

Supplementary material

Supplemental Table 1: Implementation Research Priorities by Priority Area

Priority 1.1: Ensure timely, equitable, respectful, evidence-based and safe maternal-perinatal health care, delivered through context-appropriate implementation strategies
<ul style="list-style-type: none">• With focus on countries with MMR>420, identify and test models of care, to address the direct causes of maternal death.• In countries with MMR between 70 and 420, determine the existing diversity of care needed, and test facilities' capability, including referral, to deliver known effective means to prevent and treat the main causes of maternal mortality, at scale, and in diverse contexts.• In countries with MMR<70, use data to better understand effective models of service provision, avoid over-intervention and waste, reduce women's and providers' fear, and ensure women's satisfaction• Develop and test means to reduce response times and delays at the level - of the family, and within and between facilities, including maternity waiting homes and emergency medical services• Implement and test participatory approaches for monitoring and improving quality, including adoption of clinical practice guidelines; prioritize refinement of quality of care (QOC) indicators and development of user-friendly tools to facilitate data collection, analysis, and use these to direct improvements on a timely basis• Develop and test means to limit the unnecessary or inappropriate medical interventions around childbirth, specifically non-medically indicated cesarean section or labour induction, unsafe labour augmentation, routine amniotomy and episiotomy, including by hospital-sited midwifery-led birthing units• Develop and evaluate approaches to prevent disrespect and abuse during maternity care, and to increase women's satisfaction with care• Test clinical and technical innovations (e.g., Odon device, NASG, provider aids) to improve maternal health at lower levels of the health system
Priority 1.2: Build linkages within and between maternal-perinatal and other health care services to address the increasing diversity of the burden of poor maternal health
<ul style="list-style-type: none">• Determine the requirements for integrating or linking maternal health services with those addressing perinatal health, NCDs, indirect causes of maternal death, malnutrition/obesity and mental health among pre-pregnant, pregnant and postpartum women, and among adolescent women• Establish the implications of such integrated services on providers' workload and service quality, as well as on laboratory technicians, community health workers and supply chain managers, among others• Ensure that the research & development agenda includes treatments that are relevant for pregnant and postpartum women; conduct post-marketing surveillance for adverse events• Test means to improve adherence to clinical practice guidelines and treatments, particularly for NCDs and other indirect causes• Identify and test means of improving women's, families' and providers' perceptions of the conditions and treatments (especially for NCDs and mental health) that impact women's

pregnancy, and their receptivity to treatment

Priority 2: Promote equity through universal coverage of quality maternal health services, including for the most vulnerable women

- Develop better tools to identify vulnerable populations, and the services needed to respond to them
- Study the distribution and characteristics of vulnerable groups in specific countries and regions, and document and understand the barriers women face in accessing maternal health care, and their perspectives on seeking care
- Develop, implement and evaluate approaches and interventions to overcome the identified barriers (e.g., gender inequality, humanitarian crises, functional referral systems)
- Evaluate the impact of financial mechanisms (e.g., conditional or unconditional cash transfer programmes) on access to and utilization of care by vulnerable groups; implementation of UHC on use of MH services, including for indirect causes of death/morbidity).
- Test innovative models of care to redistribute and reorganize facilities and the health workforce to better meet population needs and increase satisfaction with care
- Evaluate how interventions to empower women as health care users and health care providers affect health system functioning and health outcomes.
- Identify mechanisms to improve care-seeking behaviors of pregnant and postpartum women, through increased knowledge, awareness and satisfaction of/with maternal and fetal health and family planning, or through means that draw from behavioral economics
- Develop and evaluate interventions aimed at building capacity of women, men, families, communities and citizen groups to actively engage with each other, health providers, managers, and policy-makers, and hold health systems accountable
- Explore psychological and behavioral factors that affect demand for maternal health services and evaluate the implementation of behavioral economics strategies for improving use and provision of maternal health care (e.g. reminders, commitment devices, vouchers)

Priority 3: Increase the resilience and strength of health systems by optimizing the health workforce and improving facility capability

- Test means of scaling up pre-service training to increase numbers of providers quickly, including such means as distance learning or use of mannequins
- Evaluate means of ensuring available skilled care and adequate facility capability for vulnerable populations, including how to site services, both in remote and fragile areas and urban slums, to optimize access
- Document ways governments have worked with the private sector

Priority 4: Guarantee sustainable financing for maternal-perinatal health

- Test how financial incentives can be deployed at scale to promote quality, satisfaction, and equity, and ensure better maternal health outcomes result
- Investigate how addressing the growing importance of the indirect causes of maternal death (including malaria, HIV and AIDS, NCDs, malnutrition, and mental health problems) will affect maternal health financing needs in LMICs
- Determine strategies to expand coverage and achieve UHC, including those that address other conditions that impact maternal health (e.g., s NCDs) and reduce the financial burden on families via expansion of insurance or other financial protection schemes
- Identify how governments and private sector can best work together to improve access and quality

Priority 5.1: Develop better metrics and support implementation research to promote accountable, evidence-based maternal health care

Measurement

- Support efforts to improve data on numbers and causes of death, with standardized definitions, and their risk factors
- Measure persistent social and economic inequalities (data and indicators beyond economic inequality) to explain variation in quality of care and health outcomes and to track progress in reducing equity gaps.
- Develop mechanisms for improved measurement of the proximal and distal causes of maternal morbidities to set priorities for interventions and improve quality of care, specifically for high-risk groups
- Refine indicators of health service outputs, including facility capability, and generate appropriate benchmarks and minimal thresholds
- Improve Health Management Information Systems and develop better planning tools and guidelines

Implementation Research

- When in pregnancy and postpartum do morbidities occur, what needs to be screened for, and how/where can affected women be treated?
- Identify vulnerable individuals and population groups to provide relevant public health and clinical interventions.
- Develop mechanisms to support small scale locally generated site-specific research including vehicles for sharing and publishing knowledge gained
- For key health systems aspects where the evidence base is not clear fund independent high-quality large scale robust impact evaluation
- Improve data on M-health for implementation and expansion of programs for communities to report on quality of care and build accountability
- Develop platforms and systems which are updated regularly, and are transparent and accessible

Priority 5.2: Translate evidence into action through effective advocacy and accountability for maternal health

- Generate technical knowledge to support policy advocacy to increase the availability, accessibility, acceptability and quality of essential services for maternal health, including contraception and safe abortion services
- Identify the most effective advocacy approaches to ensure that UHC is designed for women and women are included in the design, and that maternal health coverage and impact are included within monitoring frameworks
- Explore the needs and opportunities of LMICs to reach health convergence without outside assistance
- Generate evidence on the contribution of women to achieving the health and other SDGs
- Test innovative tools for advocacy, for example maps and social media

Supplemental Figure 1: Interconnections between maternal, fetal and immediate newborn health, and interventions (adapted from Lassi et al, The Interconnections between maternal and newborn health – evidence and implications for policy *The journal of maternal-fetal & neonatal medicine* 2013; 26 Suppl 1: 3-53)

	Maternal and Fetal / Newborn Conditions and Predisposing Factors	Maternal and Fetal / Newborn Interventions
Reproductive / Preconception	<ul style="list-style-type: none"> • Nutritional deficiencies or overnutrition/obesity • Maternal chronic illness (e.g. diabetes, hypertension) • Maternal infections (e.g. STIs, HIV, TB, malaria) • Unmet need for contraception • Lack of access to safe abortion 	<ul style="list-style-type: none"> • Diversified nutritious diet/balance protein energy/ iron folic acid • Prevention and management of diabetes, hypertension, other chronic illnesses • Prevention and management for infections (e.g. STIs, HIV, TB, malaria) • Family planning / safe abortion services
Post- Abortion	<ul style="list-style-type: none"> • Sepsis • Hemorrhage 	<ul style="list-style-type: none"> • Post-abortion care • Family planning: information, counseling, and service provision
Antenatal	<ul style="list-style-type: none"> • Nutritional deficiencies or overnutrition/obesity • Maternal chronic illness (e.g. diabetes, hypertension) • Maternal infections (e.g. STIs, HIV, TB, malaria) • Inadequate fetal growth / fetal growth restriction 	<ul style="list-style-type: none"> • Diversified nutritious diet/balance protein energy/ iron folic acid • Prevention and management of diabetes, hypertension, other chronic illnesses • Preventions and management/treatment for infections (e.g. STIs, HIV, TB, malaria) • Monitoring for adequate fetal growth • Birth plan + complication readiness
Intrapartum	<ul style="list-style-type: none"> • Preterm labor • Pre-labor rupture of membranes • Maternal complications (e.g. post-partum hemorrhage, eclampsia) • No skilled birth attendance • No referral access 	<ul style="list-style-type: none"> • Good quality maternal care • Basic or comprehensive emergency obstetric care as needed • Community-based intervention packages, such as Home-based Life-saving skills • Transport, referral as needed
Postpartum	<ul style="list-style-type: none"> • Maternal complications (e.g. post-partum hemorrhage, sepsis) • Maternal anemia / other nutritional deficiencies or over nutrition/obesity • Infections (STIs, HIV, TB, malaria) • Maternal depression • Newborn hypothermia • Newborn hypoglycemia • Newborn sepsis • Insufficient birth spacing 	<ul style="list-style-type: none"> • Monitoring and treatment for complications, infections, maternal depression, nutrition • Diversified nutritious diet/balance protein energy/ iron folic acid • Thermal care / kangaroo mother care for newborns • Immediate breastfeeding • Family planning information, counseling and services

Supplemental Figure 2: Country Action Steps To Improve Facility Capabilities

- 1. Determine actual capability (i.e. facility infrastructure, staffing, equipment and drugs for routine and emergency obstetric and newborn care) of country facilities, regardless of current designation**
- 2. Develop a clear national statement of what should constitute first-level care for uncomplicated deliveries, and what mechanisms need to be in place for complicated deliveries**
- 3. Bring existing facilities to the desired level of care for routine deliveries (at least BEmOC):**
 - a. Developing long-term plans for human resource development, with targets**
 - b. Budgeting appropriately, including for increased workload, infrastructure and equipment improvements, and drugs and supplies**
- 4. Explore options for inter-facility referral and maternity waiting homes for remote regions**

Supplemental Figure 3: WHO framework illustrating human resources for health pathways and associated policy levers

