



Merck for mothers
Committed to Saving Lives

MERCK FOR MOTHERS
EVIDENCE FOR IMPACT
2018 RESEARCH COMPENDIUM



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A MESSAGE FROM MERCK FOR MOTHERS



Dr. Naveen Rao
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At Merck for Mothers, we believe that actionable research is essential for taking on maternal mortality. On behalf of the Merck for Mothers team and our many partners, we are pleased to share Evidence for Impact, our first Merck for Mothers Research Compendium.

This document includes links to over 100 publications we have supported over the past six years – including independent evaluations, peer-reviewed articles, program reports, and policy briefs. The questions these publications explore and the answers they uncover have been invaluable for informing our work. We hope they continue to spur innovation and steer us all toward more effective approaches for reducing maternal mortality globally.

Merck for Mothers is Merck's 10-year, \$500 million global initiative to create a world where no woman dies giving life. Over the past six years, we have improved the quality of health care for more than six million women in over 30 countries around the world, contributing to the global effort to save women's lives, strengthen health systems and meet the United Nations' Sustainable Development Goals.

We've brought Merck's invention and private sector expertise to the cause, advancing lifesaving medicines, building reliable supply chains and developing new technologies — always ensuring that women and their health providers are at the center of our solutions.

Our commitment to funding research and evaluation partnerships is rooted in Merck's core identity as a science-driven company that prides itself on inventing for life. Learning from evidence, adapting from failure, and following the science is part of our DNA. As our CEO, Ken Frazier, has said, "The business of biomedical research is mostly about failure. Few projects we commission will ultimately

result in success. But every study we do contributes to the body of knowledge that brings science and society closer to a solution."

At Merck for Mothers, we are continuously refining our work based on the lessons we've learned and bringing us closer to solving today's maternal health challenges as well as tomorrow's. The publications included in this compendium advance our collective understanding of the problem of maternal mortality, inform the design and implementation of programs aiming to improve women's health, and strengthen the global health community of practice to save women's lives.

Our research questions and findings also have benefits that extend beyond maternal health and family planning – providing insights relevant to child health, HIV/AIDS, vaccination, and the growing burden of chronic disease in low- and middle-income countries.

This 2018 Research Compendium is just the beginning. We are continuing to generate actionable and real-time evidence about what works, what doesn't, and expanding knowledge that will help encourage greater investment in women's health. We look forward to disseminating what we learn.

We congratulate and thank the many researchers whose outstanding work is represented in the Merck for Mothers Research Compendium. All of you have made invaluable contributions to advancing our global knowledge. Special thanks to the Maternal Healthcare Markets Evaluation Team at the London School of Hygiene & Tropical Medicine, our longstanding and prolific partners in generating disruptive evidence. Together, we believe our collective curiosity, experimentation, and innovation are paving the way for sustainable solutions to end maternal mortality.

A MESSAGE FROM THE LONDON SCHOOL OF HYGIENE & TROPICAL MEDICINE



Professor Peter Piot
Director, London School of
Hygiene & Tropical Medicine

Over the last six years, the London School of Hygiene & Tropical Medicine has been proud to collaborate with Merck for Mothers as the initiative's principal evidence generation partner. We are pleased to share what we've learned as part of the larger body of Merck for Mothers-supported research featured in this important compendium.

Taken together, this collection of more than 100 research publications is a major contribution to the global health field. Many shed light on new areas for exploration. For example, our **Maternal Healthcare Markets Evaluation Team (MET)** has generated lots of new evidence about the role of private health care providers in low- and middle-income countries and their potential for getting us closer to the ambitious goal of universal health coverage, while uncovering just how much we still have to learn about effective intervention.

This compendium also demonstrates *Merck for Mothers'* commitment to research. **It's worth noting how unusual yet refreshing it is for a donor – especially a corporate one – to put their investments under the microscope.**

And it's heartening that the initiative is actively disseminating the findings – both positive and negative – to inform and improve global health programming around the world.

Indeed, *Merck for Mothers* asked tough questions about which of their investments did and did not work. The initiative sends an important message to the global health community that without curiosity, transparency, and learning, we will miss opportunities to make the leap towards ending maternal mortality. And it is women, especially those who are most marginalized, who can benefit the most.

This compendium is also a reflection of dynamic partnerships between *Merck for Mothers* and academic research institutions, which have generated many new insights, new questions, and opportunities for cross-sector learning, the results of which can be found within these pages.

On behalf of my colleagues, I thank the numerous implementing partners who indulged our frequent site visits and questions. Without your commitment and contributions, our research would not have been possible. Our hope is that the evidence generated about your efforts will help us all improve women's health care.



INTRODUCTION

At *Merck for Mothers* we don't accept business as usual. We challenge assumptions. We ask the tough questions. We push ourselves and our partners to invest in new and innovative ideas that disrupt the status quo, and we recognize that risk and learning from failure are part of the process. This Research Compendium is our way of sharing with you what we've learned about promising solutions to end the global tragedy of women dying from complications of pregnancy and childbirth. Given the multi-faceted nature of maternal mortality, the publications in this compendium span a variety of issues, providing insights on strengthening health systems to improve women's health before, during, and after pregnancy.

Generating evidence is part of our commitment to collaborating and partnering across disciplines, sectors, and industries to improve women's lives. Over the past six years, we have invested in both asking and answering critical questions to help advance the global health field and accelerate progress in reducing maternal mortality and morbidity.

The Compendium shares the pioneering publications of our partners - a diverse group of leading academic institutions, private sector partners, and implementing organizations. We routinely use this new evidence to strengthen our programming, guide our decisions about which models to scale and how, and advocate for more strategic investments in maternal health. We hope these findings will be as helpful for the broader global health community.

>100 PUBLICATIONS

>400 AUTHORS

>50 COUNTRIES

46 INSTITUTIONS

14 INNOVATIONS

FIVE THEMATIC AREAS:

1. UNDERSTANDING THE PROBLEM | MATERNAL HEALTH LANDSCAPE AND TRENDS

2. EXPLORING PROMISING SOLUTIONS | QUALITY OF MATERNITY CARE

3. UNDERSTANDING WOMEN'S PREFERENCES | ACCESS TO MODERN CONTRACEPTION

4. IMPROVING HEALTH CARE DELIVERY | HEALTH SYSTEMS STRENGTHENING

5. NURTURING A CULTURE OF INVENTION | PRODUCT AND DIGITAL INNOVATIONS

RESEARCH HIGHLIGHTS



UNDERSTANDING THE PROBLEM | MATERNAL HEALTH LANDSCAPE AND TRENDS

PROMINENCE OF PRIVATE MATERNITY PROVIDERS

The London School of Hygiene & Tropical Medicine (LSHTM) conducted the most comprehensive analysis to date on where women receive maternity care, revealing that private providers play a substantial role. By standardizing Demographic and Health Survey data across nearly 60 low- and middle-income countries, LSHTM uncovered that approximately 40% of women, including the poor, receive maternity and family planning services from private healthcare providers.

The findings have important implications as governments and global health leaders consider how to integrate private providers into their strategies for achieving universal health coverage.

RACIAL DISPARITIES IN MATERNAL MORBIDITY

In the U.S., rising maternal mortality and morbidity rates reflect striking inequities. The New York City Department of Health & Mental Hygiene (NYCDOHMH) analyzed the city's surveillance data on maternal morbidities and found that in New York City, black women are three times as likely as white women to experience maternal morbidity. Severe maternal morbidity resulted in excess costs of \$17 million each year. This analysis was made possible through a collaboration among the NYCDOHMH, *Merck for Mothers*, and the Fund for Public Health NYC to create the country's first monitoring system for severe maternal morbidity.

The findings will inform New York City's approach to improving public health through neighborhood-based interventions and have prompted the establishment of the first city-wide maternal morbidity review committee – with learnings that can be applied nationwide.



EXPLORING PROMISING SOLUTIONS | QUALITY OF MATERNITY CARE

SUCCESSFUL QUALITY IMPROVEMENT INTERVENTIONS

Private providers are often overlooked by quality improvement initiatives globally despite inconsistent quality. For example, findings from one study in India revealed that both public and private healthcare providers in Uttar Pradesh – one of India's largest states with the highest need – offered poor quality maternity care.

Fortunately, our partners have found that private providers are willing and able to improve the quality of care they offer if they have the right tools tailored to their needs. Jhpiego and the Federation of Obstetrics and Gynecological Societies of India (FOGSI) published promising results of their quality improvement initiative in India, including guidance on how to work with private providers by streamlining quality standards, creating flexible training schedules, and offering on-site mentoring.

In the United States, our partners at the California Maternal Quality Care Collaborative disseminated encouraging results from their project to standardize how California hospitals manage postpartum hemorrhage. This research, which showed that women experienced significantly better maternal health outcomes, is spurring a national scale up of evidence-based practices ("safety bundles") for three causes of maternal death: hemorrhage, preeclampsia/eclampsia, and venous thromboembolism.



UNDERSTANDING WOMEN'S PREFERENCES | ACCESS TO MODERN CONTRACEPTION

HIGHER UNMET NEED AMONG ADOLESCENTS

Choosing a contraceptive method is a personal decision for women – including adolescent women – globally. LSHTM conducted several analyses of DHS data to understand where women typically seek contraceptive products and how unmet need for contraception differs among women of different age groups. Analyses revealed that in some settings, national gains in addressing unmet need are greater among older women, suggesting gaps in reaching younger women, including adolescents.



IMPROVING HEALTH CARE DELIVERY | HEALTH SYSTEMS STRENGTHENING

PRIVATE SECTOR SOLUTIONS TO STRENGTHEN SUPPLY CHAINS

Weak supply chains severely impede access to essential products. Our implementing partner in Senegal – IntraHealth – found that integrating private logistics providers into public health supply chains can substantially increase the availability of contraceptives. Stockouts of contraceptives dropped to less than 2% from as high as 80% in certain districts with the development of a supply chain innovation known as the Informed Push Model with third party logistics providers. This body of research generated the evidence that the Government of Senegal needed to expand the IPM-3PL to include more than 90 essential medicines and scale the model nationally. LSHTM is conducting a rigorous evaluation of the model. Thus far, LSHTM has published its research protocol, with results expected soon.

EFFECTIVENESS OF MATERNITY WAITING HOMES

Distance is a major barrier to timely, quality maternity care, especially for women in remote areas. However, improving the availability and quality of maternity waiting homes (MWHs) – residential facilities where women can await their delivery – could encourage more women from rural areas to give birth in a health facility. An assessment by Boston University and the Zambia Center for Applied Health Research and Development (ZCAHRD), in collaboration with the Zambia Ministry of Health, reviewed the quality of MWHs in two districts of Zambia, finding that women with access to high quality MWHs were nearly twice as likely to deliver in a facility than women whose local MWHs were of poor quality. Partners also found that women value quality, based on their reported willingness to pay to stay in a MWH that meets their needs. While maternity waiting homes are popular in certain regions, the research on their effectiveness in overcoming the distance barrier to facility delivery has been inconclusive up until now. Additional findings from Boston University, ZCAHRD, the University of Michigan, and Africare are expected in 2019.



NURTURING A CULTURE OF INVENTION | PRODUCT AND DIGITAL INNOVATIONS

ASSESSMENT OF A NEW DRUG TO PREVENT POSTPARTUM HEMORRHAGE

In order to offer quality care, providers need quality medicines. We supported the world's largest clinical trial of postpartum hemorrhage testing a new, heat-stable uterotonic. The methodology used to conduct this ground-breaking trial, which the World Health Organization completed earlier this year, is included in this compendium. Results from this trial will be available in 2018 and will inform the prevention of postpartum hemorrhage – the #1 cause of maternal death.

UNDERSTANDING THE PROBLEM | MATERNAL HEALTH LANDSCAPE AND TRENDS

To develop effective solutions, it is critical to first understand the nature of the problem. For *Merck for Mothers*, that meant asking and answering fundamental questions about where women go for maternal health care services, the quality of care they receive, and the disparities in maternal mortality and morbidity globally and in the U.S. Using a variety of methodologies – secondary analyses of national household survey data sets, maternal mortality reviews, and birth registries – our partners sought answers to these questions.

The 23 publications in this section ask and answer questions such as:

- **WHERE DO WOMEN IN LOW- AND MIDDLE-INCOME COUNTRIES RECEIVE MATERNITY CARE?**
- **WHY ARE WOMEN DYING DURING PREGNANCY AND CHILDBIRTH IN THE UNITED STATES?**
- **WHAT IS THE BURDEN AND COST OF SEVERE MATERNAL MORBIDITY IN THE UNITED STATES?**

“Investing in the creation of a standardized Demographic and Health Survey data set for low- and middle-income countries was a significant contribution to the field. Today, we not only better understand where women seek care and can use this data set to answer a multitude of other important questions, these insights have advanced efforts to strengthen engagement with local private sector providers as critical partners in achieving the reproductive and maternal health related SDGs.”

Mariam Claeson, MD, MPH
Senior Adviser, Health, Nutrition and Population, World Bank

“Disparities in maternal health outcomes between white women and women of color are persistent, intolerable and preventable. Merck for Mothers’ support of maternal morbidity research is shedding light on the enduring impact structural racism has on health and is spurring New York City’s response to this urgent public health problem.”

Mary T. Bassett, MD, MPH
Commissioner, New York City Department of Health and Mental Hygiene

SPOTLIGHT PUBLICATION

When we launched *Merck for Mothers*, one of our first questions was: where are pregnant women seeking care, and what can we do to enhance that experience and make sure they have a healthy pregnancy and a safe childbirth? With our support, the London School of Hygiene & Tropical Medicine conducted the most comprehensive analysis to date of where women seek maternal health services based on Demographic and Health Survey data from nearly 60 low- and middle-income countries.

Family planning, antenatal and delivery care: cross-sectional survey evidence on levels of coverage and inequalities by public and private sector in 57 low- and middle-income countries

Tropical Medicine & International Health, February 2016. Campbell, O.M., et al.

OBJECTIVE: The objective of this study was to assess the role of the private sector in low- and middle-income countries (LMICs). We used Demographic and Health Surveys for 57 countries (2000 - 2013) to evaluate the private sector's share in providing three reproductive and maternal/newborn health services (family planning, antenatal and delivery care), in total and by socio-economic position.

METHODS: We used data from 865,547 women aged 15 - 49, representing a total of 3 billion people. We defined 'met and unmet need for services' and 'use of appropriate service types' clearly and developed explicit classifications of source and sector of provision.

RESULTS: Across the four regions (sub-Saharan Africa, Middle East/Europe, Asia and Latin America), unmet need ranged from 28% to 61% for family planning, 8% to 22% for ANC and 21% to 51% for delivery care. The private-sector share among users of family planning services was 37 - 39% across regions (overall mean: 37%; median across countries: 41%). The private-sector market share among users of ANC was 13 - 61% across regions (overall mean: 44%; median across countries: 15%). The private-sector share among appropriate deliveries was 9 - 56% across regions (overall mean: 40%; median across countries: 14%). For all three healthcare services, women in the richest wealth

quintile used private services more than the poorest. Wealth gaps in met need for services were smallest for family planning and largest for delivery care.

CONCLUSIONS: The private sector serves substantial numbers of women in LMICs, particularly the richest. To achieve universal health coverage, including adequate quality care, it is imperative to understand this sector, starting with improved data collection on healthcare provision.

SPOTLIGHT PUBLICATION

While maternal mortality is a problem that mainly affects developing countries, surprisingly, it is on the rise in the United States. We supported research that would help us understand the maternal health landscape nationwide. For example, we partnered with The New York City Department of Health & Mental Hygiene to conduct the first-ever analysis of the burden of severe maternal morbidity: unexpected outcomes of labor and delivery that result in significant short- or long-term health consequences.

New York City, 2008–2012: Severe Maternal Morbidity. *New York City Department of Health and Mental Hygiene, Bureau of Maternal, Infant and Reproductive Health. 2016*

Despite a century of significant improvements in maternal health, pregnancy-related deaths in the United States continue to rise. Similarly, severe maternal morbidity (SMM)—life-threatening complications during delivery—has increased steadily in recent years. To date, much of the national conversation on maternal health has focused on maternal mortality, although it represents a small proportion of the total burden of maternal morbidity. This report focuses on SMM in New York City from 2008 to 2012.

KEY FINDINGS:

The rate of SMM in New York City increased 28.2% from 2008 to 2012 (197.2 per 10,000 deliveries in 2008 to 252.9 per 10,000 deliveries in 2012)

- New York City's rate of SMM was 1.6 times the national rate from 2008 to 2009.
- Black non-Latina women had the highest SMM rate—three times that of White non-Latina women. This rate remained high even after stratifying by other known risk factors such as low education, neighborhood poverty level and pre-pregnancy obesity. Rates were also high among Puerto Rican and other Latina women compared to White non-Latina women.
- SMM rates were highest among women living in high-poverty neighborhoods.
- The leading indicators of SMM included blood transfusion, disseminated intravascular coagulation, hysterectomy, ventilation and

adult respiratory distress syndrome. These indicators reflect the management of, and the end-organ failure associated with, many of the leading causes of pregnancy-related mortality, including hemorrhage, pregnancy-induced hypertension and embolism.

- Women with an underlying chronic condition such as hypertension, diabetes or heart disease were three times as likely to have SMM as women with no chronic conditions.
- The economic burden of SMM was high, with SMM deliveries costing, on average, \$15,714 compared to \$9,357 for deliveries without SMM (after adjusting for other drivers of cost). From 2008 to 2012, the total excess costs related to SMM in New York City exceeded \$85 million, an extra \$17 million each year.

KEY RECOMMENDATIONS:

- Implement programmatic and policy interventions aimed at improving women's overall health and directed at populations disproportionately burdened by SMM.
 - Document costs and cost savings of intervention
 - Conduct ongoing surveillance to measure the impact of interventions and track progress in reducing SMM in New York City.
 - Research the conditions and modifiable risk factors that contribute to SMM disparities, including qualitative research on the experiences of women and families impacted by SMM.
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PUBLICATIONS

GLOBAL

PAPERS

Agrawal, P., et al., **The role of private providers in maternal health.** *Lancet Global Health*; 2(3): e133-4. doi: 10.1016/S2214-109X (14)70006-3. March 2014

Benova, L., et al., **Role of the private sector in childbirth care: Cross-sectional survey evidence from 57 low- and middle-income countries using Demographic and Health Surveys.** *Tropical Medicine & International Health*; 20(12):1657-73. December 2015

Benova, L., et al., **Should I stay or should I go?: Consistency and switching of delivery locations among new mothers in 39 Sub-Saharan African and South/Southeast Asian countries.** *Health Policy and Planning*; 32(9):1294-1308. doi: 10.1093/heapol/czx087. November 2017

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Firoz, T., et al., **Measuring maternal health: Focus on maternal morbidity.** *The Bulletin of the World Health Organization*; 91(10):794-6. doi: 10.2471/BLT.13.117564. October 2013

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Gamell, A., et al., on behalf of the KIULARCO Study Group, **Prevention of mother-to-child transmission of HIV Option B+ cascade in rural Tanzania: The One Stop Clinic model.** *PLoS One*; 12(7): e0181096. doi: 10.1371/journal.pone.0181096. July 2017

Gamell, A., et al., **A case series of acquired drug resistance-associated mutations in human immunodeficiency virus-infected children: An emerging public health concern in rural Africa.** *Open Forum Infectious Diseases*; 3(1): ofv199. doi: 10.1093/ofid/ofv199. December 2015

Oakley, L., et al., **Early breastfeeding practices: Descriptive analysis of recent Demographic and Health Surveys.** *Maternal & Child Nutrition*. doi: 10.1111/mcn.12535. October 2017

Oladapo, O.T., et al., **When getting there is not enough: A nationwide cross-sectional study of 998 maternal deaths and 1451 near-misses in public tertiary hospitals in a low-income country. Nigeria Near-miss and Maternal Death Surveillance Network.** *British Journal of Obstetrics and Gynaecology*; 123(6):928-38. doi: 10.1111/1471-0528.13450. May 2016

Owolabi, O., et al., **Comparing the use and content of antenatal care in adolescent and older first-time mothers in 13 countries of west Africa: A cross-sectional analysis of Demographic and Health Surveys.** *The Lancet Child & Adolescent Health*. August 2017

Powell-Jackson, T., et al., **The role of the private sector in the provision of antenatal care: A study of Demographic and Health Surveys from 46 low- and middle-income countries.** *Tropical Medicine & International Health*; 20(2):230-9. February 2015

US

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Agrawal, P., **Maternal mortality and morbidity in the United States of America.** *The Bulletin of the World Health Organization*; 93(3):135. doi: 10.2471/BLT.14.148627. March 2015

Agrawal, P., **Leveraging the Affordable Care Act to improve the health of mothers and newborns.** *Obstetrics & Gynecology*; 122(4):904. doi: 10.1097/AOG.0b013e3182a79b11. October 2013

Ananth, C.V. and D'Alton, M.E. **Maternal mortality and serious morbidity in New York.** *Seminars in Perinatology*; 40(2):79-80. doi: 10.1053/j.semperi.2015.11.010. December 2015

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Goffman, D., et al., **Obstetric hemorrhage: A global review.** *Seminars in Perinatology*; 40(2):96-8. doi: 10.1053/j.semperi.2015.11.014. December 2015

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Pugh, T. and Schafer, P., **Recent and ongoing initiatives in New York to reduce maternal mortality.** New York Maternal Mortality Summit. February 2018

EXPLORING PROMISING SOLUTIONS | QUALITY OF MATERNITY CARE

Between 2003 and 2013, the proportion of women who delivered in health facilities increased in every region of the world among almost all wealth groups. Despite this success, maternal mortality rates are still not declining as rapidly as anticipated, likely due to the poor quality of care women receive. Meanwhile, the rise in maternal mortality in the U.S. is causing growing concern about women's care. National and international leaders are calling for greater attention to care quality, which may be the linchpin to save more lives.

The 34 *Merck for Mothers*-supported publications in this section respond to that call by asking and answering questions such as:

- **WHAT KINDS OF MODELS AND APPROACHES CAN IMPROVE THE QUALITY OF MATERNAL HEALTH CARE?**
- **CAN FRANCHISING PRIVATE MATERNITY PROVIDERS IMPROVE QUALITY, ACCESS, AND EQUITY?**
- **DO NURSES AND PATIENTS KNOW WHAT POSTPARTUM COMPLICATIONS LOOK LIKE IN THE UNITED STATES?**

"The evidence on gaps in nurses' knowledge points to a clear need to re-think how we approach postpartum education so that women have the information they need to recognize warning signs and obtain the care they need in the U.S."

Debra Bingham, DrPH, RN, FAAN
Founder and Executive Director, Institute for Perinatal Quality Improvement

"By supporting the rigorous evaluation of quality improvement models for private providers, Merck for Mothers is filling a critical gap in global efforts to improve the quality of care women receive during labor and delivery."

Margaret E. Kruk, MD, MPH
Associate Professor of Global Health, Harvard T.H. Chan School of Public Health

SPOTLIGHT PUBLICATION

Some women choose private providers because they perceive that quality of care is better. With our support, teams from LSHTM evaluated the quality of maternity care among public and private providers in Uttar Pradesh, India. The findings signal that quality is subpar across sectors. To ensure that quality maternity care is universally available, we believe that both private and public providers must be part of national quality initiatives.

Quality of routine essential care during childbirth: clinical observations of uncomplicated births in Uttar Pradesh, India

Bulletin of the World Health Organization, April 2017. Sharma, G., et al.

OBJECTIVE: To evaluate the quality of essential care during normal labour and childbirth in maternity facilities in Uttar Pradesh, India.

METHODS: Between 26 May and 8 July 2015, we used clinical observations to assess care provision for 275 mother–neonate pairs at 26 hospitals. Data on 42 items of care were collected, summarized into 17 clinical practices and three aggregate scores and then weighted to obtain population-based estimates. We examined unadjusted differences in quality between the public and private facilities. Multilevel linear mixed-effects models were used to adjust for birth attendant, facility and maternal characteristics.

FINDINGS: The quality of care we observed was generally poor in both private and public facilities; the mean percentage of essential clinical care practices completed for each woman was 35.7%. Weighted estimates indicate that unqualified personnel provided care for 73.0% and 27.0% of the mother–neonate pairs in public and private facilities, respectively. Obstetric, neonatal and overall care at birth appeared better in the private facilities than in the public ones. In the adjusted analysis, the score for overall quality of care in private facilities was found to be six percentage points higher than the corresponding score for public facilities.

CONCLUSION: In 2015, the personnel providing labour and childbirth care in maternity facilities were often unqualified and adherence to care protocols was generally poor. Initiatives to measure and improve the quality of care during labour and childbirth need to be developed in the private and public facilities in Uttar Pradesh.

SPOTLIGHT PUBLICATION

In the United States, we worked with leading provider associations and quality improvement partners to test models that equip providers to offer quality care. These partners implemented evidence-based practices (“safety bundles”) to manage obstetric emergencies in more than 300 hospitals in five states. Informed by the success of this initiative and related ones, the U.S. government and *Merck for Mothers* are exploring a nationwide scale-up of safety bundles for three of the leading causes of maternal death: hemorrhage, preeclampsia/eclampsia and venous thromboembolism.

Reduction of severe maternal morbidity from hemorrhage using a state-wide perinatal collaborative

American Journal of Obstetrics and Gynecology, January 2017. Main, E.K., et al.

BACKGROUND: Obstetric hemorrhage is the leading cause of severe maternal morbidity and of preventable maternal mortality in the United States. The California Maternal Quality Care Collaborative developed a comprehensive quality improvement tool kit for hemorrhage based on the national patient safety bundle for obstetric hemorrhage and noted promising results in pilot implementation projects.

OBJECTIVE: We sought to determine whether these safety tools can be scaled up to reduce severe maternal morbidity in women with obstetric hemorrhage using a large maternal quality collaborative.

STUDY DESIGN: We report on 99 collaborative hospitals (256,541 annual births) using a before-and-after model with 48 noncollaborative comparison hospitals (81,089 annual births) used to detect any systemic trends. Both groups participated in the California Maternal Data Center providing baseline and rapid-cycle data. Baseline period was the 48 months from January 2011 through December 2014. The collaborative started in January 2015 and the postintervention period was the 6 months from October 2015 through March 2016. We modified the Institute for Healthcare Improvement collaborative model for achieving breakthrough improvement to include the mentor model whereby 20 pairs of nurse and physician mentors experienced in quality improvement gave additional support to small

groups of 6-8 hospitals. The national hemorrhage safety bundle served as the template for quality improvement action. The main outcome measurement was the composite Centers for Disease Control and Prevention severe maternal morbidity measure, for both the target population of women with hemorrhage and the overall delivery population. The rate of adoption of bundle elements was used as an indicator of hospital engagement and intensity.

RESULTS: Compared to baseline period, women with hemorrhage in collaborative hospitals experienced a 20.8% reduction in severe maternal morbidity while women in comparison hospitals had a 1.2% reduction ($P < .0001$). Women in hospitals with prior hemorrhage collaborative experience experienced an even larger 28.6% reduction. Fewer mothers with transfusions accounted for two-thirds of the reduction in collaborative hospitals and fewer procedures and medical complications, the remainder. The rate of severe maternal morbidity among all women in collaborative hospitals was 11.7% lower and women in hospitals with prior hemorrhage collaborative experience had a 17.5% reduction. Improved outcomes for women were noted in all hospital types (regional, medium, small, health maintenance organization, and non-health maintenance organization). Overall, 54% of hospitals completed 14 of 17 bundle elements, 76% reported regular unit-based drills, and 65% reported regular post hemorrhage debriefs. Higher

SPOTLIGHT PUBLICATION CONT.

rate of bundle adoption was associated with improvement of maternal morbidity only in hospitals with high initial rates of severe maternal morbidity.

CONCLUSION: We used an innovative collaborative quality improvement approach (mentor model) to scale up implementation of the national hemorrhage bundle. Participation in the collaborative was strongly associated with reductions in severe maternal morbidity among hemorrhage patients. Women in hospitals in their second collaborative had an even greater reduction in morbidity than those approaching the bundle for the first time, reinforcing the concept that quality improvement is a long-term and cumulative process.

PUBLICATIONS

GLOBAL

PAPERS

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UNDERSTANDING WOMEN'S PREFERENCES | ACCESS TO MODERN CONTRACEPTION

When women have reliable access to modern contraception, we can avert up to one-third of maternal deaths. Lower maternal mortality is just one of the ripple effects that using modern contraception can have on a woman's life. Despite global increases in use of contraception, unmet need for modern contraception remains too high. That is why *Merck for Mothers* invests in programs, evidence, and advocacy to increase women's access to the contraceptive method of their choice.

The five publications in this section ask and answer questions such as:

- **WHERE DO WOMEN RECEIVE CONTRACEPTIVE SERVICES AND PRODUCTS?**
- **HOW DO ADOLESCENTS' UNMET NEEDS FOR CONTRACEPTION DIFFER FROM OLDER WOMEN'S?**

"Understanding the needs and preferences of women – especially adolescents – in seeking contraceptive products and services is a critical step towards reducing unmet need globally."

Julia Bunting, MSc
President, Population Council

SPOTLIGHT PUBLICATION

Our partners at the London School of Hygiene & Tropical Medicine analyzed Demographic Health Survey data to improve the field's understanding of where women seek family planning services. Better understanding women's preferences – across ages and geographies – informs the solutions we and others can develop to help ensure women have access to the contraceptive methods of their choice, no matter where they seek services.

Who, what, where: An analysis of private sector family planning provision in 57 low- and middle-income countries

Journal of Tropical Medicine & International Health, December 2015. Campbell, O.M., et al.

OBJECTIVE: Family planning service delivery has been neglected; rigorous analyses of the patterns of contraceptive provision are needed to inform strategies to address this neglect.

METHODS: We used 57 nationally representative Demographic and Health Surveys in low- and middle-income countries (2000-2013) in four geographic regions to estimate need for contraceptive services, and examined the sector of provision, by women's socio-economic position. We also assessed method mix and whether women were informed of side effects.

RESULTS: Modern contraceptive use among women in need was lowest in sub-Saharan Africa (39%), with other regions ranging from 64% to 72%. The private sector share of the family planning market was 37-39% of users across the regions and 37% overall (median across countries: 41%). Private sector users accessed medical providers (range across regions: 30-60%, overall mean: 54% and median across countries 23%), specialised drug sellers (range across regions: 31-52%, overall mean: 36% and median across countries: 43%) and retailers (range across regions: 3-14%, overall mean: 6% and median across countries: 6%). Private retailers played a more important role in sub-Saharan Africa (14%) than in other regions (3-5%). NGOs and FBOs served a small percentage. Privileged women (richest wealth quintile, urban residents or secondary-/tertiary-level education) used private sector services more than the less privileged. Contraceptive method types with

higher requirements (medical skills) for provision were less likely to be acquired from the private sector, while short-acting methods/injectables were more likely. The percentages of women informed of side effects varied by method and provider subtype, but within subtypes were higher among public than private medical providers for four of five methods assessed.

CONCLUSION: Given the importance of private sector providers, we need to understand why women choose their services, what quality services the private sector provides, and how it can be improved. However, when one of the two sectors (public vs. private), it is critical to consider the potential impact on contraceptive prevalence and equity of met need.

SPOTLIGHT PUBLICATION

Our partners analyzed DHS data from sub-Saharan Africa to better understand where young women seek contraceptive services. Understanding young women's preferences for contraceptive services informs how we – and others – develop approaches to ensure that adolescents' and young women's health care needs are not overlooked.

Who meets the contraceptive needs of young women in sub-Saharan Africa?

Journal of Adolescent Health, March 2018. Radovich, E., et al.

PURPOSE: Despite efforts to expand contraceptive access for young people, few studies have considered where young women (age 15-24) in low- and middle-income countries obtain modern contraceptives and how the capacity and content of care of sources used compares with older users.

METHODS: We examined the first source of respondents' current modern contraceptive method using the most recent Demographic and Health Survey since 2000 for 33 sub-Saharan African countries. We classified providers according to sector (public/private) and capacity to provide a range of short- and long-term methods (limited/comprehensive). We also compared the content of care obtained from different providers.

RESULTS: Although the public and private sectors were both important sources of family planning (FP), young women (15-24) used more short-term methods obtained from limited-capacity, private providers, compared with older women. The use of long-term methods among young women was low, but among those users, more than 85% reported a public sector source. Older women (25+) were significantly more likely to utilize a comprehensive provider in either sector compared with younger women. Although FP users of all ages reported poor content of care across all providers, young women had even lower content of care.

CONCLUSIONS: The results suggest that method and provider choice are strongly linked, and recent efforts to increase access to long-term methods among young women may be restricted by where they seek care. Interventions to increase adolescents' access to a range of FP methods and quality counseling should target providers frequently used by young people, including limited-capacity providers in the private sector.

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2 IMPROVING HEALTH CARE DELIVERY | HEALTH SYSTEMS STRENGTHENING

Maternal mortality is often called a health systems problem. When women do not survive labor and delivery, it is typically because some element of the health system was not functioning as it should. As a health care company, we understand the importance of strong, resilient health systems to save lives and improve the health of millions of people around the world.

The 28 publications in this section ask and answer questions such as:

- CAN PRIVATE SECTOR SOLUTIONS HELP STRENGTHEN PUBLIC HEALTH SUPPLY CHAINS?
- HOW CAN BETTER SURVEILLANCE MECHANISMS – SUCH AS MATERNAL MORTALITY REVIEW BOARDS – LEAD TO A MORE EFFECTIVE HEALTH SYSTEM RESPONSE?
- CAN MATERNITY WAITING HOMES HELP WOMEN OVERCOME THE DISTANCE BARRIER TO DELIVERING IN FACILITIES?

“Research undertaken by Saving Mothers, Giving Life, one of the most impactful public private partnerships we’ve seen in maternal health, emphasized the importance of understanding not only implementation challenges but also the dynamics of a complex partnership.”

Claudia Morrissey Conlon, MD, MPH
USAID Senior Maternal and Newborn Health Advisor
USG Lead, *Saving Mothers, Giving Life*

SPOTLIGHT PUBLICATION

Our partners documented insights and results from an innovative model to strengthen the contraceptive supply chain in Senegal by integrating private logistics providers. After documenting substantial reductions in stock-outs, the model is expanding broadly, enabling the country to reliably distribute an additional 90 commodities, including critical medicines for pediatric illnesses, HIV/AIDS, tuberculosis and malaria.

Understanding and addressing contraceptive stockouts to increase family planning access and uptake in Senegal.

Journal of Pharmaceutical Policy and Practice, December 2014. Hasselback, L., et al.

BACKGROUND: Senegal's government has pledged to reduce contraceptive stockouts, which have been frequent in public sector health facilities. An innovative distribution system called the Informed Push Model (IPM) addresses supply chain obstacles through direct regional-to-facility delivery of contraceptives and use of private sector logistics operators. Following promising pilot results, Senegal's Ministry of Health and Social Action committed to a three-year (2013–2016) expansion of IPM to all public health facilities nationwide.

METHODS: From August 2014 – July 2016, IPM's six logisticians made 29,319 visits to restock public sector health facilities. During these regular facility visits, the logisticians conducted a physical inventory to flag contraceptive stockouts (no usable stock of any single method available) and asked facility staff to identify the primary reason for documented stockouts. Our descriptive study examines stockout trends over the course of IPM scale-up. The study also describes trends in contraceptive consumption over the three-year period using facility-level data collected by the logisticians.

RESULTS: Contraceptive consumption rose by 91% over 35 months in the first three IPM regions, and by 118% in the next five regions (over 26 months). After scale-up to 1,394 health facilities, nationwide consumption rose by 48% over one year. On average, logisticians documented stockouts at fewer than 2% of facility visits. In comparison, two pre-IPM

studies in 2011 identified stockouts of selected modern contraceptives at 60–70% of facilities visited, with 84% of clients reporting stockouts in the past year. Six factors (including consumption spikes, IPM-preventable causes, and community outreach) explained most remaining stockouts.

CONCLUSIONS: IPM has been highly successful in ensuring full availability of contraceptives across regions and health facilities. The model also has facilitated the flow of essential data on consumption and stockouts from facilities up to district, regional, and central-level managers. These achievements highlight the relevance of professionalizing supply chain management while continuing to mitigate stockouts through enhanced stakeholder communication and improved training, coaching, and supervision of third-party logistics operators. Supply reliability is critical in shaping demand for and regular use of contraception. The government is transitioning the IPM to full management by the National Supply Pharmacy.

SPOTLIGHT PUBLICATION

Merck for Mothers is a proud partner in *Saving Mothers, Giving Life*: a comprehensive initiative focused on strengthening health systems at the district level. The success of this health systems strengthening effort hinged on making a distinctive public private partnership work. We believe that working across sectors is critical for real systems change.

‘Big push’ to reduce maternal mortality in Uganda and Zambia enhanced health systems but lacked a sustainability plan

Health Affairs, June 2014. Kruk, M.E., et al.

In the past decade, “big push” global health initiatives financed by international donors have aimed to rapidly reach ambitious health targets in low-income countries. The health system impacts of these efforts are infrequently assessed. *Saving Mothers, Giving Life* is a global public-private partnership that aims to reduce maternal mortality dramatically in one year in eight districts in Uganda and Zambia. We evaluated the first six to twelve months of the program’s implementation, its ownership by national ministries of health, and its effects on health systems. The project’s impact on maternal mortality is not reported here. We found that the *Saving Mothers, Giving Life* initiative delivered a large “dose” of intervention quickly by capitalizing on existing US international health assistance platforms, such as the President’s Emergency Plan for AIDS Relief. Early benefits to the broader health system included greater policy attention to maternal and child health, new health care infrastructure, and new models for collaborating with the private sector and communities. However, the rapid pace, external design, and lack of a long-term financing plan hindered integration into the health system and local ownership. Sustaining and scaling up early gains of similar big push initiatives requires longer-term commitments and a clear plan for transition to national control.

SPOTLIGHT PUBLICATION

In the U.S., *Merck for Mothers* worked with the Centers for Disease Prevention and Control (CDC) to strengthen maternal death surveillance nationally. As a next step, the CDC is working across the country to strengthen state review boards' capacity to translate findings from maternal death reviews into action.

Building U.S. Capacity to Review and Prevent Maternal Deaths

MMRIA Review to Action. 2018

Approximately 700 women across the United States (U.S.) die each year as a result of pregnancy or pregnancy-related complications. Non-Hispanic black women experience maternal deaths at a rate three to four times that of non-Hispanic white women, a racial disparity that is mirrored across many maternal and infant outcomes. While surveillance using vital statistics can tell us about trends and disparities, state and local maternal mortality review committees (MMRC) are best positioned to comprehensively assess maternal deaths and identify opportunities for prevention. The Maternal Mortality Review Information Application (MMRIA) and its precursor, the Maternal Mortality Review Data System (MMRDS), assist MMRCs in abstracting relevant data from a diversity of sources, documenting committee decisions for each reviewed maternal death, and analyzing data for action. Using data from nine MMRCs (hereafter, the Nine Committees), this updated and expanded report includes—for the first time—recommendations for prevention, discussion of severe maternal morbidity review, and novel work on a MMRIA socio-spatial dashboard to incorporate health equity into MMRC discussions.

Nearly 50% of all pregnancy-related deaths were caused by hemorrhage, cardiovascular and coronary conditions, cardiomyopathy, or infection. The leading underlying causes of death varied by race. Preeclampsia and eclampsia, and embolism were leading underlying causes of death among non-Hispanic black women. Over a three-year period, the United Kingdom had only two deaths from preeclampsia and eclampsia, suggesting deaths from these hypertensive disorders of pregnancy are highly preventable. Mental health conditions

were a leading underlying cause of death among non-Hispanic white women, reinforcing the value of MMRCs including mental health-related maternal deaths in the scope of their review, and having access to information beyond death certificates.

The Nine Committees estimated that over 60% of pregnancy-related deaths were preventable. The most common factors identified as contributing to the death were patient/family factors (e.g., lack of knowledge on warning signs and need to seek care) followed by provider (e.g., misdiagnosis and ineffective treatments) and systems of care factors (e.g., lack of coordination between providers). While the Nine Committees most commonly identified patient factors, the patient factors identified are often dependent on providers and systems of care. For the first time, the Nine Committees provided analyzable recommendations to prevent future maternal deaths and the estimated level of potential impact if those recommendations were implemented. The following were the most common recommendation themes that the Nine Committees also estimated to have the largest potential for population-level impact if implemented: adopting levels of maternal care, improving policies regarding prevention initiatives, enforcing policies and procedures related to obstetric hemorrhage, and improving policies related to patient management. Social and environmental factors may also contribute to a woman's risk of dying during or within one year of pregnancy. MMRCs can incorporate contextual social determinants of health into case discussions and translate findings into specific recommendations. This report is a demonstration of MMRCs' potential to address health equity as a strategy to reduce maternal mortality and severe maternal morbidity.

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NURTURING A CULTURE OF INVENTION | PRODUCT AND DIGITAL INNOVATIONS

Innovation and invention are part of Merck's DNA, so it was important that our research examine cutting-edge solutions. We invest in research that explores the potential for new products and digital platforms to help healthcare providers and health systems deliver care more effectively.

The 14 publications in this section ask and answer questions such as:

- WHAT IMPACT HAS A MOBILE TRAINING TOOL HAD ON IMPROVING HEALTHCARE WORKERS' KNOWLEDGE AND SKILLS?
- WHAT IS THE QUALITY OF UTEROTONICS IN LOW- AND MIDDLE-INCOME COUNTRIES?
- HOW EFFECTIVE AND SAFE IS A HEAT-STABLE ALTERNATIVE TO OXYTOCIN TO PREVENT POSTPARTUM HEMORRHAGE?

"Merck for Mothers' commitment to taking risks on new innovations was essential in getting the Safe Delivery App to where it is today."

Anna Cecilia Frellsen
CEO, Maternity Foundation

SPOTLIGHT PUBLICATION

We are continually exploring how new and improved products could improve maternal health outcomes. In partnership with organizations like the World Health Organization, we are focusing on the leading causes of maternal mortality, like eclampsia, postpartum hemorrhage, and puerperal sepsis. A clinical trial of heat-stable carbetocin – the largest clinical trial of postpartum hemorrhage to date – has the potential to offer game-changing evidence on how to prevent postpartum hemorrhage.

Room temperature stable carbetocin for the prevention of postpartum hemorrhage during the third stage of labor in women delivering vaginally: study protocol for a randomized controlled trial

Trials, March 2016. Widmer, M., et al.

BACKGROUND: Postpartum haemorrhage (PPH) is the leading cause of maternal mortality in low-income countries and contributes to nearly a quarter of maternal deaths globally. The current available interventions for prevention of postpartum haemorrhage, oxytocin and carbetocin, are limited by their need for refrigeration to maintain potency, as the ability to maintain a cold chain across the drug distribution and storage network is inconsistent, thus restricting their use in countries with the highest burden of maternal mortality. We describe a randomized, double-blind non-inferiority trial comparing a newly developed room temperature stable formulation of carbetocin to the standard intervention (oxytocin) for the prevention of PPH after vaginal birth.

METHODS/DESIGN: Approximately 30,000 women delivering vaginally will be recruited across 22 centres in 10 countries. The primary objectives are to evaluate the non-inferiority of room temperature stable carbetocin (100 µg intramuscular) versus oxytocin (10 IU intramuscular) in the prevention of PPH and severe PPH after vaginal birth. The primary endpoints are blood loss ≥ 500 mL or the use of additional uterotonics (composite endpoint required by drug regulatory authorities) and blood loss $\geq 1,000$ mL (WHO requirement). Non-inferiority will be assessed using a two-sided 95 % confidence interval for the relative risk of the above endpoints for room temperature stable

carbetocin versus oxytocin. The upper limit of the two-sided 95 % confidence interval for the relative risk for the composite endpoint of blood loss ≥ 500 mL or the use of additional uterotonics, and for the endpoint of blood loss $\geq 1,000$ mL, will be compared to a non-inferiority margin of 1.16 and 1.23, respectively. If the upper limit is below the corresponding margin, non-inferiority will have been demonstrated. The safety analysis will include all women receiving treatment. Safety and tolerability will be assessed by a review of adverse events, by conducting inferential testing with significance levels for between-group comparisons.

DISCUSSION: If the results of the study show that room temperature stable carbetocin is a safe and effective alternative to oxytocin, this could have a substantial impact on the prevention of postpartum haemorrhage and maternal survival worldwide.

SPOTLIGHT PUBLICATION

We are also working with partners to design and test promising digital innovations to improve maternal health and family planning services. For example, we partnered with the Maternity Foundation to understand the potential for the Safe Delivery App to train health care workers. The evaluation found that the app could improve healthcare workers' knowledge – offering a promising low-tech, scalable tool for healthcare training in global settings.

Association between the Safe Delivery App and quality of care and perinatal survival in Ethiopia: A randomized clinical trial

JAMA Pediatrics, June 2016. Lund, S., et al.

IMPORTANCE: Health apps in low-income countries are emerging tools with the potential to improve quality of health care services, but few apps undergo rigorous scientific evaluation.

OBJECTIVE: To determine the effects of the safe delivery app (SDA) on perinatal survival and on health care workers' knowledge and skills in neonatal resuscitation.

DESIGN, SETTING, AND PARTICIPANTS: In a cluster-randomized clinical trial in 5 rural districts of Ethiopia, 73 health care facilities were randomized to the mobile phone intervention or to standard care (control). From September 1, 2013, to February 1, 2015, 3601 women in active labor were included at admission and followed up until 7 days after delivery to record perinatal mortality. Knowledge and skills in neonatal resuscitation were assessed at baseline and at 6 and 12 months after the intervention among 176 health care workers at the included facilities. Analyses were performed based on the intention-to-treat principle.

INTERVENTIONS: Health care workers in intervention facilities received a smartphone with the SDA. The SDA is a training tool in emergency obstetric and neonatal care that uses visual guidance in animated videos with clinical instructions for management.

MAIN OUTCOMES AND MEASURES: The primary outcome was perinatal death. Secondary outcomes

included the knowledge and clinical management of neonatal resuscitation (skills) of health care workers before the intervention and after 6 and 12 months.

RESULTS: The analysis included 3601 women and 176 health care workers. Use of the SDA was associated with a nonsignificant lower perinatal mortality of 14 per 1000 births in intervention clusters compared with 23 per 1000 births in control clusters (odds ratio, 0.76; 95% CI, 0.32-1.81). The skill scores of intervention health care workers increased significantly compared with those of controls at 6 months (mean difference, 6.04; 95% CI, 4.26-7.82) and 12 months (mean difference, 8.79; 95% CI, 7.14-10.45) from baseline, corresponding to 80% and 107%, respectively, above the control level. Knowledge scores also significantly improved in the intervention compared with the control group at 6 months (mean difference, 1.67; 95% CI, 1.02-2.32) and at 12 months (mean difference, 1.54; 95% CI, 0.98-2.09), corresponding to 39% and 38%, respectively, above the control level.

CONCLUSIONS AND RELEVANCE: The SDA was an effective method to improve and sustain the health care workers' knowledge and skills in neonatal resuscitation as long as 12 months after introduction. Perinatal mortality was insignificantly reduced after the intervention. The results are highly relevant in low-income countries, where quality of care is challenged by a lack of continuing education.

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GLOBAL

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CONCLUSION

The publications presented here represent just some of the work we are doing to advance the field. By taking on issues such as quality of care, health systems strengthening, and access to modern contraception, we hope to move closer to understanding how we can best reduce maternal mortality. This compendium is our way of documenting what we and our partners have done and what we've learned. When we think of the future, we seek to break new ground through our collaboration with implementers, researchers, and advocates to generate evidence that turns maternal mortality into a problem of the past.

ACKNOWLEDGEMENTS

Merck for Mothers thanks our many evidence generation partners for their contributions to this research compendium and their collaboration throughout the initiative, including:

Africare
The American College of Obstetricians and Gynecologists
Association of Maternal and Child Health Programs
Association of Obstetricians and Gynaecologists of Uganda
Association of Women's Health, Obstetric and Neonatal Nurses
The Bill & Melinda Gates Foundation
Boston University
The California Maternal Quality Care Collaborative
The CDC Foundation
Columbia University
Concept Foundation
Convergence Sante pour le Developpement (CSD)
Department of Sociology, Universite Cheikh Anta Diop de Dakar
The Federation of Obstetric and Gynecological Societies of India
Ferring Pharmaceuticals
GfK
Global Financing Facility
Harvard University
Health Insurance Fund
Impact Partners for Social Development (Impact)
IntraHealth
Jhpiego
Johns Hopkins University
The London School of Hygiene & Tropical Medicine
The Maternity Foundation
McGill University
Ministère de la Santé et L'Action Sociale
M4ID
New York Academy of Medicine
The New York City Department of Hygiene and Mental Health: Fund for Public Health in New York
New York University
Ohio State University
PATH
PharmAccess Group
Pharmacie Nationale D'Approvisionnement
Population Council
Population Services International
Programme for Accessible Health Communication and Education (PACE)
Rabin Martin
Sambodhi Research and Communications
Saving Mothers, Giving Life
Sinergias-Alianzas Estratégicas para la Salud y el Desarrollo Social
Society for Family Health
Swiss Tropical Public Health Institute
TRIOs Development Support
University of Colorado
University of Copenhagen
University of Michigan
Vecna Cares
The World Health Organization
Yale University
Zambia Center for Applied Health Research and Development

