ARA, Goldstein M, Tuttle A, et al. Innovations in the prevention and treatment of postpartum hemorrhage: Analysis of a novel medicines development pipeline database. Int J Gynaecol Obstet. 2022;158 Suppl 1(Suppl 1):31-9.
9. PPH Prevention and Management: Updated PPH Guidelines. New Delhi: FOGSI; September 2022. Available from: https://www.fogsi.org/wp-content/uploads/tog/pph-prevention-and-management-updated-sept-2022.pdf
10. Overton E, D'Alton M, Goffman D. Intrauterine devices in the management of postpartum hemorrhage. Am J Obstet Gynecol. 2024;230(3S):S1076-88.
11. Committee on Practice Bulletins-Obstetrics. Practice Bulletin No. 183: Postpartum Hemorrhage. Obstet Gynecol. 2017;130(4):e168-86.
12. Tyagi P, Anamika, Verma P, et al. Comparative Analysis of Panicker's Vacuum Suction Hemostatic Device Versus the Chhattisgarh Balloon Tamponade in the Management of Postpartum Hemorrhage at a Tertiary Health Facility in Uttar Pradesh, India. Cureus. 2025;17(3):e81399.

Chapter 13

FOGSI Nari Swasthya Janandolan Yatra—Na Na Anemia Yatra

Hrishikesh Pai

The **Nari Swasthya Janandolan Yatra**, famously known as the **Na Na Anemia Ride**, was an extraordinary and transformative journey, a testament to our collective commitment to improving women's health across the nation. Supported by **P&G Health**, **IJCP**, and **Together Events**, this initiative symbolized a relentless pursuit of a healthier tomorrow for India's women.

Spanning **90 days**, this ambitious Yatra traveled a staggering **9,000 kilometers**, weaving through **10 states and 39 cities**. From the serene landscapes of **Uttarakhand** and **Kerala** to the bustling metropolises of **Karnataka**, **Tamil Nadu**, and beyond, the Yatra touched lives, sparked conversations, and created a ripple effect of awareness and action.

The campaign reached an awe-inspiring **100 million people** through its wide-ranging activities. In each city, the Na Na Anemia Yatra conducted three activities, namely:

1. **Medical Screening Camps with Free Investigations:** Thousands of women underwent free health checkups, addressing critical health concerns and promoting early detection and prevention. The patients were screened for weight, BP, haemoglobin, blood sugar, and TSH. Generally, the camps were conducted from morning to afternoon.
2. **Public Education Forums:** These platforms became the voice of the initiative, educating communities about anemia, its prevention, and broader health issues affecting women. These forums were generally for one hour and were carried out just prior to the CME activities.
3. **Continuing Medical Education (CMEs):** Engaging healthcare professionals across the journey ensured the message of women's health reached beyond communities, impacting healthcare delivery directly. These CMEs were conducted in the evening by 3 to 4 national speakers and speakers from the local society. The national speakers stayed on to cover at least 2 to 4 cities.

The first part of the Yatra was conducted in the Northern states. It started from Rishikesh, Uttarakhand, on the banks of the river Ganges. The Yatra consisted of a red NaNa Anemia bus and a mid-size video truck, mounted with a large video screen. We had created a public service cartoon of 10 minutes centered around a character called Doctor Didi; this cartoon discussed all the medical issues that a woman comes across in her journey from birth to menopause. This cartoon was continuously played on the videoscreen as a public service and a patient awareness initiative. The Yatra then proceeded to Dehradun, where the Yatra was inaugurated by the Chief Minister of Uttarakhand, Shri Dhamiji. The Yatra then went through Meerut, Khora Makanpur, Aligarh, Agra, Kanpur, Gorakhpur, Lucknow, Prayagraj, Varanasi, Mau, Patna, Muzaffarpur, Bhagalpur, Ranchi, Dhanbad, Jamshedpur, Durgapur, Bardhaman, and ended in Kolkata. The Yatra thus covered five states of Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal and ended in Kolkata, during my installation as President at the All India Congress of OBGYN. The second part of the Yatra was conducted in the southern states of Andhra Pradesh, Telangana, Karnataka, Tamil Nadu, and Kerala. We covered the cities Visakhapatnam, Kakinada, Vijayawada, Khammam, Tirupati, Chennai, Vellore, Kodaikanal, Coimbatore, Trichy, Madurai, Mangalore, Bengaluru, Hubbali, Cochin, Nagercoil, Thiruvananthapuram, Calicut, and Kanyakumari. Each state welcomed the initiative with open arms, and every city embraced the vision of healthier, empowered women. The **Na Na Anemia Ride** was more than a journey; it was a movement, a **Janandolan**, that galvanized communities to prioritize women's health. It fostered partnerships, inspired countless individuals, and left an indelible mark on public health in India. As the Yatra concluded, it became a powerful reminder that change is possible when we come together with a shared purpose. The echoes of its impact will resonate for generations, inspiring future initiatives and driving India closer to a healthier, anemia-free future for all women.

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FOGSI ANEMIAMUKT NARI

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