

Stillbirths 4



Stillbirths: how can health systems deliver for mothers and babies?

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The causes of stillbirths are inseparable from the causes of maternal and neonatal deaths. This report focuses on prevention of stillbirths by scale-up of care for mothers and babies at the health-system level, with consideration for effects and cost. In countries with high mortality rates, emergency obstetric care has the greatest effect on maternal and neonatal deaths, and on stillbirths. Syphilis detection and treatment is of moderate effect but of lower cost and is highly feasible. Advanced antenatal care, including induction for post-term pregnancies, and detection and management of hypertensive disease, fetal growth restriction, and gestational diabetes, will further reduce mortality, but at higher cost. These interventions are best packaged and provided through linked service delivery methods tailored to suit existing health-care systems. If 99% coverage is reached in 68 priority countries by 2015, up to 1·1 million (45%) third-trimester stillbirths, 201 000 (54%) maternal deaths, and 1·4 million (43%) neonatal deaths could be saved per year at an additional total cost of US\$10·9 billion or \$2·32 per person, which is in the range of \$0·96–2·32 for other ingredients-based intervention packages with only recurrent costs.

Introduction

The causes of stillbirths are inseparable from those that kill pregnant women and their newborn babies.¹ 350 000 maternal deaths² and 3·6 million neonatal deaths occur every year and are counted in the Millennium Development Goals, but no global goals or routine data tracking are in place for the 2·65 million stillbirths.³

Yet effective interventions can reduce stillbirths. In the third paper of *The Lancet's* Stillbirths Series,¹ Bhutta and colleagues estimate that obstetric care and targeting of hypertensive disease in pregnancy can avert a major proportion of stillbirths, and substantial additional reductions can be achieved with interventions targeting syphilis, malaria, post-term birth, fetal growth restriction, and diabetes. All of these interventions would be expected to have an effect on maternal or neonatal outcomes. For policy and programmatic decision makers, the crucial issues are cost and the number of maternal and neonatal deaths and stillbirths averted.

In our report, we examine how key interventions could be scaled up within maternal and neonatal care packages in countries of low and middle income, in which 98% of stillbirths occur. The fifth paper in this Series addresses the very different context of high-income countries.⁴ We used statistical modelling based on the Lives Saved Tool (LiST) to estimate the potential number of lives saved and the cost to implement packages of interventions. Additionally, we have identified evidence gaps and priorities for research in settings with the highest stillbirth rates.

Selection of interventions

According to Bhutta and colleagues,¹ ten interventions during pregnancy and childbirth could prevent 45% of stillbirths in 68 countries listed as priorities in the

Countdown to 2015 report,⁵ and in which 92% of the world's stillbirths occurred in 2008 (panel 1). Most of these interventions are already part of recommended packages for maternal and neonatal care, and many are universally applicable, such as comprehensive emergency obstetric care. However, interventions such as malaria prevention are situational and will depend on the local

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Key messages

- Effective interventions to reduce stillbirths often overlap with those to reduce maternal and neonatal deaths. Birth is a window in which the risks of morbidity and mortality are substantial for both mother and baby, especially in low-income and middle-income countries.
- Interventions are best packaged and provided through linked service delivery methods that are tailored to suit existing health-care systems. Services are best integrated to provide a continuum of care from before pregnancy through to postnatal care.
- Interventions should be tailored to the health-system context, with skilled care at birth and emergency obstetric care taking priority in settings with the highest burden and the weakest health systems. More complex interventions could be added as mortality declines and the capacity of the health system increases.
- In 68 countries accounting for 92% of the worldwide burden of stillbirths in 2008, universal coverage of care (99%) with intervention packages in 2015 could save up to 1·1 million (45%) third-trimester stillbirths, 201 000 (54%) maternal deaths, and 1·4 million (43%) neonatal deaths at an additional cost of US\$2·32 per person, which is well below the WHO and World Bank criteria for cost-effectiveness.
- A health-care system is a complex adaptive system, so interventions at the key interfaces are needed to successfully implement and sustain programmes. Coverage is improved by provision of basic information and service access to health-care users, thereby empowering the community, and quality of care is improved by ensuring health-care providers have skills, knowledge, and resources to provide care. Specific implementation strategies are needed to target these aspects of care and meet the needs of the population.

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For more on LiST see [http://
www.jhsph.edu/dept/ih/
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See Online for webappendix

Panel 1: Packages of interventions to reduce stillbirths in pregnant women

Before pregnancy and basic antenatal care

- Periconceptional folic acid supplementation or fortification
- Prevention of malaria with insecticide-treated bednets or intermittent preventive treatment with antimalarial drugs
- Syphilis detection and treatment

Advanced antenatal care

- Detection and management of hypertensive disease of pregnancy, including treatment with magnesium sulphate and hospital care, or caesarean section if needed
- Detection and management of diabetes in pregnancy
- Detection and management of fetal growth restriction
- Identification and induction of mothers with 41 weeks of gestation or more

Childbirth care

- Skilled care at birth and immediate care for neonates
- Basic emergency obstetric care
- Comprehensive emergency obstetric care

context and burden of disease. Some interventions are applicable only for health systems with high capacity—eg, routine induction of labour at 41 weeks might not be justified in low-resource settings because calculation of gestational age might not be accurate, and induction with poor intrapartum monitoring could result in uterine hyperstimulation or even uterine rupture.⁶ Five further interventions might not reduce stillbirths, but they have substantial health benefits specifically for mothers and neonates, and can be feasibly delivered at the same time as other stillbirth-specific interventions: tetanus toxoid immunisation during pregnancy (two or more vaccine doses), antibiotics for preterm premature rupture of membranes, antenatal corticosteroids for preterm labour, active management of the third stage of labour, and neonatal resuscitation.

Increasing evidence suggests that when interventions are packaged and provided through linked service delivery methods that are tailored to suit existing health-care systems, cost-effectiveness is heightened and available human resources are maximised.⁷ The ten key effective interventions identified by Bhutta and colleagues¹ can be organised in packages across the continuum of care from before pregnancy through pregnancy, labour, and childbirth (panel 1), and, together with the five interventions specifically for mothers and neonates, can be integrated across service delivery methods (community care, outreach or outpatient care, and clinical care; figure 1). Table 1 outlines the effect of these 15 interventions plus contraception, delivered in the same packages at the same time, on maternal and neonatal deaths.

A continuum of care from household to hospital is essential, especially for care around the time of birth.¹³

Outreach or outpatient services, staffed by skilled health workers, provide care close to home. Supported by a programme for community and home care, such services encourage care seeking for danger signs during pregnancy, and are associated with substantially increased use of skilled care during childbirth.^{14,15} A protocol-based referral system allows consultation or transfer of problem cases to clinical care, staffed by doctors, midwives, or appropriately trained personnel, up to the level of comprehensive emergency obstetric care and advanced neonatal care.¹⁴ Community care comprises promotion and uptake of healthy practices, such as appropriate diet, avoidance of tobacco and indoor air pollution, family involvement, birth preparedness, and increasing demand for safe childbirth attended by properly trained health workers in an appropriately equipped facility.¹⁶

Effects and cost of interventions

Choices about implementation of health services and priority of interventions are not always based on systematic decision-making processes and local data.¹⁷ Defined levels of stillbirth rates have been used in this Series as a first step towards a data-driven approach to priority setting. The top priority should be given to interventions that have the highest effects on mortality, are affordable and feasible, and improve equity.

We used LiST (version 4.23, beta 14) to model the numbers of maternal and neonatal deaths and stillbirths averted by scale-up of intervention packages to 60%, 90%, and 99% coverage (table 2). LiST is based on modelling of lives saved in *The Lancet's* Series on Child Survival,¹⁸ Neonatal Survival,¹⁹ and Maternal and Child Undernutrition, and is built into the freely available software package Spectrum. LiST is linked to modules to estimate the effect of family planning interventions and AIDS interventions,²⁰ and preloads national data for health status, mortality in 2008, and intervention coverage. LiST models the effect of changes in coverage of individual interventions on the reduction in deaths due to specific causes. Effect estimates for each intervention were generated from a standardised review process developed by the Child Health Epidemiology Reference Group (CHERG), by use of an adapted version of the WHO GRADE criteria to assess the quality of evidence, and with meta-analysis of intervention effect size where appropriate.²¹ For interventions with insufficient or inadequate data, but clear biological mechanisms, expert opinion was sought to produce effect estimates for a specific cause of death. Inputs and methods have been published previously,²¹ and coverage assumptions for this analysis are detailed in the third paper of this Series.¹ Table 1 shows the effect estimates used in the LiST model. Further details are provided in webappendix pp 1–2.

To model the cost-effectiveness of interventions, we estimated the total cost of each intervention from the

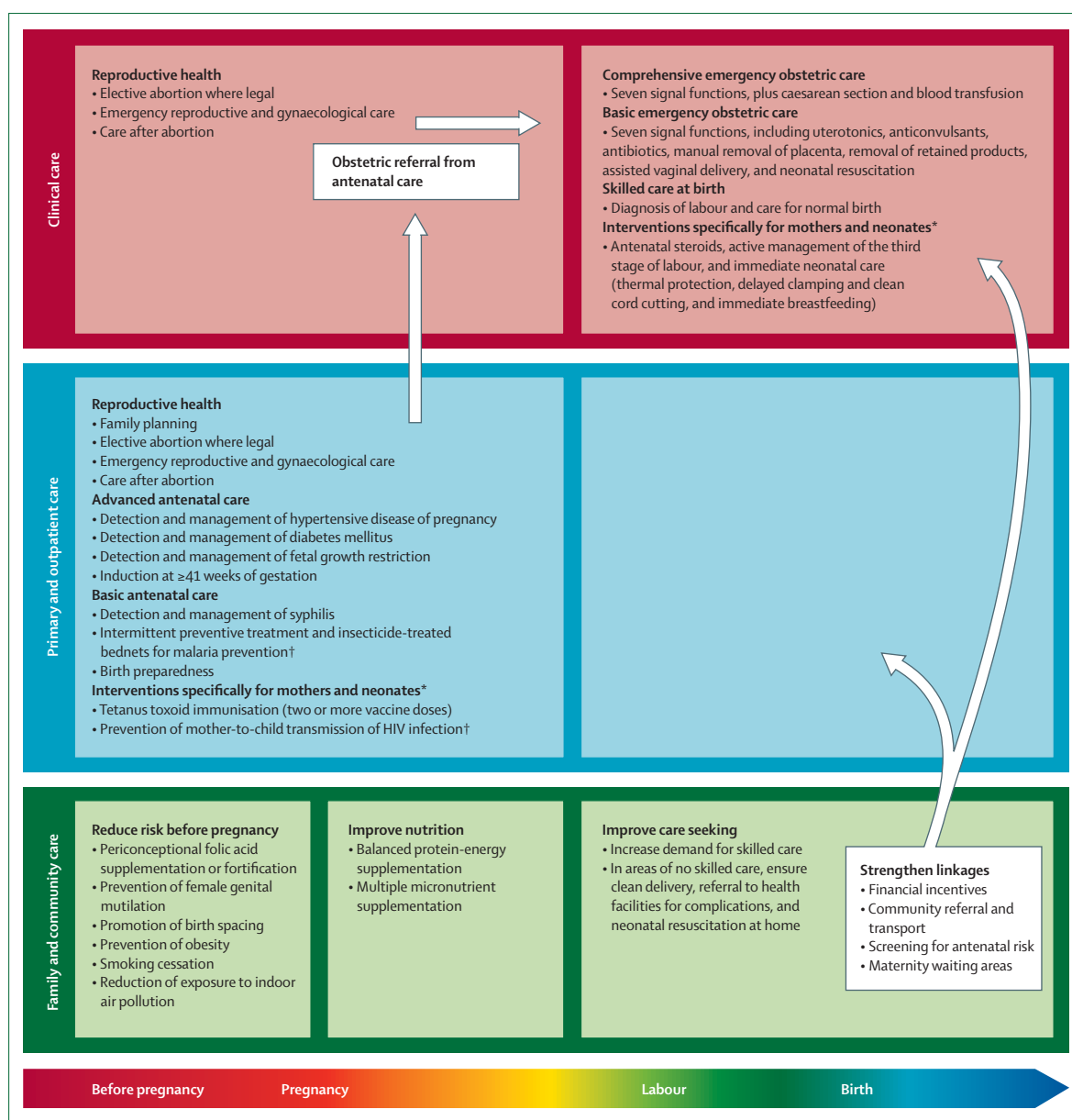


Figure 1: Integration of intervention packages across service delivery methods and the continuum of care to reduce maternal and neonatal deaths and stillbirths
 Postnatal interventions are also important for maternal and neonatal survival but are not included because they do not directly reduce stillbirths and are not delivered at the same time as stillbirth-specific interventions. Figure adapted from Kerber and colleagues.⁷ *Interventions specific to maternal and neonatal health, and without an estimated direct effect on stillbirths. †Setting-specific interventions.

average cost per pregnant woman multiplied by the number of women covered by the intervention. The type and quantity of drugs, supplies, and personnel time needed for each intervention were specified based on standard WHO protocols and expert opinion. The average cost per pregnant woman was then calculated by use of international drug prices (supplied by the UNICEF supply catalogue,²² and the Management Sciences for Health international drug price indicator²³) and country-specific salary data from the WHO-CHOICE (CHOosing Interventions that are Cost Effective) database.²⁴ For

facility-based interventions, facility or overhead costs were added by use of country-specific estimates for the cost of an outpatient visit at a clinic or an overnight stay at a hospital, also from the WHO-CHOICE database. Cost per use of equipment needed for specific interventions was calculated from the cost of the equipment divided by the expected number of uses of the item over its lifetime. An additional percentage was added to account for expenses from extra training, supervision, monitoring, and evaluation related to the scale-up of interventions. We did not estimate the

	Effect on maternal deaths	Effect on stillbirths	Effect on neonatal deaths
Periconceptional period			
Contraception*	Reduced number of pregnancies	Reduced number of pregnancies	Reduced number of pregnancies
Folic acid supplementation or fortification	No effect†	0·41 for neural tube defects‡	0·35 for congenital deaths§
Pregnancy			
Insecticide-treated bednets or intermittent preventive treatment for malaria prevention	0·40 for malaria	0·22 for antepartum stillbirths‡	Effect through reduced intrauterine growth restriction at term¶
Syphilis detection and treatment	Assumed minimal effect	0·82 for antepartum stillbirths‡	0·03 for sepsis
Detection and management of hypertensive disease of pregnancy	0·59 for hypertensive disease	0·20 for antenatal and intrapartum stillbirths‡	Effect calculated as part of basic and comprehensive emergency obstetric packages
Detection and management of diabetes	Unknown effect†	0·10 for antepartum and intrapartum stillbirths‡	Unknown effect†
Detection and management of fetal growth restriction	No effect†	0·20 for antepartum and intrapartum stillbirths‡	Unknown effect†
Identification and induction of mothers with ≥41 weeks of gestation	No effect†	0·69 on antepartum and intrapartum stillbirths‡	Unknown effect†
Tetanus toxoid immunisation*	No effect†	No effect†	0·94 for tetanus ¹⁰
Childbirth			
Skilled care at birth and immediate care for neonates	0·10 for sepsis	0·23 on intrapartum stillbirths	0·25 for asphyxia; 0·10 for prematurity; 0·25 for sepsis; 0·36 for tetanus
Basic emergency obstetric care	0·08 for obstructed labour; 0·20 for antepartum haemorrhage; 0·65 for postpartum haemorrhage; 0·50 for sepsis	0·45 for intrapartum stillbirths	0·40 for asphyxia; 0·10 for prematurity; 0·25 for sepsis; 0·36 for tetanus
Comprehensive emergency obstetric care	0·99 for obstructed labour; 0·80 for antepartum haemorrhage; 0·95 for postpartum haemorrhage; 0·99 for hypertensive disease of pregnancy; 0·70 for sepsis	0·75 for intrapartum stillbirths	0·80 for asphyxia; 0·10 for prematurity; 0·25 for sepsis; 0·36 for tetanus
Antibiotics for preterm premature rupture of membranes*	0·26 for sepsis	Unknown effect†	0·12 for prematurity; 0·08 for sepsis
Antenatal corticosteroids for preterm labour*	No effect†	No effect†	0·53 for prematurity ¹¹
Active management of the third stage of labour*	0·27 for postpartum haemorrhage	No effect†	No effect†
Neonatal resuscitation*	No effect†	Assumed minimal effect	0·30 for asphyxia ¹²
Effect estimates refer to the reduction in deaths due to a specific cause as a result of intervention—eg, 0·41 for stillbirths due to neural tube defects means that 41% of stillbirths due to neural tube defects could be averted with introduction of folic acid supplementation or fortification. Postnatal interventions are not included so the estimates do not represent the full effect on neonatal deaths. *Interventions do not reduce stillbirths but were included in the packages and delivered at the same contact point, and the reduction in maternal and neonatal mortality was included in the Lives Saved Tool model. †Effect estimate not included in Lives Saved Tool model. ‡Applies to pregnant women affected based on prevalence data.			
Table 1: Effect estimates for interventions before pregnancy, during pregnancy, and at birth to reduce maternal and neonatal deaths and stillbirths			

additional cost of building new facilities or major non-specific health-system strengthening. Linear costs of scale-up are unlikely, especially at the highest coverage—eg, the increase in costs associated with an increase in coverage from 95% to 99% is likely to be greater than from 50% to 55%. We used adapted assumptions of increasing costs for all visits and hospital stays from the WHO-CHOICE database, but not for drug costs. Costs of visits were estimated to be 9% higher in regions with 80–95% coverage, and 24% higher in regions with 95–99% coverage, than were visits in regions with less than 80% coverage. Cost assumptions are detailed in webappendix pp 3–15. For the cost per death averted we regarded maternal and neonatal deaths and stillbirths as equal.

If full coverage of care (99% including the five interventions specifically for mothers and neonates) was reached in 2015, up to 1·1 million (45%) third-trimester stillbirths, 201 000 (54%) maternal deaths, and 1·4 million (43%) neonatal deaths could be prevented per year (table 2) at an additional cost per person of US\$2·32 and a total package cost of \$10·9 billion (table 3) in 68 Countdown countries. The five interventions specifically for mothers and neonates could save 622 000 lives per year (table 2) and account for \$0·28 of the cost per person (table 3). The cost per maternal and neonatal death and stillbirth averted for the ten stillbirth-specific interventions alone is \$4762, and drops to \$3920 with simultaneous delivery of the five interventions specific to mothers and neonates.

	Stillbirths (2 499 000 at baseline*)		Maternal deaths (371 000 at baseline*)		Neonatal deaths (3 333 000 at baseline*)		Total deaths (6 203 000 at baseline*)	
	Deaths averted	Reduction in deaths	Deaths averted	Reduction in deaths	Deaths averted	Reduction in deaths	Deaths averted	Reduction in deaths
60% coverage†	615 000	25%	106 000	29%	388 000	12%	1 109 000	18%
90% coverage†	1 017 000	41%	175 000	47%	712 000	21%	1 903 000	31%
99% coverage†	1 134 000	45%	198 000	53%	828 000	25%	2 161 000	35%
99% coverage plus maternal and neonatal interventions‡	1 134 000	45%	201 000	54%	1 447 000	43%	2 782 000	45%

Numbers of deaths averted have been rounded to nearest thousand, but percentages were based on actual numbers. Each death (maternal death, neonatal death, and stillbirth) has equal weight. *Projected number of deaths in 2015, assuming no change in coverage levels from those in 2011. †Coverage of ten stillbirth-specific interventions. ‡Coverage of ten stillbirth-specific interventions plus five interventions specifically for mothers and neonates and with no estimated effect on stillbirths.

Table 2: Potential stillbirths, neonatal deaths, and maternal deaths averted in 2015 according to level of coverage

	Number of deaths averted			Total additional cost (US\$)	Cost per death averted (US\$)				Cost per person (general population*; US\$)
	Stillbirths	Maternal deaths	Neonatal deaths		Stillbirth	Maternal death	Neonatal death	Stillbirth, maternal death, or neonatal death	
Intervention packages	..	..	..	9 573 310 000	8591	52 711	13 787	4762	2.04
Basic antenatal care	198 000	1000	103 000	860 605 000	4348	1 611 623	8364	2856	0.18
Advanced antenatal care	240 000	10 000	Not estimated†	4 762 192 000	19 840	475 113	Not estimated†	19 045	1.01
Childbirth care	696 000	171 000	591 000	3 950 513 000	5673	23 094	6679	2708	0.84
Interventions specific to maternal and neonatal health	Not estimated‡	19 000	753 000	1 331 645 000	Not estimated‡	69 823	1768	1724	0.28
Total for all intervention packages	1 134 000	201 000	1 447 000	10 904 955 000	9614	54 347	7536	3920	2.32

Numbers of deaths averted and total additional cost have been rounded to nearest thousand. *Calculated with the estimated population size of 4 696 000 000 according to UN estimates for 2008. †These interventions have an unknown effect on neonatal deaths, so cost per death averted was not estimated in the Lives Saved Tool model. ‡These interventions have an unknown effect on stillbirths, so cost per death averted was not estimated in the Lives Saved Tool model.

Table 3: Cost per death averted in 2015 with implementation of intervention packages at 99% coverage

Although interventions in the basic and advanced antenatal care packages are crucial, most deaths are prevented through comprehensive emergency obstetric care (figure 2). If all women gave birth in health facilities offering high-quality comprehensive emergency obstetric care, 27% (696 000) of stillbirths, 46% (171 000) of maternal deaths, and 18% (591 000) of neonatal deaths could be averted. Childbirth care is an expensive package at a total additional cost of just under \$4 billion, but has the biggest effect on the number of deaths, with a cost per death averted of \$2708, and a cost per person of just \$0.84 (table 3). Increased access to setting-specific interventions, such as intermittent preventive treatment and insecticide-treated bednets for malaria prevention in pregnancy, could prevent 40 000 deaths per year at a cost per person of only \$0.06. Family planning interventions were not included in our analysis, but this crucial package would probably have a major effect on the number of deaths prevented at an affordable extra cost. In a separate analysis by the Guttmacher Institute, the cost to meet the unmet need for modern family planning methods was estimated to

be \$3.6 billion in addition to the \$3.1 billion that has been allocated for modern contraceptives.^{25,26}

Achievable scale-up of interventions

Outreach services

Reaching 60% of mothers and babies with the ten interventions from before pregnancy through to childbirth could prevent 18% of deaths (table 2), but this rapid increase in coverage might be unrealistic in the highest mortality settings. In health systems with low access, increase in outreach and outpatient services is easiest at first and can ensure equitable access while advanced clinical and referral care is strengthened. In previous analyses of community care and outreach or outpatient care, improvement of coverage was estimated to reduce neonatal deaths by a third, even without advanced clinical care.^{19,27} Similar analyses for maternal deaths have not been undertaken. For outreach services providing care before pregnancy and basic antenatal care, an increase in coverage of just 20% could be achievable in these settings by 2015. This moderate increase could save 85 000 lives per year. Strengthening of family planning

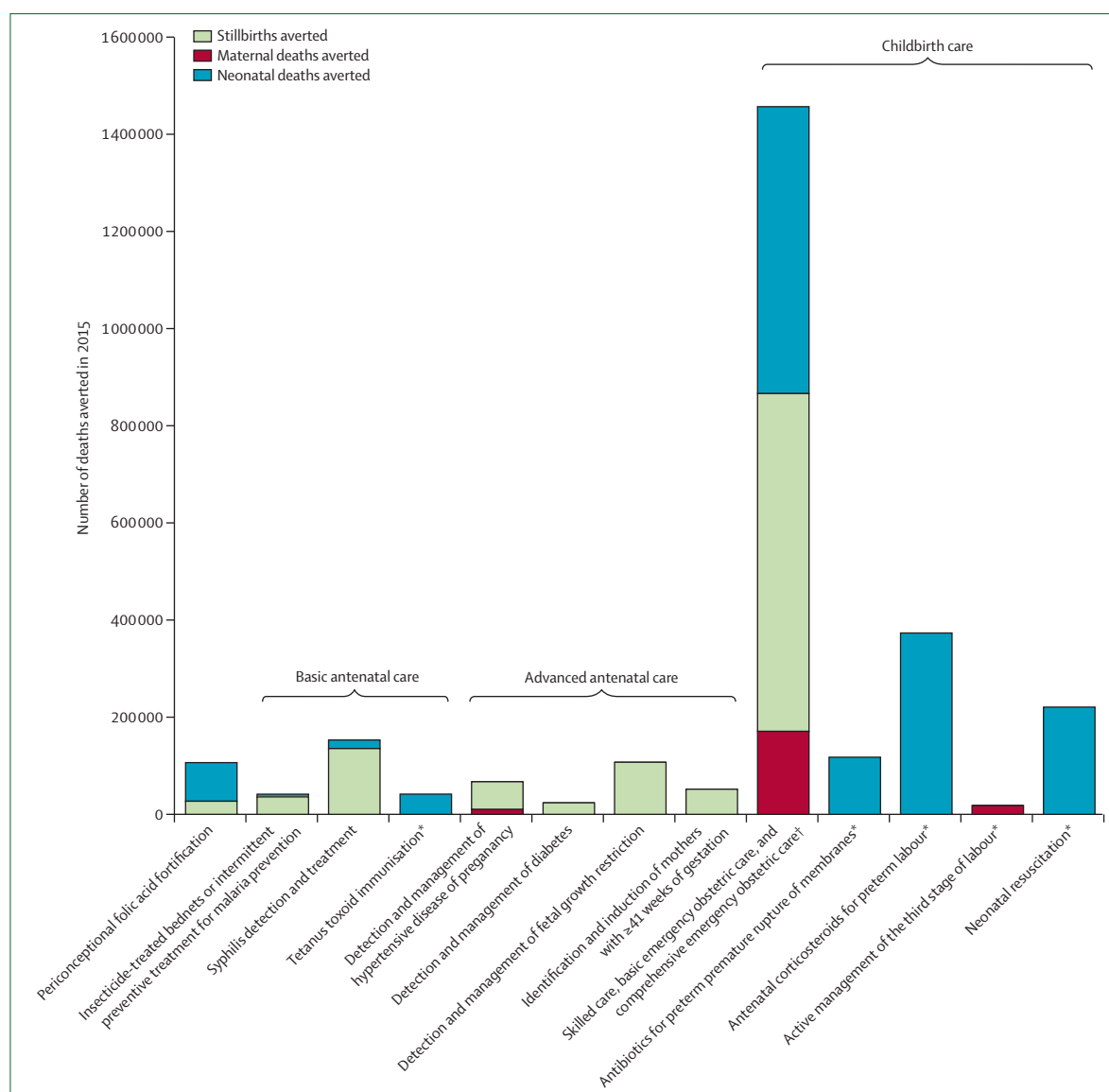


Figure 2: Number of lives saved in 2015 at full (99%) coverage by package

*Interventions specific to maternal and neonatal health, and without an estimated direct effect on stillbirths. †Women receiving comprehensive emergency obstetric care are assumed to have access to the highest level of care during childbirth, including skilled care and basic emergency obstetric care if needed.

services would save lives through fewer pregnancies and helping families to plan and space pregnancies. Services that can be scheduled (ie, do not need 24-h clinical care availability) are most amenable to fairly rapid improvements, but can be constrained by issues with supply chain management and the need for increased demand for care.

Health systems vary and local context is highly important. An intervention will not have the same effect, cost, and feasibility everywhere, and variation is often substantial even within countries. Health-system performance and existing platforms for scale-up (eg, policy to enable task shifting for caesarean section, mass media campaigns for behaviour

change), and funding opportunities or financial constraints should be considered in health planning and prioritisation.

Settings with 25 stillbirths per 1000 births or more

In settings with the highest mortality, only half of all births take place in health facilities, and often the quality of care is low, with essential supplies and trained providers often absent (table 4). The programmatic priority is for communities to be linked to care for family planning, basic antenatal care, and skilled care at birth, including caesarean section. Until basic links are developed, community structures might need to be strengthened to provide care at or close to home,

	≥25 stillbirths per 1000 births	15–24·9 stillbirths per 1000 births	5–14·9 stillbirths per 1000 births	<5 stillbirths per 1000 births
Number of stillbirths	1 120 000	1 010 000	470 000	45 000
Median skilled birth attendance (IQR)	50% (39–59)	65% (48–81)	98% (93–99)	100% (99–100)
Number of intrapartum stillbirths	563 000 (50%)	509 000 (50%)	110 000 (23%)	7000 (16%)
Priorities	Ensure availability and access to family planning, basic antenatal care services, skilled attendance at birth, basic emergency obstetric care, comprehensive emergency obstetric care, and clean and safe delivery where referral care is not possible	Add major focus on hypertensive disease of pregnancy	Consider addition of stillbirth-specific interventions, including induction for post-term pregnancy, increased screening for fetal growth restriction, and increased detection and management of diabetes mellitus	Improve professional care, and undertake clinical audits
Situational interventions	Prevent malaria in pregnancy with insecticide-treated bednets and intermittent preventive treatment, and prevent mother-to-child transmission of HIV infection	Prevent malaria in pregnancy with insecticide-treated bednets and intermittent preventive treatment, prevent mother-to-child transmission of HIV infection, and consider folic acid supplementation or fortification	Address lifestyle factors, such as prevention of obesity, smoking cessation, and reduction of alcohol consumption	Address lifestyle factors, such as prevention of obesity, smoking cessation, and reduction of alcohol consumption
Programmatic principles	Promote demand for care, build on outreach services, and strengthen district health facilities	Increase coverage of skilled care and referral systems, target the poorest individuals, and close equity gaps	Improve quality of care, and ensure equity	Improve quality of care, and ensure equity

Table 4: Priorities for reduction of stillbirths and maternal and neonatal deaths according to stillbirth rates in 2015

including promotion of antenatal risk screening, clean and safe birth, and neonatal resuscitation. Concomitantly, the quality of care provided within the health system during family planning advice, and antenatal, intrapartum, and postnatal care should be also improved, thereby encouraging the community to use the facilities available. Although delivery of individual or vertical health interventions can be crucial to rapidly increase coverage, interventions to address stillbirths are less amenable to a vertical approach, and a more sustainable solution is to integrate interventions and delivery strategies within existing health-system packages.²⁸

Settings with 15–24·9 stillbirths per 1000 births

In settings with high mortality, about two-thirds of births take place in a health facility, and the priority is to increase coverage of advanced antenatal care services, particularly hypertensive diseases of pregnancy and high-quality comprehensive emergency obstetric care (table 4). To maintain such service delivery, specific plans for human resources are needed. Simultaneously, demand for skilled birth attendance could be increased by community mobilisation efforts, financial incentives, communication and transport systems, and community birthing centres to target the poorest, hard-to-reach, and most at-risk populations. Improvement of the skills and knowledge of health-care providers towards specialised care is feasible.

Settings with five–14·9 stillbirths per 1000 births

In settings with moderate mortality, the vast majority of pregnant women deliver in facilities. Induction for post-term pregnancy, increased screening and management

for fetal growth restriction and diabetes, and addressing of lifestyle factors should be possible, together with the interventions expected in settings with more than 15 stillbirths per 1000 births (table 4).

Settings with less than five stillbirths per 1000 births

In settings with the lowest mortality, priorities include addressing of inequity and a focus on lifestyle factors, including prevention of risk factors before conception such as maternal obesity, smoking, and alcohol consumption, as discussed by Flenady and colleagues⁴ in this Series (table 4).

Increasing the reach of the existing health system Change in practice and implementation of new interventions sustainably

Efforts to achieve the maximum from existing opportunities are accompanied by opportunities to plan, invest, and act now to reach universal coverage. The health system is a complex adaptive system in which the actions of individual agents within the system are interconnected and can change the context for other agents.²⁹ Improvement of the quality and coverage of care to reduce maternal and neonatal deaths and stillbirths is similarly complex. Successful implementation of known lifesaving interventions within health-system packages requires consideration of many interfaces between individual agents that affect whether the introduction of the packages will be effective (figure 3). Every interface contributes to reduction of unnecessary deaths of mothers and their babies. Other interfaces are possible—eg, direct communication of policy makers with health-care providers or the community. A summary of

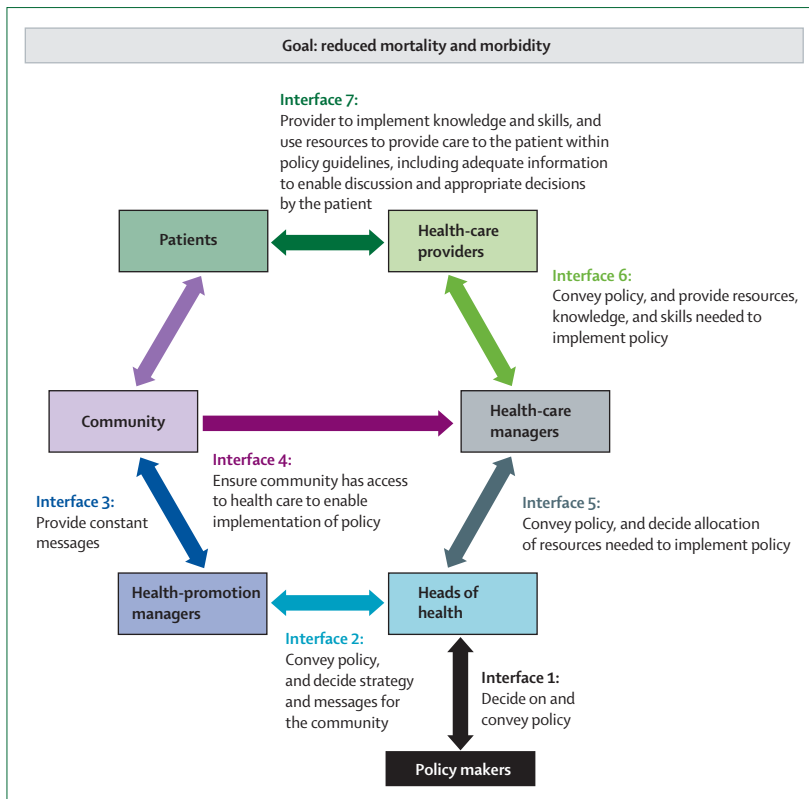


Figure 3: Key health-system interfaces to affect change

published reports of strategies for each interface is provided in webappendix pp 16–22.

Policy makers and heads of health

Emergence of attention to a disease or public health concern can be analysed through a framework of actor power, ideas, issue characteristics, and political context.³⁰ Shiffman³⁰ argued that to propose policies to governments, ideas and global health organisations might be the most important instruments to direct policy. Stillbirths are not prominent on the agenda of policy makers and heads of health despite the high burden and cost-effectiveness of intervention.³¹ To put stillbirths and neonatal and maternal deaths on the policy agenda, global health advocates need to define the problem, communicate the problem and solution, and possibly create institutions, or at least sections within institutions, that are dedicated to this issue. A good opportunity for decision makers would be to ensure availability of high-quality emergency obstetric care services, thereby preventing the largest proportion of all stillbirths and neonatal and maternal deaths.

Health-promotion managers and the community

Evidence suggests that mass media campaigns have an important role in affecting use of health-care interventions for maternal and child health, and therefore such campaigns are also relevant to stillbirth

Panel 2: Strategies for settings with high stillbirth rates (≥ 25 per 1000 births): India's JSY programme

In 2005, the Government of India launched the JSY programme, a national conditional cash transfer scheme to provide incentives to women of low socioeconomic status to give birth in a health facility. JSY is implemented by community health workers who identify pregnant women and help them to get to the health facility. The health workers also help the women to receive at least three antenatal care visits, immunisation for the neonate, a postnatal examination, and counselling to help start and continue breastfeeding. In an analysis from the nationwide district-level household surveys done in 2002–04 and 2007–09, the JSY programme had increased the coverage of three antenatal visits by 15–20% and facility-based births by about 30%. With the increase in care seeking, perinatal and neonatal deaths reduced by about 10%, but the change in maternal mortality was not significant. The restricted coverage of the programme to reach the poorest women, and gaps in the quality of implementation, might partly explain the fairly small mortality reduction. Findings of the analysis showed a need to maintain and improve the quality of obstetric and neonatal care available in health facilities to cope with increasing demand.

JSY=Janani Suraksha Yojana. Adapted from Lim and colleagues.⁴²

prevention.³² Mass media campaigns can effectively change smoking behaviour in adults,³³ prevent initial uptake of smoking in young people,³⁴ promote HIV testing,³⁵ and increase the awareness, knowledge, and consumption of folic acid before and during pregnancy to reduce neural tube defects.³⁶ Patient-mediated interventions can also improve health care with different levels of effectiveness and feasibility of implementation³²—eg, working with women's groups in a participatory way can be an effective mechanism to convey messages, develop local solutions to problems, and improve demand for high-quality care.^{37–39}

In high mortality settings in which most births occur at home, community-based interventions reduce neonatal mortality and stillbirths.¹⁶ Findings of a Cochrane review of 18 cluster-randomised or quasi-randomised trials showed that community-based packages significantly reduced maternal morbidity by 25%, neonatal mortality by 24%, and stillbirths by 16%, and also increased healthy behaviours such as referrals for pregnancy-related complications and early breastfeeding.¹⁶ Evidence for reduction in maternal mortality from community care is weak, but strong evidence suggests that community interventions do increase demand for skilled care.¹³ Intensive community mobilisation activities have been associated with a doubling of skilled birth attendance over 1–3 years.^{13,40} Successful initiatives including the community can originate in community groups, such as mothers' groups.³⁷

Health-care managers and the community

Health-care managers have direct interaction with the community in improvement of accessibility. Effective strategies to link mothers with skilled care during pregnancy, labour and birth, described by Lee and colleagues,¹³ included increase of community demand for obstetric care through community mobilisation and financing strategies, and use of approaches to bring pregnant women closer to the formal health system, such as community referral systems and transport schemes, antenatal risk screening by health workers, and maternity waiting homes.

Incentives to create demand, such as vouchers and conditional cash transfers, have successfully increased facility-based births, and these strategies are possible even at wide scale, and seem to increase the uptake of preventive services and encourage some preventive behaviours.⁴¹ An example is India's Janani Suraksha Yojana (JSY) programme (panel 2).⁴² However, the reduction in mortality according to the perinatal evaluation is somewhat disappointing—policymakers also need to invest in improvement of quality of care in facilities.

Darmstadt and colleagues⁴³ systematically reviewed the effect of community-based skilled birth attendants, trained traditional birth attendants, and community-based workers on perinatal and intrapartum outcomes, and recommended skilled care for all pregnant women and linkage of community strategies with prompt, high-quality emergency obstetric care. Innovative community-based strategies combined with health-system strengthening could improve care and coverage for the rural poor. Although there is sometimes tension between the formal health system and community structures, findings of two studies in Pakistan showed that effective linkages could be created in settings where 70% of births take place at home.^{38,39} In the first study,³⁸ the district used specially trained Lady Health Workers in antenatal and postnatal care, traditional birth attendants to ensure clean births and in neonatal care and resuscitation, and community volunteers. The community volunteers helped to set up health committees for maternal and neonatal care in their villages in close liaison with the Lady Health Workers. These committees supported Lady Health Workers in undertaking 3-monthly group education sessions in the intervention villages, helped to establish an emergency transport fund for mothers and neonates, and managed to increase the number of births in health facilities, significantly reducing the rates of stillbirths and neonatal deaths. In the second study,³⁹ traditional birth attendants were trained and issued with disposable delivery kits, Lady Health Workers linked traditional birth attendants with established primary-care facilities, and obstetric teams provided outreach clinics for antenatal care. These interventions led to significant reductions in rates of stillbirths and neonatal mortality rates, and fewer maternal complications.

Panel 3: Strategies for settings with moderate stillbirth rates (5–14.9 per 1000 births): reduction of perinatal mortality in Belo Horizonte, Brazil

Belo Horizonte is the fourth largest city in Brazil. In 1994, the municipality implemented a national public health system to provide universal health care, resulting in improved access for about 80% of people living in the city, with 149 health centres distributed in the poorest areas. Surveillance of maternal deaths began in 1997 after a national recommendation by the ministry of health. In 1999, a perinatal health commission of relevant stakeholders and professional organisations did a comprehensive audit of maternity care in Belo Horizonte. A policy framework was then established by the politicians and heads of health care to reduce maternal and perinatal mortality (interface 1; figure 3).

Consistent health-promotion messages were introduced (interfaces 2 and 3), and, in 2000, all women attending antenatal clinics received educational information and prenatal cards. Media campaigns and information on health-care facilities were conveyed to the population, and community health workers visited pregnant women in deprived areas, urging them to attend antenatal clinics. A municipal regulation in 2000 forbade hospitals from turning away women in labour, and made clinical assessment obligatory before transfer to appropriate care. Access (interface 4) was further improved by a system to transport pregnant women between health institutions. A new municipal perinatal health system defined referral pathways and the levels of care that each hospital could provide (interface 5). Maternity services in hospitals providing inadequate care were closed, affecting nine of the 16 public service hospitals. Additional resources were channelled into the remaining seven maternity hospitals, and bed capacity for neonates doubled between 2000 and 2002. Neonatal intensive care units were equipped and opened (interface 5). A continuum of care after maternity discharge was established, with home visits and a primary health clinic appointment in the first week after birth for each mother and baby. From 2000, the municipality introduced staff training in emergency obstetric and neonatal care, including triage methods to prioritise care within the health centres and maternity hospitals.

In 2002, perinatal audit, including process audit, was introduced, and the results fed back to the staff. For example, in 1999, only 20% of women in labour were monitored with partography, whereas in 2006, 80% had an adequate or complete partograph (interface 6). From 2003, emphasis was placed on the patient to health-care provider interface (interface 7), with seminars in the humanisation of obstetrics and neonatal care. In 2005, municipal legislation guaranteed each woman the right to have a companion in labour. Community volunteers are now available in six of the seven maternity hospitals.

These comprehensive changes through all seven interfaces were accompanied by reductions in perinatal mortality: in 1999, 9.9 perinatal deaths per 1000 births (birthweight ≥ 1500 g) occurred, of which 4.2 per 1000 births were from intrapartum causes, whereas in 2007, 4.2 perinatal deaths per 1000 births occurred, of which 1.3 per 1000 births were from intrapartum causes.

Heads of health and health-care managers

To save the most lives, increasing coverage of, and access to, care is not enough, but is still part of the remit of heads of health and health-care managers. Quality must improve and remain high to maintain demand for health services. Provision of high-quality services requires staff with appropriate skills, and essential equipment and drugs. Strategies to select appropriate technology and ensure adequate delegation and use of resources can be highly effective, according to several systematic reviews.^{32,44} Health-care managers decide

	Low-income countries (n=25)*	Middle-income countries (n=14)†
Does training and retraining of professional midwives in antenatal and intrapartum care reduce stillbirth rates?	1	6
What is the most cost-effective antenatal care package, with clearly defined component interventions, for the prevention of stillbirths?	2	2
Does training of community health workers in promotion of pregnancy health reduce stillbirth rates?	3	NA
Can community mobilisation strategies improve care-seeking patterns and reduce stillbirth rates?	4	NA
Do training drills for simulation of management of obstetric emergencies reduce stillbirth rates?	5	5
What is the most effective strategy for implementation of on-site syphilis screening and treatment at antenatal clinics?	6	1
Does training and retraining of midwives and physicians in neonatal resuscitation reduce stillbirth and perinatal mortality rates?	7	3
How can perinatal audit and improvement of facility quality be most effectively undertaken to reduce stillbirth rates?	8	4
How can antenatal care be made easily available to all pregnant women at community level?	9	NA
What are the benefits, if any, of community support groups on reduction of the risk of stillbirth?	10	NA

The first ten ranked research questions for low-income countries are shown. Detailed research questions scored are provided in webappendix pp 23–26 for low-income countries and in webappendix pp 27–30 for middle-income countries. n=number of research questions. NA=not applicable because the research question was not included as an option in the list for scorers. *Scored by 23 experts. †Scored by 19 experts.

Table 5: Rankings of research priorities for implementation of interventions to reduce stillbirths in low-income and middle-income countries by 2015

which guidelines are most cost effective, especially relating to the use of equipment and technology, and request resources from heads of health care. Health-care managers might also be responsible for assignment of certain tasks. Task shifting can be used to transfer capacity and responsibility to the next level of providers, including nurses or medical assistants, to do aspects of obstetric care, such as delivery by caesarean section. Evaluation of large-scale task shifting in African countries has shown that this strategy is feasible, safe, and cost effective.¹⁷

Health-care managers and health-care providers

In a meta-analysis of before and after studies, use of a perinatal death audit reduced perinatal mortality by 30%, but the challenge is to scale up the audit to identify and implement solutions, and, especially, ensure the audit cycle is closed (ie, implementation of interventions completed).⁴⁵ Although many training programmes have been rolled out, there are few rigorous evaluations of their effectiveness and cost.⁴⁶ The success of these programmes and different training models, particularly with mentoring and accreditation components, should be a priority for assessment in developing countries. Other successful methods for intervention at the level of health-care managers and providers are detailed in webappendix pp 16–22.

Health-care providers and health-care users

During the interaction between health-care providers and health-care users (patients), an empathetic relationship improves client satisfaction, but might also contribute to improvement of outcomes.⁴⁷ For example, women with diabetes who were given more information and felt respected achieved better diabetic control than did those receiving standard treatment regimens.^{47,48} Although we could not identify a randomised trial related to motivational interviewing or shared decision making in antenatal care, findings of a review showed that antenatal counselling was a key factor in improved uptake of skilled care during childbirth.⁴⁹ Appropriate selection and implementation of strategies can lead to large reductions in mortality, as seen in the massive decline in perinatal mortality in Belo Horizonte, Brazil (panel 3).

Knowledge gaps

We used the method described by Joy Lawn and colleagues in the second paper of this Series,³ and published previously,⁵⁰ to develop research questions related to implementation of interventions to prevent stillbirths. These questions focused on service delivery in low-income and middle-income countries, drawing on experience, published reports of delivery of interventions to prevent stillbirths, and reviews of the pregnancy and childbirth database of Cochrane systematic reviews (webappendix pp 23–30).^{17,51} The research questions were divided into categories of development and implementation of interventions; those pertaining to development are reported in the third paper of this Series.¹ In some cases, research questions overlapped between low-income and middle-income countries. From networks of researchers and professionals with an interest in stillbirths, we contacted experts by email to score the questions.

We identified three broad research priorities: systems for antenatal and intrapartum care, training, and access to care (table 5). Training of professionals in both low-income and middle-income countries included training and retraining of midwives in maternal care, training in neonatal resuscitation, training drills for obstetric emergencies, and training in outreach work and telemedicine for resource-poor settings. For low-income countries, a research question on training community health workers also received high priority. Perinatal audit is a well established instrument to improve services and reduce perinatal mortality.⁴⁵ However, the best methods to implement perinatal audit and improve facility quality are unclear, which was recognised by the high priority given to this question for both low-income and middle-income countries.

Lack of access to obstetric care services in low-income countries is a serious hindrance to reduction of stillbirths.⁵² This issue was addressed by three research questions that emerged as priorities, one on community mobilisation, one on availability of community-based antenatal care,

	Countries	Interventions	Year of baseline coverage	Target coverage	Costing method	Total additional yearly cost in 2015	Cost per person per year (total population)
<i>The Lancet's Child Survival Series (2005)</i> ⁵⁶	42	23 neonatal and child interventions	2000	99%	Ingredients-based running costs with human resource time based on normative delivery schedule and amortised facility costs, plus additional time for training, supervision, monitoring, and evaluation	5.1 billion (in 2004 US\$)	1.23 (in 2004 US\$)
<i>The Lancet's Neonatal Survival Series (2005)</i> ⁵⁹	75	16 neonatal interventions	2000	90%	Ingredients-based running costs with human resource time based on normative delivery schedule and amortised facility costs, plus additional time for training, supervision, monitoring, and evaluation	4.1 billion (in 2004 US\$)	0.96 (in 2004 US\$)
Countdown to 2015 (2005) ⁵⁹	60	32 maternal, neonatal, and child interventions	2005	99%	Ingredients-based running costs with human resource time based on normative delivery schedule and amortised facility costs, plus additional time for training, supervision, monitoring, and evaluation	7 billion (range 4.6–10.7 billion; in 2004 US\$)	1.62 (in 2004 US\$)
WHO World Health Report (2005) ⁵⁷	75	67 maternal, neonatal, and child health interventions and services (23 for mothers and neonates)	2005	95%	Bottom-up ingredients-based approach	7.8 billion (in 2004 US\$)	1.05 (in 2004 US\$)
Guttmacher Institute (2009; ²⁵ revised in 2010 ²⁶)	UN Development Programme developing countries (all except Australia, Canada, Japan, New Zealand, USA, and all European nations)	26 reproductive, maternal, and neonatal interventions	2008	Universal coverage (100% met need for family planning interventions)	Direct costs based on UN Population Fund's reproductive health costing tool; indirect costs, including overhead costs for programme management, supervision, health education, monitoring, and evaluation, advocacy, human resources training, information systems, commodity supply systems, and capital costs to maintain and expand the physical capacity of health facilities	12.8 billion (3.6 billion for family planning, 9.2 billion for maternal and neonatal care; in 2008 US\$)	2.23 for maternal and neonatal care (in 2008 US\$)
Taskforce for Innovative International Financing for Health Systems (2009) ⁵⁸	49 low-income countries (not including China and India)	135 maternal, neonatal, child, and infectious disease interventions	2008	No specified target	WHO normative approach, and MBB method; ingredients-based approach, including health-systems strengthening (eg, new facilities), and incentives for increasing demand; costs for health-systems strengthening were 62% of MBB estimated costs and 74% of WHO normative estimated costs	18.6–36.5 billion from MBB estimate, 45.2–58 billion from WHO normative estimate (in 2005 US\$)	24 from MBB estimate, 29 from WHO normative estimate (in 2005 US\$)
WHO Commission on Macroeconomics and Health (2002) ⁶⁰	All sub-Saharan African countries plus all other countries with gross national product below US\$1200 per person	34 priority interventions, including interventions for mothers, perinatal period, children, tobacco use, tuberculosis, and HIV/AIDS and sexually transmitted infections	2002	65–95%, dependent on the intervention	Capital components and requirements for complementary management and institutional support; investments in new facilities, and recruitment and training of new personnel; and cost estimates to address various constraints, specifically the shortage of appropriately qualified staff, poor distribution of staff, weak technical guidance, poor programme management and supervision, inadequate drug and medical supplies, lack of equipment and infrastructure, and poor accessibility of health services	94 billion (in 2002 US\$)	10 (in 2002 US\$)
<i>The Lancet's Stillbirths Series (2011)</i>	68	15 maternal and perinatal interventions (ten specific to stillbirths)	2008	99%	Ingredients-based running costs with human resource time and amortised facility costs based on the Lives SavedTool, UNICEF drug costs according to UNICEF, and inputs from the WHO-CHOICE database	10.9 billion (in 2008 US\$)	2.32 (in 2008 US\$)

MBB=marginal budgeting for bottlenecks.

Table 6: Comparison of multicountry costing exercises for maternal, neonatal, and child health, with a target year of 2015

and one on the possible benefits of community support groups. Surprisingly, the question on task shifting for caesarean section was rated poorly, which might indicate resistance to the idea by some scorers.

Several priority areas were identified for research in antenatal care. The WHO antenatal care trial has resulted

in the application of simple and effective packages of antenatal care in many countries.⁵³ However, little is known about the cost-effectiveness of packages in terms of prevention of stillbirths, and the best mix of component interventions. On-site syphilis screening is an essential component of antenatal care, and is second to obstetric

care in number of deaths averted, but gaps remain in strengthening of the supply chain to ensure availability of diagnostic equipment and drugs. The potential effect of antiretroviral treatment was of high research priority for middle-income countries, but less so for low-income countries. A research priority in delivery of intrapartum care was understanding of barriers to community volunteer companionship for women in labour; this strategy is beneficial to maternal and neonatal outcomes, but stillbirths have not been assessed as an outcome.⁵⁴ We also noted some research interest in critical time intervals during emergency caesarean section in middle-income countries.

Implications for investment

In countries with the highest burden of maternal and neonatal deaths, stillbirths are also high. The global stillbirth rate has reduced since 1995, and some middle-income countries have made remarkable progress, but the gap for the poorest countries and families, especially in rural Africa, is increasing. Our estimates suggest that a total additional running cost of about \$10·9 billion would be needed per year to provide this maternal, neonatal, and stillbirth package to 99% of families in 68 Countdown countries, which translates to an additional \$2·32 per person per year (table 3). When maternal and neonatal deaths and stillbirths are considered together, the cost is less than \$4000 per death averted (table 3), which, at twice the average gross national income per person in these 68 countries, is well below the WHO and World Bank criteria for cost-effectiveness.⁵⁵ For every country, the package without advanced antenatal care is highly cost effective. Advanced antenatal care is cost effective in middle-income countries with a high burden of maternal and neonatal deaths and stillbirths. Obstetric care is the most cost-effective package to reduce maternal deaths, but if only maternal deaths are considered we estimate a cost of \$23 094 per death averted, compared with \$2708 per death averted if stillbirths and neonatal deaths are also included. Advocacy for investment in obstetric care would benefit from inclusion of these outcomes.

Comparisons of different cost estimates for scale-up of maternal, neonatal, and child health are complex because estimates vary in terms of countries included, coverage targets, timeframes for scale-up, interventions, and costing approaches.^{19,25,56–58} Our cost estimates for 2015 are broadly similar to previous estimates that used ingredients-based approaches for the highest burden countries—notably, the WHO World Health Report 2005,⁵⁷ the Countdown to 2015 report in 2005,⁵⁹ and reports by the Guttmacher Institute^{25,26} (table 6). We estimate slightly higher total costs than do these previous estimates because of different countries included, 99% coverage targets, and inclusion of advanced antenatal interventions that have not previously been considered. However, we have not included interventions for postnatal and child care.

Most of these previous costing exercises did not include costs for health-system strengthening, which is clearly a limitation in terms of specifying the true amount of funding needed to scale up services. However, these comparisons do suggest that the recurrent costs of the interventions to reduce stillbirth proposed in our report are roughly consistent with estimates using similar approaches but a different set of interventions. The two estimates which did include these systems costs—the Taskforce for Innovative International Financing for Health Systems,⁵⁸ and the WHO Commission on Macroeconomics and Health⁶⁰—had much higher estimated costs (table 6). Besides the additional costs for health-system strengthening, these cost estimates also included a larger range of interventions than we investigated (eg, multisectoral interventions for HIV/AIDS infection, tuberculosis, tobacco use, water, and sanitation) towards reaching all health-related Millennium Development Goals.⁵⁸ Cost estimates by the Taskforce for Innovative International Financing for Health Systems accounted for 62–74% of the total costs of health-system strengthening.⁵⁸

Conclusion

The health of mothers and neonates has received increased attention and funding in the past 5 years,^{61,62} but stillbirths have not received a similar increase in attention.³¹ Existing packages designed to save the lives of mothers and neonates can have an important effect on stillbirths, and stillbirths could be further reduced by addition of selected stillbirth and neonatal interventions to existing health-system packages. Essential packages should prioritise interventions with the highest effect and cost-effectiveness based on local problems, and interventions should be phased appropriately for a particular health-system context. To save the most lives, care needs to be delivered at all levels of the health system and implemented with proven techniques that target key health-system interfaces. The most effective way to reduce mortality is to strengthen the health system, starting with skilled care at birth, emergency obstetric care, development of community linkages especially in rural and underserved populations, and increasing quality and equity, with addition of more complex interventions as mortality declines and the capacity of the health system increases. Every year, the lives of more than 1·7 million women and neonates could be saved with interventions that are known to be effective during pregnancy and birth, and more than 1 million third-trimester stillbirths could be prevented with the same care, providing a triple return for every dollar invested.

Contributors

RP, KK, JEL, MB, and EB compiled the report with contributions from all authors. IKF ran the lives saved analysis. EW ran the cost analysis. KK, IKF, EW, and NW described the lives saved and costing; EB, MM, KK, and RP described the interventions; MB, KK, SL, and RP described implementation of the interventions; and EB, IR, and RP coordinated the research priorities. All authors read and approved the final report.

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Conflicts of interest

RP received travel and accommodation support to attend meetings for this report from the South African Medical Research Council. EB received travel and accommodation support to attend meetings for this report from the Medical Research Council Maternal and Infant Health Care Strategies Research Unit (University of Pretoria, Pretoria, South Africa) and the Norwegian Institute of Public Health (Oslo, Norway). All other authors declare that they have no conflicts of interest.

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References

- Bhutta ZA, Yakoob MY, Lawn JE, et al, for *The Lancet's* Stillbirths Series steering committee. Stillbirths: what difference can we make and at what cost? *Lancet* 2011; published online April 14. DOI:10.1016/S0140-6736(10)62050-8.
- WHO, UNICEF, UN Population Fund, World Bank. Trends in maternal mortality: 1990 to 2008. Geneva: World Health Organization, 2010.
- Lawn JE, Blencowe H, Pattinson R, et al, for *The Lancet's* Stillbirths Series steering committee. Stillbirths: Where? When? Why? How to make the data count? *Lancet* 2011; published online April 14. DOI:10.1016/S0140-6736(10)62187-3.
- Flenady V, Middleton P, Smith GC, et al, for *The Lancet's* Stillbirths Series steering committee. Stillbirths: the way forward in high-income countries. *Lancet* 2011; published online April 14. DOI:10.1016/S0140-6736(11)60064-0.
- Bhutta ZA, Chopra M, Axelson H, et al. Countdown to 2015 decade report (2000–10): taking stock of maternal, newborn, and child survival. *Lancet* 2010; **375**: 2032–44.
- Hofmeyr GJ, Haws RA, Bergstrom S, et al. Obstetric care in low-resource settings: what, who, and how to overcome challenges to scale up? *Int J Gynaecol Obstet* 2009; **107** (suppl 1): S21–45.
- Kerber KJ, de Graft-Johnson JE, Bhutta ZA, Okong P, Starrs A, Lawn JE. Continuum of care for maternal, newborn, and child health: from slogan to service delivery. *Lancet* 2007; **370**: 1358–69.
- Blencowe H, Cousens S, Modell B, Lawn J. Folic acid to reduce neonatal mortality from neural tube disorders. *Int J Epidemiol*; **39** (suppl 1): i110–21.
- Bhutta ZA, Ahmed T, Black RE, et al, for the Maternal and Child Undernutrition Study Group. What works? Interventions for maternal and child undernutrition and survival. *Lancet* 2008; **371**: 417–40.
- Blencowe H, Lawn J, Vandelaer J, Roper M, Cousens S. Tetanus toxoid immunization to reduce mortality from neonatal tetanus. *Int J Epidemiol* 2010; **39** (suppl 1): i102–09.
- Mwansa-Kambafwile J, Cousens S, Hansen T, Lawn JE. Antenatal steroids in preterm labour for the prevention of neonatal deaths due to complications of preterm birth. *Int J Epidemiol* 2010; **39** (suppl 1): i122–33.
- Lee AC, Wall S, Cousens S, et al. Neonatal resuscitation and immediate newborn assessment and stimulation for the prevention of neonatal deaths: a systematic review, meta-analysis and Delphi estimation of mortality effect. *BMC Public Health* 2011; **11** (suppl 3): S12.
- Lee AC, Lawn JE, Cousens S, et al. Linking families and facilities for care at birth: what works to avert intrapartum-related deaths? *Int J Gynaecol Obstet* 2009; **107** (suppl 1): S65–88.
- WHO. Recommended interventions for improving maternal and newborn health. Geneva: World Health Organization, 2009.
- Barros FC, Bhutta ZA, Batra M, Hansen TN, Victora CG, Rubens CE, and the GAPPs Review Group. Global report on preterm birth and stillbirth (3 of 7): evidence for effectiveness of interventions. *BMC Pregnancy Childbirth* 2010; **10** (suppl 1): S3.
- Lassi ZS, Haider BA, Bhutta ZA. Community-based intervention packages for reducing maternal and neonatal morbidity and mortality and improving neonatal outcomes. *Cochrane Database Syst Rev* 2010; **11**: CD007754.
- Lawn JE, Kinney M, Lee AC, et al. Reducing intrapartum-related deaths and disability: can the health system deliver? *Int J Gynaecol Obstet* 2009; **107** (suppl 1): S123–42.
- Bryce J, el Arifeen S, Pariyo G, Lanata CF, Gwatkin D, Habicht J-P, and the Multi-Country Evaluation of IMCI Study Group. Reducing child mortality: can public health deliver? *Lancet* 2003; **362**: 159–64.
- Darmstadt GL, Bhutta ZA, Cousens S, Adam T, Walker N, de Bernis L, for the Lancet Neonatal Survival Steering Team. Evidence-based, cost-effective interventions: how many newborn babies can we save? *Lancet* 2005; **365**: 977–88.
- Stover J, McKinnon R, Winfrey B. Spectrum: a model platform for linking maternal and child survival interventions with AIDS, family planning and demographic projections. *Int J Epidemiol* 2010; **39** (suppl 1): i7–10.
- Walker N, Fischer-Walker C, Bryce J, Bahl R, Cousens S. Standards for CHERG reviews of intervention effects on child survival. *Int J Epidemiol* 2010; **39** (suppl 1): i21–31.
- UNICEF. Supply catalogue. <http://www.supply.unicef.dk/catalogue> (accessed Oct 21, 2010).
- Management Sciences for Health. International drug price indicator guide, 2009 edn. http://erc.msh.org/dmpguide/pdf/DrugPriceGuide_2009_en.pdf (accessed Oct 21, 2010).
- WHO. CHOosing Interventions that are Cost Effective (WHO-CHOICE), 2010. <http://www.who.int/choice/en> (accessed Oct 21, 2010).
- Singh S, Darroch JE, Ashford LS, Vlassoff M. Adding it up: the costs and benefits of investing in family planning and maternal and newborn health. New York, NY: Guttmacher Institute and UN Population Fund, 2009.
- Guttmacher Institute. Facts on investing in family planning and maternal and newborn health. <http://www.guttmacher.org/pubs/FB-AIU-summary.pdf> (accessed Oct 21, 2010).
- Darmstadt GL, Walker N, Lawn JE, Bhutta ZA, Haws RA, Cousens S. Saving newborn lives in Asia and Africa: cost and impact of phased scale-up of interventions within the continuum of care. *Health Policy Plan* 2008; **23**: 101–17.
- Kinney MV, Kerber KJ, Black RE, et al. Sub-Saharan Africa's mothers, newborns, and children: where and why do they die? *PLoS Med* 2010; **7**: e1000294.

- 29 Plsek PE, Greenhalgh T. Complexity science: the challenge of complexity in health care. *BMJ* 2001; **323**: 625–28.
- 30 Shiffman J. A social explanation for the rise and fall of global health issues. *Bull World Health Organ* 2009; **87**: 608–13.
- 31 Frøen JF, Cacciatore J, McClure EM, et al, for *The Lancet's* Stillbirths Series steering committee. Stillbirths: why they matter. *Lancet* 2011; published online April 14. DOI:10.1016/S0140-6736(10)62232-5.
- 32 Althabe F, Bergel E, Cafferata ML, et al. Strategies for improving the quality of health care in maternal and child health in low- and middle-income countries: an overview of systematic reviews. *Paediatr Perinat Epidemiol* 2008; **22** (suppl 1): 42–60.
- 33 Bala M, Strzeszynski L, Cahill K. Mass media interventions for smoking cessation in adults. *Cochrane Database Syst Rev* 2008; **1**: CD004704.
- 34 Sowden AJ, Stead LF. Community interventions for preventing smoking in young people. *Cochrane Database Syst Rev* 2003; **1**: CD001291.
- 35 Vidanapathirana J, Abramson MJ, Forbes A, Fairley C. Mass media interventions for promoting HIV testing. *Cochrane Database Syst Rev* 2005; **3**: CD004775.
- 36 Chivu CM, Tulchinsky TH, Soares-Weiser K, Braunstein R, Brezis M. A systematic review of interventions to increase awareness, knowledge, and folic acid consumption before and during pregnancy. *Am J Health Promot* 2008; **22**: 237–45.
- 37 Manandhar DS, Osrin D, Shrestha BP, et al, and members of the MIRA Makwanpur trial team. Effect of a participatory intervention with women's groups on birth outcomes in Nepal: cluster-randomised controlled trial. *Lancet* 2004; **364**: 970–79.
- 38 Jokhio AH, Winter HR, Cheng KK. An intervention involving traditional birth attendants and perinatal and maternal mortality in Pakistan. *N Engl J Med* 2005; **352**: 2091–99.
- 39 Bhutta ZA, Memon ZA, Soofi S, Salat MS, Cousens S, Martinez J. Implementing community-based perinatal care: results from a pilot study in rural Pakistan. *Bull World Health Organ* 2008; **86**: 452–59.
- 40 Hounton SH, Byass P, Brahim B. Towards reduction of maternal and perinatal mortality in rural Burkina Faso: communities are not empty vessels. *Global Health Action* 2009; published online May 7. DOI:10.3402/gha.v2i0.1947.
- 41 Lagarde M, Haines A, Palmer N. The impact of conditional cash transfers on health outcomes and use of health services in low and middle income countries. *Cochrane Database Syst Rev* 2009; **4**: CD008137.
- 42 Lim SS, Dandona L, Hoisington JA, James SL, Hogan MC, Gakidou E. India's Janani Suraksha Yojana, a conditional cash transfer programme to increase births in health facilities: an impact evaluation. *Lancet* 2010; **375**: 2009–23.
- 43 Darmstadt GL, Lee AC, Cousens S, et al. 60 million non-facility births: who can deliver in community settings to reduce intrapartum-related deaths? *Int J Gynaecol Obstet* 2009; **107** (suppl 1): S89–112.
- 44 Meads CA, Cnossen JS, Meher S, et al. Methods of prediction and prevention of pre-eclampsia: systematic reviews of accuracy and effectiveness literature with economic modelling. *Health Technol Assess* 2008; **12**: iii–iv, 1–270.
- 45 Pattinson R, Kerber K, Waiswa P, et al. Perinatal mortality audit: counting, accountability, and overcoming challenges in scaling up in low- and middle-income countries. *Int J Gynaecol Obstet* 2009; **107** (suppl 1): S113–22.
- 46 Opiyo N, English M. In-service training for health professionals to improve care of seriously ill newborn or child in low and middle-income countries (Review). *Cochrane Database Syst Rev* 2010; **4**: CD007071.
- 47 Davies MJ, Heller S, Skinner TC, et al. Effectiveness of the diabetes education and self management for ongoing and newly diagnosed (DESMOND) programme for people with newly diagnosed type 2 diabetes: cluster randomised controlled trial. *BMJ* 2008; **336**: 491–95.
- 48 DAFNE Study Group. Training in flexible, intensive insulin management to enable dietary freedom in people with type 1 diabetes: dose adjustment for normal eating (DAFNE) randomised controlled trial. *BMJ* 2002; **325**: 746.
- 49 The Skilled Care Initiative. Testing approaches for increasing skilled care during childbirth: key findings. New York, NY: Family Care International, 2007.
- 50 Rudan I, Gibson JL, Ameratunga S, et al. Setting priorities in global child health research investments: guidelines for implementation of CHNRI method. *Croat Med J* 2008; **49**: 720–33.
- 51 Victora CG, Rubens CE. Global report on preterm birth and stillbirth (4 of 7): delivery of interventions. *BMC Pregnancy Childbirth* 2010; **10** (suppl 1): S4.
- 52 McClure EM, Goldenberg RL, Bann CM. Maternal mortality, stillbirth and measures of obstetric care in developing and developed countries. *Int J Gynaecol Obstet* 2007; **96**: 139–46.
- 53 Villar J, Ba'aqeel H, Piaggio G, et al, for the WHO Antenatal Care Trial Research Group. WHO antenatal care randomised trial for the evaluation of a new model of routine antenatal care. *Lancet* 2001; **357**: 1551–64.
- 54 Hodnett ED, Gates S, Hofmeyr GJ, Sakala C. Continuous support for women during childbirth. *Cochrane Database Syst Rev* 2007; **3**: CD003766.
- 55 Lawn JE, Zupan J, Begkoyan G, Knippenberg R, Jamison D, Measham A. Newborn survival. In: Disease control priorities. Washington, DC: World Bank and US National Institutes of Health, 2005.
- 56 Bryce J, Black RE, Walker N, Bhutta ZA, Lawn JE, Steketee RW. Can the world afford to save the lives of 6 million children each year? *Lancet* 2005; **365**: 2193–200.
- 57 WHO. World health report 2005: make every mother and child count. Geneva: World Health Organization, 2005.
- 58 Taskforce for innovative international financing for health systems. More money for health, and more health for the money. London: International Health Partnership, 2009.
- 59 Lawn J. The price tag for newborn and child survival. Tracking Progress in Child Survival: Countdown to 2015; University of London, London, UK; Dec 13–14, 2005.
- 60 WHO Commission on Macroeconomics and Health. Improving health outcomes of the poor: the report of Working Group 5 of the Commission on Macroeconomics and Health. Geneva: World Health Organization, 2002.
- 61 Shiffman J. Generating political priority for maternal mortality reduction in 5 developing countries. *Am J Public Health* 2007; **97**: 796–803.
- 62 Shiffman J. Issue attention in global health: the case of newborn survival. *Lancet* 2010; **375**: 2045–49.