

REVIEW ARTICLE

GLOBAL HEALTH

Global Maternal, Newborn, and Child Health — So Near and Yet So Far

Zulfiqar A. Bhutta, M.B., B.S., Ph.D., and Robert E. Black, M.D.

From the Centre for Global Child Health, Hospital for Sick Children (SickKids), Toronto (Z.A.B.); the Center of Excellence in Women and Child Health, Aga Khan University, Karachi, Pakistan (Z.A.B.); and the Institute for International Programs, Bloomberg School of Public Health, Johns Hopkins University, Baltimore (R.E.B.). Address reprint requests to Dr. Bhutta at the Centre for Global Child Health, Hospital for Sick Children (SickKids), Toronto, ON M5G 0A4, Canada, or at zulfiqar.bhutta@sickkids.ca.

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ALITTLE MORE THAN 13 YEARS AGO, WORLD LEADERS ASSEMBLED IN NEW York to sign the Millennium Declaration to address some of the greatest moral dilemmas of our times — unequal global health, poverty, and inequities in development — and to establish a set of interrelated goals and targets to be met by 2015. Key goals included the Millennium Development Goal (MDG) 4 targeting a reduction in mortality among children younger than 5 years of age by two thirds and MDG 5 targeting a reduction in maternal mortality by three quarters, both from 1990 base figures. With less than 3 years to go, despite overall global progress, these two MDGs are seriously off target for many countries.¹

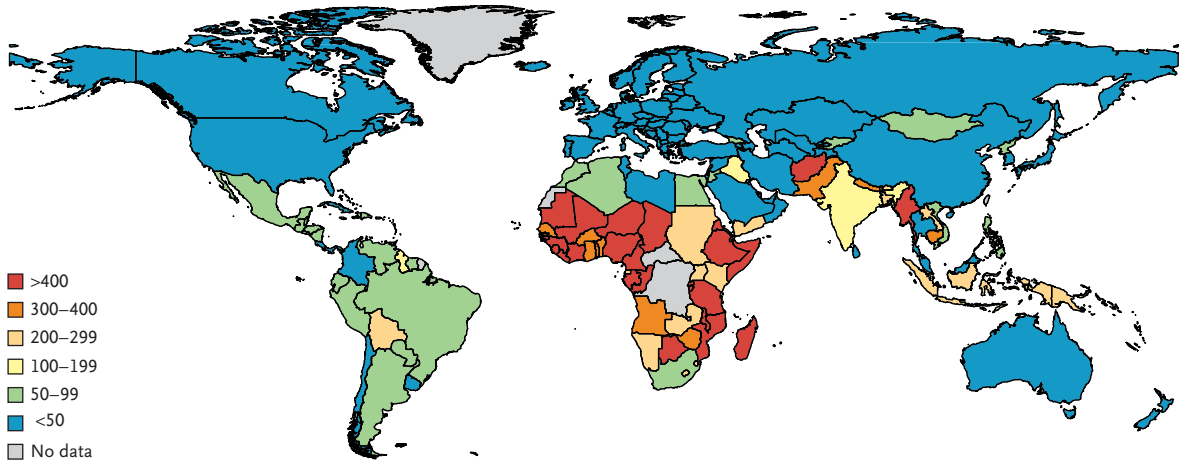
Recent assessment of global statistics suggests that despite major gains, among the 75 so-called Countdown countries that have 98% of all maternal deaths and deaths among children younger than 5 years of age, only 17 are on track to reach the MDG 4 target for child mortality and only 9 are on track to reach the MDG 5 target for maternal mortality.² However, estimates from the Institute for Health Metrics and Evaluation suggest that 31 countries will achieve MDG 4, 13 countries will achieve MDG 5, and only 9 countries will achieve both targets.³ As we celebrate the fact that the annual number of deaths among children younger than 5 years of age has fallen to 6.6 million (uncertainty range, 6.3 to 7.0 million), which is a 48% reduction from the 12.6 million deaths (uncertainty range, 12.4 to 12.9 million) in 1990, despite an increased number of births in many high-burden countries during the same time period,⁴ the sobering realization is that even in countries that will reach their MDG 4 and 5 targets, many will still have high numbers of deaths, with much scope for improvement.

GLOBAL BURDEN AND MORTALITY TRENDS

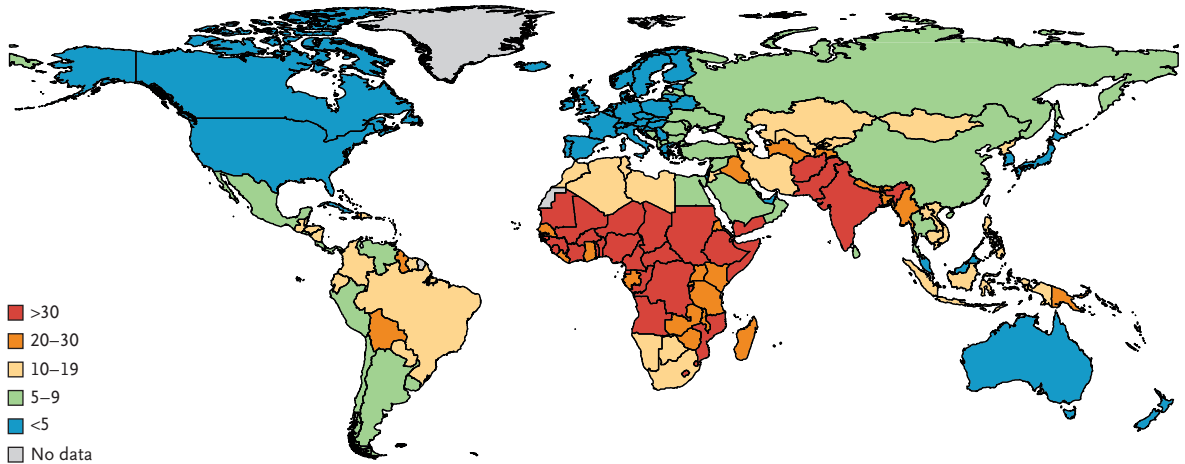
The largest numbers and highest rates of maternal, neonatal, and child deaths are in countries of sub-Saharan Africa and South Asia (Fig. 1).³⁻⁵ A total of 10 countries have almost two thirds of the global burden of maternal and newborn deaths, as well as stillbirths.⁶ Lozano et al.³ compared the rates of decline from 1990 through 2000 with the rates of decline from 2000 through 2011 and found that the majority of countries (106 of 193 countries) had accelerated declines in child mortality in the period from 2000 through 2011. Much of the decline was related to a reduction in postneonatal mortality, whereas the reduction in neonatal mortality was much lower. Lozano et al. also reported an estimated decline in maternal mortality, from 409,100 deaths worldwide in 1990 (uncertainty range, 382,900 to 437,900) to 273,500 deaths in 2011 (uncertainty range, 256,300 to 291,700), which was broadly consistent with the estimate calculated by a United Nations interagency group.⁵

As has been underscored recently,⁷ the bulk of the reduction in child mortality occurred in the decade after the MDG targets were set in 2000 (a 3.2% reduction per year between 2000 and 2011 vs. a 1.8% reduction per year between 1990 and

A Maternal Deaths per 100,000 Live Births in 2010



B Neonatal Deaths per 1000 Live Births in 2011



C Deaths in Children <5 Yr of Age per 1000 Live Births in 2011

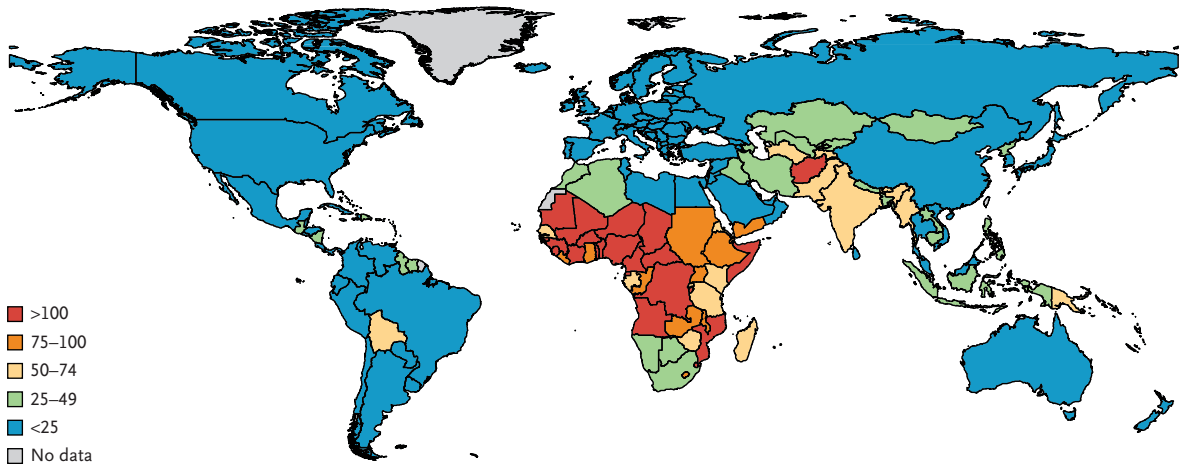
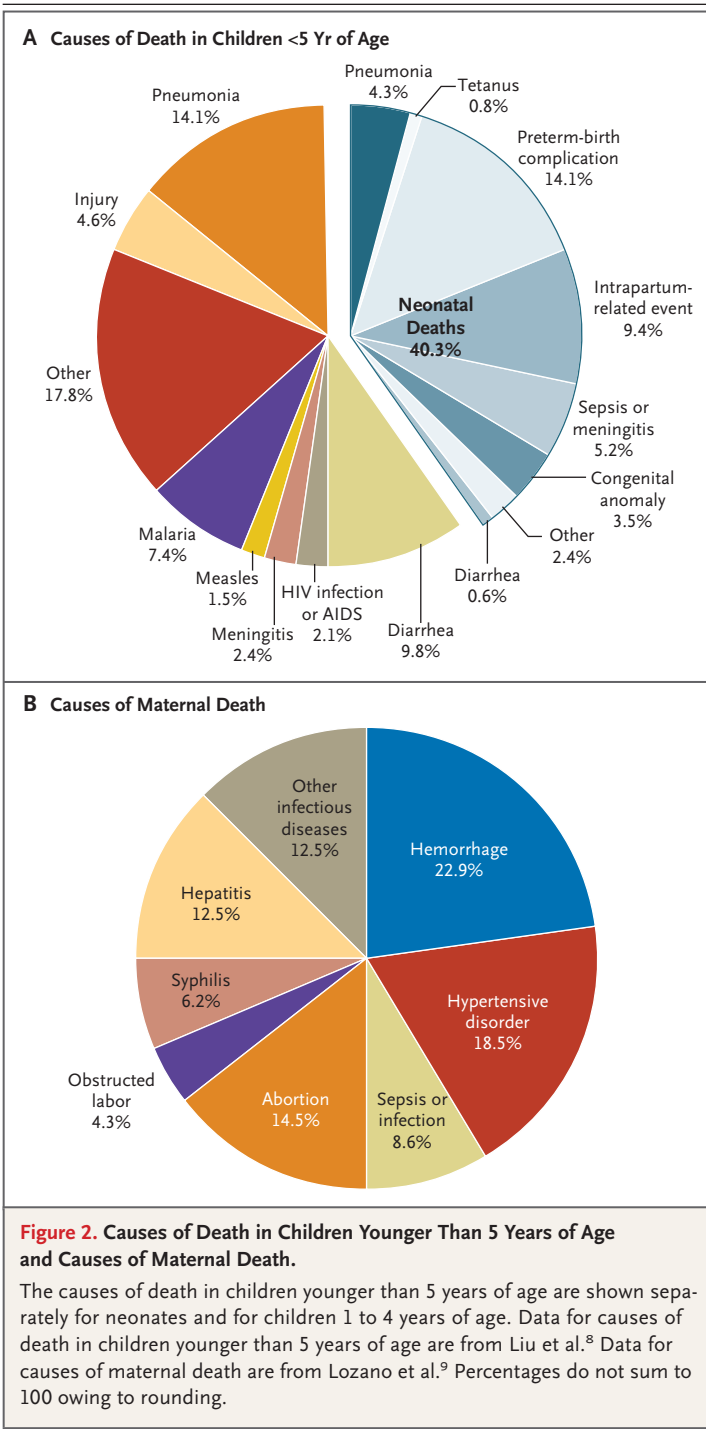


Figure 1. Maternal, Neonatal, and Child Mortality Worldwide.

Maps were generated with data from Lozano et al.,³ the United Nations Children's Fund,⁴ and the United Nations Population Fund.⁵



a reduction in newborn mortality, which currently accounts for 30 to 50% of all deaths among children younger than 5 years of age in sub-Saharan Africa and South Asia.^{3,4,8}

CAUSES OF DEATH

Our knowledge of major causes of maternal, newborn, and child death has increased in parallel with improved global statistics on mortality burden and trends and improved methods for allocating cause of death, although methods and estimates vary considerably. The Child Health Epidemiology Reference Group estimated that 40.3% of 7.6 million deaths among children younger than 5 years of age in 2010 (3.1 million deaths) occurred in neonates.⁸ Major causes of death in newborns included complications of premature birth (14.1% of deaths among children younger than 5 years of age [1.1 million deaths; uncertainty range, 0.9 to 1.3 million]); intrapartum-related complications, previously labeled as birth asphyxia (9.4% [0.7 million deaths; uncertainty range, 0.6 to 0.9 million]); and sepsis or meningitis (5.2% [0.4 million deaths; uncertainty range, 0.3 to 0.6 million]). Other leading causes of death among children younger than 5 years of age included pneumonia (18.4% of deaths [1.4 million deaths; uncertainty range, 1.2 to 1.6 million]), diarrhea (10.4% [0.8 million deaths; uncertainty range, 0.6 to 1.2 million]), and malaria (7.4% [0.6 million deaths; uncertainty range, 0.4 to 0.8 million]) (Fig. 2A).

It must be noted that much of the data are derived from oral autopsies (which are based on questioning family members regarding the mode of death and the events preceding it in circumstances in which medical certification of causes of death and pathological autopsies are not possible) and that in 2010 only 2.7% of the deaths among children younger than 5 years of age (0.2 million deaths) were medically certified. Recent estimates from the Global Burden of Disease (GBD2010) study⁹ suggested broadly similar figures for deaths among children younger than 5 years of age, although some categories were clearly different — notably, a higher proportion of deaths from malaria among children younger than 5 years of age in the GBD2010 estimates and lower numbers of death from pneumonia.

Understanding the causes of deaths allows for improved planning and targeting of interventions. Between 2000 and 2010, most of the reduction

2000). To reach the global MDG target for child survival by 2015, countries would need to accelerate their efforts and achieve at least an annual rate of reduction of 5.5% to reach a projected mortality target for children younger than 5 years of age of 35 deaths per 1000 live births by 2020.^{7,8} Much of the reduction would need to result from

in mortality among children younger than 5 years of age was related to decreases in the rates of death from pneumonia (decrease of 0.5 million deaths; uncertainty range, 0.3 to 0.5 million), measles (decrease of 0.4 million deaths; uncertainty range, 0.3 to 0.4 million), and diarrhea (decrease of 0.4 million deaths; uncertainty range, 0.2 to 0.5 million). The reductions in neonatal deaths during that period from causes other than tetanus, notably those associated with prematurity and intrapartum complications, were minimal. Targeting interventions toward major causes of death and risk factors is a critical step toward achieving MDG 4.

Stillbirth is an unrecognized and unaddressed burden globally. It is not included in the GBD2010 estimates but has been reported separately. An estimated 2.6 million stillbirths (uncertainty range, 2.1 to 3.8 million) occurred worldwide in 2009, of which 76.2% occurred in South Asia and sub-Saharan Africa, mostly among rural populations.¹⁰ An estimated 45% of these stillbirths (1.2 million stillbirths; uncertainty range, 0.8 to 2.0 million) occur during the intrapartum period, which reflects a clear extension of the category of neonatal deaths related to intrapartum events, previously labeled as deaths due to birth asphyxia.¹⁰ This combined burden of stillbirth and early newborn death related to intrapartum events (1.9 million deaths) is similar to the combined number of deaths among children younger than 5 years of age that are related to diarrhea or pneumonia; however, as yet, the burden of stillbirths has not received adequate policy attention.

The information on major causes of maternal death globally is more limited than data on causes of death in children. The last effort to define major categories of maternal death in various regions of the world involved available databases from 1997 through 2002 and was based largely on a review of the literature rather than on registration data on births and deaths.¹¹ Since then, there have been substantial changes in the reporting hierarchy, and recent estimates of causes of maternal death in the GBD2010 analysis (Fig. 2B)⁹ exclude 18,970 deaths related to human immunodeficiency virus (HIV) infection, which are reported separately. As a reflection of the ways in which the diagnostic hierarchies of the *International Classification of Diseases, 10th Revision*, and methods of analysis affect global estimates, the same group reported in

2011 that there were an estimated 56,100 deaths due to HIV infection among pregnant women.³

CAUSES OF THE CAUSES

No discussion of global maternal, newborn, and child health is complete without addressing basic issues of social determinants.¹² Marmot notes that, according to the World Health Organization, “Social determinants of health are the conditions in which people are born, grow, live, work, and age; these circumstances are shaped by the distribution of money, power and resources at global, national, and local levels.”¹³ Much of the burden of maternal and child mortality and ill health is concentrated among the poorest populations in countries of sub-Saharan Africa and South Asia. In many of these countries, the highest mortality is observed among the marginalized and poor, who frequently reside in remote and rural areas with limited access to health care services.

However, a sizable proportion of deaths occurs among the urban poor, who live in slum conditions with limited social-support networks and abysmal living conditions. It has been noted that environmental health factors such as overcrowding, poor air quality, and poor sanitary conditions may be much worse in urban slums than in many rural areas and can adversely affect women and children.^{14,15} This clustering of deaths also reflects the lack of access to quality health services in both rural and urban settings for a number of reasons, including the paucity of trained medical personnel and transportation facilities in rural populations and the lack of knowledge about health services among marginalized, socially isolated migrant families in urban slums.¹⁶

The close link between poverty and undernutrition is also well recognized. It has been estimated that 45% of all deaths among children younger than 5 years of age may be associated with undernutrition, as manifested by fetal growth restriction, stunting, wasting, deficiencies of vitamin A and zinc, and suboptimal breast-feeding (e.g., partial or no breast-feeding and early weaning).¹⁷ Recent analyses of trends in the global burden of stunting suggest that the reductions in rates of stunting in Africa and Asia remain very slow, although there have been improvements elsewhere in the world.^{18,19} The concern regarding undernutrition has also been heightened because of economic crises and an unprecedented increase

in food prices.²⁰ The global food-price indexes are at their highest in decades, with the greatest increases occurring in the prices of cereals, dairy products, and oils.²¹

The relationship of excess child mortality with armed conflict and population displacement is well recognized, although it is not adequately highlighted in global dialogues.²² Not only are women and children much more vulnerable to excess risks than men are, but more than one third (36%) of the total global burden of maternal death, child death, and stillbirth exists in countries that have ongoing national or subnational armed conflict.

For example, it has been estimated that among the 24,853 civilian deaths in the Iraq conflict (among persons of known age) between 2003 and 2008, a total of 15% of the civilian deaths were among women and children, according to the so-called Dirty War Index.²³ The Dirty War Index is calculated as the ratio of undesirable or prohibited cases (defined as civilian death and child death, torture, or injury) as a proportion of total documented cases and deaths, including those in combatants.²⁴ As is evident from the lamentable use of chemical weapons against women and children in Syria,²⁵ the targeting of innocent women and children in conflict zones has become a weapon of war and frequently takes place concomitantly with disrupted and dysfunctional health services. Interventions and approaches to care in such contexts have received inadequate attention.

The disproportionate effect of poverty on the lives of women and children is intertwined with issues of female empowerment and gender equity. The contribution of maternal education to a reduction in child mortality is well described.²⁶ Closely linked with female-empowerment and sociocultural factors are issues of fertility and population growth. These important determinants of maternal and child health have been adversely affected by the lack of attention and funding for reproductive health care and family planning globally.²⁷

IMPLEMENTING EVIDENCE-BASED INTERVENTIONS

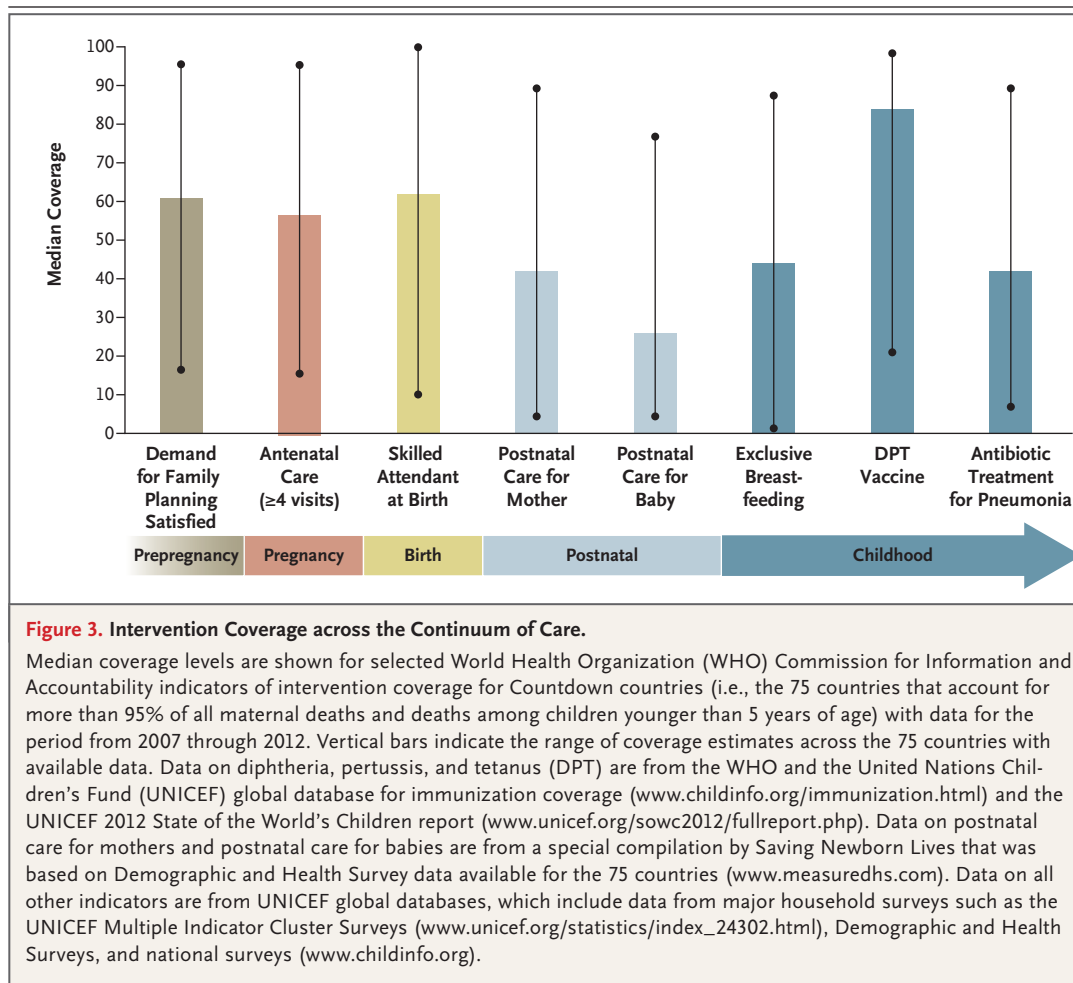
A series of rigorous studies during the previous decade has underscored the fact that there is a

host of evidence-based interventions that can potentially reduce child mortality. A decade ago, a systematic review of the evidence regarding key interventions suggested that a number of evidence-based interventions had the potential to reduce child mortality by nearly two thirds.²⁸ Since then, much progress has been made in refining the evidence base for interventions. Table S1 in the Supplementary Appendix, available with the full text of this article at NEJM.org, highlights the consensus across a range of United Nations agencies, academic bodies, and professional groups regarding the key essential evidence-based interventions that should be implemented and scaled up within health systems.

Despite wide recognition of evidence-based interventions and the availability of information and guidelines, major gaps remain in implementation. Figure 3 shows the current median coverage of key interventions across the major Countdown countries (the 75 countries with more than 98% of the current burden of maternal and child mortality) and highlights the wide disparities in coverage.¹ It is clear that interventions that have a relatively narrow delivery channel and separate management, such as immunizations, do achieve high coverage, whereas those that require functional health systems and facilities, such as skilled birth attendance and postnatal care, reach barely half the population in need. Current coverage rates for other interventions, such as the appropriate use of zinc supplements, oral rehydration solutions, and antibiotic agents for the treatment of childhood diarrhea or pneumonia, are abysmally low.

In addition to the challenge of promoting changes in behavior at the level of persons and families, there are two additional challenges with regard to scaling up key interventions. One pertains to the need to provide appropriate delivery platforms for scaling up coverage, especially in circumstances in which there is a widespread shortage of health workers.²⁹ The other pertains to the removal of financial barriers that preclude the seeking of care and access to health services in areas in which such care is not freely available within the public health system.³⁰

The global shortage of a skilled health workforce has been a key barrier to effective coverage, especially among rural and difficult-to-reach populations. In many instances, policymakers and



planners are making use of community health workers who are provided with basic training in preventive and therapeutic strategies. Such task shifting to health workers with lesser training has been shown to yield beneficial results in diverse contexts, such as the management of maternal, newborn, and child conditions, malaria, HIV infection, and the acquired immunodeficiency syndrome (AIDS).²⁹

Recent systematic reviews convincingly show improvements in household practices, care seeking, and perinatal and newborn outcomes in community settings when community health workers deliver packages of care for maternal and newborn care.^{31,32} Others have highlighted the role of participatory women's groups in inducing changes in practices and outcomes.³³ The effect of community-based approaches to addressing childhood diarrhea and pneumonia³⁴ and under-

nutrition³⁵ among the poorest populations has been well recognized and could be an important foundation for reducing morbidity and mortality.

Community-health-worker programs depend not only on training but also on the provision of basic toolkits and a steady and reliable supply of key commodities. A lack of adequate supplies and frequent depletion of necessary stock are major impediments to effective programs and implementation in primary care settings. The United Nations Commission on Life-Saving Commodities for Women and Children has recently finalized a global strategy for the procurement and availability of key commodities for family planning, as well as for the prevention and treatment of major causes of maternal, newborn, and child death.³⁶ It should be recognized, however, that the mere provision and availability of human resources and commodities are insufficient; to ensure effective

Table 1. Packages of Care, Innovations for Delivery, and Effect on Lives Saved among Mothers, Newborns, and Children.*

Care Package	Interventions	Innovations to Increase Access and Reduce Inequity	Estimated Lives Saved by 2020† no.	Applicable Deaths‡ %	Total Maternal and Child Deaths Averted
Improvement of maternal nutrition during pregnancy	Increasing minimum age at marriage and age at the birth of the first child to 18 years and limiting family size; periconception folic acid supplementation or fortification; calcium supplementation in at-risk populations; multiple micronutrient supplementation during pregnancy; balanced energy supplementation	Use of women's groups and financial support programs, including microcredit programs; communication innovations and maternal health platforms for monitoring	105,569	3.3	1.4
Maternal emergency obstetrical care and postpartum hemorrhage prevention and treatment	Management of preeclampsia with magnesium sulfate; induction of labor to prevent birth at ≥41 wk of gestation; labor and delivery management; basic emergency obstetrical care in an appropriate facility; comprehensive emergency obstetrical care; safe abortion services; case management after abortion; active management of the third stage of labor	Outreach community health workers and community midwives; safe-childbirth checklists; community use of misoprostol; use of Odon device for facilitating safe birth ³⁸ ; improved training and simulation devices	345,744	10.9	4.7
Expanded antenatal care, including prevention of stillbirth and premature birth	Antibiotic agents for preterm premature rupture of membranes; screening for and appropriate management of fetal growth restriction; antenatal glucocorticoids in preterm labor to promote fetal lung development; diabetes screening and management; tetanus toxoid vaccination; malaria prevention in pregnant women by means of intermittent preventive treatment during pregnancy or by use of an insecticide-treated bed net or protection of household by means of indoor residual spraying; syphilis detection and treatment	Improved bedside and low-cost diagnostics for infections; intrauterine growth monitoring; social-franchising models for use of antimalarial commodities	482,666	15.2	6.6
Emergency neonatal resuscitation and immediate newborn care	Clean practices and immediate essential newborn care in the home; clean postnatal practices; thermal care; Kangaroo Mother Care (skin-to-skin care); full supportive care; immediate assessment and stimulation; neonatal resuscitation	Scaled-up use of clean delivery kits; use of 4% chlorhexidine for cleaning the umbilical cord; emollient use for newborns; low-cost training materials and standardized training manuals and equipment (e.g., mannequins and resuscitation bags); thermal-care materials and low-cost heated cots	688,089	21.6	9.4
Improvement of nutrition for infants and young children	Promotion of breast-feeding (early initiation, exclusive breast-feeding for 6 mo, and continuation thereafter); appropriate complementary feeding between 6 and 24 mo of age; vitamin A supplementation; preventive zinc supplementation	Maternal-health platforms; use of ready-to-use supplementary foods	558,751	7.9	7.7

Detection and management of serious maternal and neonatal infections	Detection and case management of maternal sepsis; case management of neonatal infection, including oral or injectable antibiotics with the use of a simplified regimen	Bedside diagnostics; injectable antibiotics for primary care use (e.g., Uninject system [Becton Dickinson])	360,749	12.4	4.9
Detection and management of severe childhood illness (diarrhea, pneumonia, meningitis, and malaria)	Oral rehydration solution for diarrhea treatment; zinc for diarrhea treatment; antibiotics for dysentery treatment; oral antibiotics for case management of pneumonia; antimalarial agents (e.g., artemisinin compounds)	Simplified low-cost commodities (e.g., dispersible amoxicillin); community delivery platforms; social marketing	570,244	8.1	7.8
Management of severe acute malnutrition	Therapeutic feeding for severe acute malnutrition	Community use of RUTF; improved case-management protocols	72,962	1.8	1.0
Vaccination during childhood	Vaccines (e.g., rotavirus, Hib, pneumococcus, measles, and DPT vaccines)	New pricing and procurement systems and improved vaccines (especially combination vaccines)	546,742	13.3	7.5
Water, sanitation, and hygiene interventions	Improved water source; water connection in the home; hygienic disposal of children's stools; hand washing with soap; improved sanitation and use of latrines or toilets	Water purification with solar-powered devices; point-of-use systems for water purification; hand sanitizers; low-cost latrines	467,489	11.3	6.4

* DPT denotes diphtheria, pertussis, and tetanus; Hib *Haemophilus influenzae* type b, and RUTF ready-to-use therapeutic food (usually a fortified spread consisting of a lipid paste made from peanuts, chickpeas, or other local resources, milk powder, oil, sugar, and a micronutrient supplement).

† The estimates of lives saved were calculated with the use of the Lives Saved Tool.^{37,39}

‡ The denominator for calculating the percentage was the number of current deaths for which that care package would have been applicable.

coverage and effect, these must be coupled with sound governance, assurance of the supply chain, and attention to quality-of-care issues.²

CHALLENGES AND THE WAY AHEAD

Despite myriad challenges, innovations such as the deployment of community health workers and the use of mobile phones to reach hitherto difficult-to-reach populations and households have enormous potential to improve access to care. These innovations also include improved ways of delivering interventions, the use of low-cost technology and tools to screen for biomarkers, and improved methods of drug and vaccine delivery.

Using the Lives Saved Tool³⁷ (see the Supplementary Appendix), we estimated the potential effect on maternal and child survival of various packages of care when implemented singly and when expanded to target 90% coverage. Table 1 shows the potential evidence-based packages of care, with possible innovations that could be used to scale up coverage to 90%, as well as the estimated global maternal and child deaths that could be averted by the year 2020, as assessed by means of the Lives Saved Tool. The model indicates that many lives can be saved with packages for maternal preventive care and child care, packages for newborn resuscitation and care, and packages related to community-based case detection and management.

The effect of several intervention packages is considerably enhanced by innovations for scaling up coverage. The majority of innovations relate to low-cost interventions and diagnostic tools in the hands of health workers and to communication and information-technology platforms. In particular, targeting interventions to reach the rural and urban poor would also reduce the enormous inequalities that favor the rich and that pose a huge human-rights challenge across the developing world.

It is possible to reduce the excess mortality among the poorest and marginalized sections of the population and to accomplish this reduction rapidly — as has been shown in two recent global simulations that used targeted preventive and therapeutic strategies for addressing childhood pneumonia and diarrhea³⁴ and maternal and childhood undernutrition.³⁵ This is not just a theoretical possibility. A recent analysis of sequential household surveys in 35 countries with

equity data showed clearly that a rapid scale-up generally favors the poor and reduces inequities.⁴⁰ Accelerating the global rate of reduction of maternal and child mortality would require rapid scale-up of interventions and focused attention on maternal and child health well beyond the MDG target date of 2015.

Clearly, countries need to tackle multiple priorities, and many countries struggle with the growing demands for addressing the increasing burden of noncommunicable diseases as well as the challenges of maternal, newborn, and child health and infectious disease. Thus, there are enormous challenges regarding integration into generally fragmented health systems. The integration of new maternal and child health interventions with existing programs for maternal, newborn, and child health has been limited and has occurred only relatively recently at a global policy level. The situation is much worse with regard to integration across other, disease-specific programs and the management of various diseases. This lack of integration is most notable in large-scale vertical programs such as those addressing initiatives in HIV infection, AIDS, tuberculosis, and malaria, which have largely failed to link up with essential interventions for maternal, newborn, and child health and nutrition.

Despite the efforts with respect to reproductive health and initiatives for the prevention of HIV infection and AIDS and programs such as the President's Emergency Plan for AIDS Relief, there has been little focus on general issues re-

lated to adolescent health and nutrition and virtually no programs dealing with preconception care.⁴¹ Given the critical importance of family planning in reducing maternal mortality,⁴² family-planning interventions may also have a robust effect on birth spacing and fertility regulation and intergenerational effects on the health and nutrition of populations.

Although the focus during the past decade has been on the saving of lives, it is also important to look beyond survival to issues of reducing morbidity and disability and improving long-term outcomes of relevance to human development. The close links among poverty, inequity, undernutrition, and human deprivation are well known, and all these factors have been shown to reduce the potential for human development considerably.⁴³ There are promising interventions that can benefit survival as well as human development,^{44,45} and there is a huge public health need to integrate the two issues. Linking the agenda for maternal and child health and nutrition with the emerging issues of long-term development, human capital, and economic growth may well be the most appropriate strategy to ensure that we stay the course in solving one of the most important moral dilemmas of our times. Although the MDG target dates are in 2015, the need to keep a sustained focus on maternal and child health will remain.

No potential conflict of interest relevant to this article was reported.

Disclosure forms provided by the authors are available with the full text of this article at NEJM.org.

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