

 **Maternal Survival 2**

Strategies for reducing maternal mortality: getting on with what works

Oona M R Campbell, Wendy J Graham, on behalf of The Lancet Maternal Survival Series steering group*

Lancet 2006; 368: 1284–99

Published Online
September 28, 2006
DOI:10.1016/S0140-
6736(06)69381-1

*Group members listed at end of report

This is the second in a *Series* of five articles about maternal survival

Department of Epidemiology and Population Health, London School of Hygiene & Tropical Medicine, London WC1E 7HT, UK (O M R Campbell PhD); Department of Obstetrics and Gynaecology, University of Aberdeen, Aberdeen, UK (Prof W J Graham DPhil)

Correspondence to:
Dr Oona M R Campbell
Oona.Campbell@lshtm.ac.uk

The concept of knowing what works in terms of reducing maternal mortality is complicated by a huge diversity of country contexts and of determinants of maternal health. Here we aim to show that, despite this complexity, only a few strategic choices need to be made to reduce maternal mortality. We begin by presenting the logic that informs our strategic choices. This logic suggests that implementation of an effective intrapartum-care strategy is an overwhelming priority. We also discuss the alternative configurations of such a strategy and, using the best available evidence, prioritise one strategy based on delivery in primary-level institutions (health centres), backed up by access to referral-level facilities. We then go on to discuss strategies that complement intrapartum care. We conclude by discussing the inexplicable hesitation in decision-making after nearly 20 years of safe motherhood programming: if the fifth Millennium Development Goal is to be achieved, then what needs to be prioritised is obvious. Further delays in getting on with what works begs questions about the commitment of decision-makers to this goal.

“We know what works”¹ is a deceptively simple phrase, often used in international advocacy aiming to reduce the burden of maternal mortality in developing countries. Strategies that affect this burden have proved to be among the most successful efforts to address a specific cluster of causes of death, with developed and some developing countries having reduced the risk of maternal death by 90–99%. The 1000 deaths per 100 000 livebirths or greater risk of maternal mortality seen in the past in developed countries and now in the poorest developing countries, has been reduced to as low as 10 per 100 000. Although falling short of eradication of maternal death, these impressive reductions are similar to the effectiveness of such undisputed public-health interventions as polio immunisation (95%) or oral contraception (97%).

At the same time, however, the substantial obstacles in poor countries to achievement of the maternal mortality target of Millennium Development Goal (MDG) 5 are well acknowledged,^{2,3} and some assessments deem progress to have stalled.^{4,5}

The need to say “we know what works”¹ epitomises the advocacy of optimism essential to maintaining the commitment of those with the real power to act:⁶ politicians, donors, UN agencies, and professional bodies. At this advocacy level, many issues are necessarily simplified and assumed, especially with respect to how interventions that work can be delivered. But behind this frontline message is a more complex reality. In view of the diversity of country contexts and the multifaceted nature of maternal health and its determinants, this complexity is hardly surprising. This report grapples with this complexity to show that for maternal mortality, only a few key strategic choices need to be made. Our purpose is to restate what works, and so to help rebuild the confidence and commitment of stakeholders to act at country and international

levels. We have sought to do this in a context of substantial research-evidence gaps and genuine dilemmas in health policy and programme decision-making.

We have drawn on published and grey literature, including systematic reviews of effective single interventions and programme evaluations. However, because we focus on strategies, the evidence cited is of a lower grade of certainty (since experimental designs are impractical) limited in volume, context-specific, and presents challenges for generalisation.^{7,8} Hence we characterise this paper as a research-informed viewpoint, with six key messages (panel 1). Finally, since contradictory and confusing terminology is often used in maternal health, panel 2 shows the specific definitions of six terms that we use in this paper.

Panel 1: Key messages

- Maternal health has many valued outcomes, but maintaining focus on maternal death is crucial in areas where the mortality burden is high
- Many single interventions are available, but none alone can reduce the rate of maternal mortality in a population
- Strategies will work if the component packages are effective and the means used for their distribution achieve high coverage of the intended target group
- The epidemiology of maternal mortality requires prioritisation of the intrapartum period
- A health centre intrapartum-care strategy can be justified as the best bet to bring down high rates of maternal mortality
- There are further opportunities to alter the risks of maternal death outside the intrapartum period—antenatal care, postpartum care, family planning, and safe abortion.

Stripping complexity to reveal strategic choices

Making strategic choices requires decision-makers to be explicit about the values attached to alternative outcomes, since such values affect the target group and the packages of appropriate interventions. Some means of distribution are capable of delivering multiple packages aimed at multiple outcomes, and these opportunities are often taken for pragmatic reasons. This approach can result in a strategy that seems unfocused, with several valued outcomes and no sense of priority. As a result, contention about how to judge the worth of the strategy can arise. Such contention is apparent in the case of antenatal care (see later). In this *Lancet* series, maternal mortality is taken as the priority burden to be reduced, as endorsed by the 189 countries that signed the Millennium Declaration. We affirm this priority and build upon the logic that it implies for strategic choices.

One response to the question of what works is to refer to effective single interventions that influence mortality rates either through intervening close to a life-threatening complication, such as assuring expedited delivery for women with hypertensive crises, or by more distal and sometimes preventive routes, such as intermittent presumptive treatment for malaria or birth companions.⁹ We call such interventions single here to emphasise their difference from composite packages of interventions.

Many proven single interventions¹⁰ and composites of these are available and have been assessed.^{2,11–18} Table 1^{10,14–18} lists those reported as effective in systematic or structured reviews. Although numerous such interventions for maternal health have been assessed in randomised controlled trials, only four had maternal mortality as an outcome.^{19–22} This choice of outcome is partly because some common life-saving procedures, such as blood transfusion for postpartum haemorrhage, are so engrained in routine practice and so visibly effective that to test them under randomised conditions would be unethical, and partly because of the large sample sizes required to determine the effect of interventions on mortality. Nevertheless, effective single interventions do exist for prevention or treatment of virtually all life-threatening maternal complications, and the costs of many of these are reasonable.^{2,14,15}

However, no single intervention alone can address the diverse range of causes of maternal death described in the first report in this series. Even the most common cause—primary postpartum haemorrhage—is estimated to account for less than a quarter of all maternal deaths, and requires a multiplicity of interventions, such as oxytocic drugs, manual removal of placenta, blood replacement, and hysterectomy. Such single interventions are thus not given alone, but rather together in varying combinations that we refer to as packages. These packages in turn reach the target group of women through various means of distribution.

Panel 2: Special terms used and their definitions

Valued outcomes

Outcomes targeted for reduction, in this case maternal mortality

Single interventions

Drug treatments, procedures, or non-medical inputs such as information about danger signs in pregnancy

Packages

Combinations of single interventions

Means of distribution

The service or vehicle used to provide packages of interventions—eg, health centres with midwives, hospitals with obstetricians, radio spots, food fortification

Target

The population to which the interventions are delivered

Strategy

Specification of the component intervention package, target group, and means of distribution (figure 1). For example, a health centre intrapartum-care strategy involves health centres, with midwives as the main providers, but with other attendants working with them in a team. Care involves preventive best practices, avoidance of iatrogenic procedures, and first-line management of complications. This is targeted at all women who are giving birth

Packages of interventions and their means of distribution are interdependent. A particular method of distribution (table 2) might preclude particular interventions. For example, opting for home-based care with a traditional birth attendant rather than hospital-based delivery care with an obstetrician means caesarean sections cannot be provided. Similarly, the inclusion of a specific intervention, such as blood transfusion, will constrain the choice of the means of distribution.

If the same package of interventions can be distributed via several means, the likelihood of achieving high coverage is increased. For example, barrier and oral contraceptives can be distributed through social marketing, outreach by community workers including mobile clinics, or at facilities such as health posts and clinics. An effective package that is distributed to a substantial proportion of the target population, but without assuring quality, might have less impact than a less effective one for which quality is maintained or higher coverage achieved. For a given effectiveness, the lower the skill requirements of the component interventions and the easier the package is to distribute, the more likely it is to attain high quality and coverage.

The specification of the component intervention package, target group, and means of distribution constitutes a strategy. The effectiveness of a strategy is thus a function of the effectiveness of the package (or packages) of single interventions and the coverage

For other examples of single interventions see <http://www.cochrane.org/reviews>

(Continued from previous page)

		MM	FF	M	S	F	TBA	CHW	MW	MC	HP	HC	H
Screen urine for asymptomatic bacteriuria; treat ^{14,15,16}	Detect and treat urinary tract infection; prevent pyelonephritis							?	x	x	x	x	x
Measure blood pressure (cuff) and test urine for protein (dipstick); treat ^{14,15,16}	Detect and manage pre-eclampsia								x	x	x	x	x
Counsel and test for HIV; treat woman or only prevention of mother-to-child transmission ¹⁵	Detect HIV; if only prevention of mother-to-child transmission then neonatal focus; else prevent AIDS									x	?	x	x
Test for gonorrhoea, chlamydia, and bacterial vaginosis; treat ¹⁶	Detect and manage gonorrhoea, chlamydia, bacterial vaginosis									x	?	x	x
Rapid plasma reagin screen for syphilis; treat ^{14,15,16}	Syphilis									x	?	x	x
Test haemoglobin; treat ^{15,16}	Detect and treat anaemia									x	?	x	x
Test Rhesus factor; treat ¹⁵	Neonatal focus									?	?	x	x
Detect malpresentation (breech, transverse lie); treat and advice ¹⁵	Obstructed labour; prolonged labour						?	?	x	x	x	x	x
Listen for fetal heart; refer ¹⁵	Neonatal focus						?	?	x	x	x	x	x
Measure uterine height or conduct abdominal palpation ¹⁶	Detection of malpresentation and position						?	?	x	x	x	x	x
Estimate gestational age (ultrasound); treat post date ¹⁵	Neonatal focus											?	x
Intrapartum women (delivery and immediate postpartum)													
Diagnose labour ¹⁵	Detect prolonged labour						?	x	x			x	x
Ensure clean delivery technique and environment ^{15,16}	Prevent infection						?	x	x	x		x	x
Assistance to woman during labour and birth (including supportive companion) ^{15,16}	Prevent prolonged labour; detect complications early						?	?	?	x		x	x
Detect maternal complications early ^{15,16}	Detect complications; prevent all-causes of mortality						x	?	x			x	x
Refer maternal complications early ¹⁵	Prevent all-causes of mortality						x	?	x			x	x
Detect newborn complications early ^{15,16}	Neonatal focus						?	?	x	x		x	x
Refer newborn complications early ¹⁶	Neonatal focus						?	?	x	x		x	x
Advice on contraception ¹⁵	Prevent all-cause mortality						?	x	x			x	x
Hygienic cord care ^{14,15,16}	Neonatal focus						?	x	x	x		x	x
Ensure newborn warmth ¹⁶	Neonatal focus						?	x	x	x		x	x
Support early breastfeeding; advice promoting early and exclusive breastfeeding ¹⁶	Neonatal focus						?	x	x	x		x	x
Detect newborn infections early ¹⁶	Neonatal focus							x	x			x	x
Resuscitate newborn (ambu bag) if required ^{14,15,16}	Neonatal focus							?	x			x	x
Partograph (labour surveillance) ^{15,16}	Detect obstructed labour; prolonged labour								x			x	x
Detect foetal complications early (meconium and heart); treat or refer*	Neonatal focus							?	x			x	x
Active management of third stage (oxytocics) ^{14,15}	Prevent postpartum haemorrhage								x			x	x
Arrange organised transport to referral facilities*	Prevent all-causes of mortality						?	?	x			x	x
All postpartum women													
Advice on postnatal maternal danger signs and on postnatal maternal emergencies and referral ¹⁵	Prevent all-cause mortality	x					?	?	x	x	x	x	x
Advice on postnatally home self-care, nutrition, safe sex, breast care ^{15,16}	Promote wellbeing, avoid breast infection, anaemia, HIV infection	x					?	?	x	x	x	x	x
Advice on contraception ^{15,16}	Avert pregnancy; all-cause mortality	x					?	x	x	x	x	x	x
Advice on neonatal danger signs and neonatal emergencies and referral ¹⁶	Neonatal focus	x						x	x	x	x	x	x
Advice promoting newborn warmth and for hygienic cord care ¹⁶	Neonatal focus	x					?	x	x	x	x	x	x
Advice and support for exclusive breastfeeding ¹⁶	Avert pregnancy; all-cause mortality	x					?	x	x	x	x	x	x
Advice on newborn care-seeking including immunisation ¹⁶	Neonatal focus	x					?	x	x	x	x	x	x
Iron folate supplementation ¹⁵	Prevent anaemia			x				x	x	x	x	x	x
Insecticide treated bednets ¹⁵	Prevent malaria; anaemia			x				x	x	x	x	x	x
Detect postnatal maternal complications early ¹⁵	Prevent all-causes of mortality						?	?	x		x	x	x
Refer maternal complications early ¹⁵	Prevent all-causes of mortality						?	?	x		x	x	x
Detect newborn complications early ¹⁶	Neonatal focus						?	?	?	x	x	x	x
Refer newborn complications early ¹⁶	Neonatal focus						?	?	?	x	x	x	x
Pregnant, intrapartum, postpartum women with complications													
Amoxicillin ¹⁵	Treat bacteriuria; prevent pyelonephritis							?	x	x	x	x	x
Iron or folate tablets ¹⁵	Treat anaemia; prepare women at risk of antepartum haemorrhage							x	x	x	x	x	x

MM FF M S F TBA CHW MW MC HP HC H

(Continues on next page)

(Continued from previous page)

		MM	FF	M	S	F	TBA	CHW	MW	MC	HP	HC	H
Calcium supplementation (in women at high risk of pre-eclampsia) ¹⁵	Reduce risk of pre-eclampsia							x	x	x	x	x	x
Balanced protein-energy supplements ¹⁶	Treat low weight gain; neonatal focus							x	x	x	x	x	x
Advice for previous caesarean section, (and stillbirth) to deliver in hospital*	Prevent uterine rupture; obstructed labour				?	?		?	x	x	x	x	x
Uterine massage ¹⁴	Treat postpartum haemorrhage				?	?		?	x			x	x
Post induced-abortion contraceptive advice ¹⁵	Prevent subsequent unwanted pregnancy; unsafe abortion mortality; all-cause mortality					?		?	x			x	x
Antibiotics (erythromycin) for PROM (preterm premature rupture of membranes) ^{14,15,16}	Prevent sepsis							?	x			x	x
Stimulate nipples post term to induce labour ¹⁰	Neonatal focus								x			x	x
Induce labour (intravenous, oxytocics, ability to monitor fetus) ¹⁰	Neonatal focus for post term; treat hypertensive disorders of pregnancy											x	x
Ceftriaxone for gonorrhoea; erythromycin for chlamydia; metronidazole for trichomoniasis (but not in first trimester) ¹⁰	Treat gonorrhoea, chlamydia, trichomoniasis											x	x
Benzathine penicillin ¹⁶	Treat syphilis											x	x
Anti D (in pregnancy [28–34 weeks] and within 17 h postpartum) ¹⁶	Prevent isoimmunisation											x	x
Nevirapine (and advice on mode of delivery and guidance and support for replacement feeding) ¹⁵	Neonatal focus											x	x
Antiretroviral treatment for women (and advice on mode of delivery and guidance and support for replacement feeding) ¹⁷	Treat HIV and AIDS											x	x
Manage preterm labour to prevent pulmonary problems in the newborn (antenatal corticosteroids [betamethasone injection]; inpatient care) ^{14,15,16}	Neonatal focus											x	x
Repair lacerations ¹⁴	Prevent haemorrhage								x			x	x
Bimanual compression of uterus (gloves) ¹⁵	Treat postpartum haemorrhage								x			x	x
Manual removal of placenta ^{14,15}	Treat retained placenta; prevent postpartum haemorrhage								x			x	x
Episiotomy (aseptic technique, local anaesthesia blade; suture material) ¹⁵	Treat prolonged labour								x			x	x
Intravenous antibiotics (ampicillin injection, gentamicin plus intravenous metronidazole; intravenous saline) with or without inpatient care ^{14,15}	Treat severe infection (sepsis), retained products of conception; obstructed labour; postpartum infection and secondary postpartum haemorrhage; prevent sepsis								x			x	x
Intravenous drip, fluids ^{14,15}	Treat shock, postpartum haemorrhage, sepsis, obstructed labour, abortion								x			x	x
Oxytocic drip, oxytocics, uterotonic ¹⁵	Treat postpartum hemorrhage								x			x	x
Tocolytics (betaminics) ¹⁰	Manage premature labour								x			x	x
Antihypertensives (hydralazine) ^{14,15}	Treat hypertensive disorders of pregnancy								x			x	x
Manage airways ^{14,15}	Maintain respiration								x			x	x
Instrumental delivery (vacuum/forceps extraction): equipment ¹⁵	Prevent or treat obstructed labour; prolonged labour								x			x	x
Vacuum aspiration of retained products of conception (aspirator, anaesthetics) ¹⁵	Treat abortion; prevent sepsis; haemorrhage											x	x
Intraumbilical vein injection with saline solution and oxytocin to reduce need for manual removal of placenta ¹⁰	Prevent need for manual removal of placenta; retained placenta; postpartum haemorrhage											x	x
Magnesium sulfate ^{4,15}	Treat pre-eclampsia; eclampsia, postpartum eclampsia											x	x
Drain abscess ¹⁵	Treat infection											x	x
Nitroglycerine ^{14,15}	Shock (septic shock)											x	x
Uterine packing or balloon tamponade ¹⁵	Manage haemorrhage or retained placenta											x	x
Blood auto transfusion ¹⁵	Manage ectopic pregnancy											x	x
Destructive operation (kit; intravenous antibiotics) ¹⁵	Manage cephalo-pelvic disproportion											x	x
Treat indirect complications (diabetes, HIV, heart disease, asthma etc.) ¹⁵	Including treat severe infection associated with HIV											x	x
Symphysiotomy ¹⁵	Treat obstructed labour											?	x
Referral in case of any maternal complication ¹⁵	Prevent all-causes of mortality											x	
Cephalic version at ≥36 weeks ¹⁴	Treat malpresentation; prevent obstructed and prolonged labour												x
Group and save blood; identify donor ¹⁵	Treat antepartum haemorrhage												x

MM FF M S F TBA CHW MW MC HP HC H

(Continues on next page)

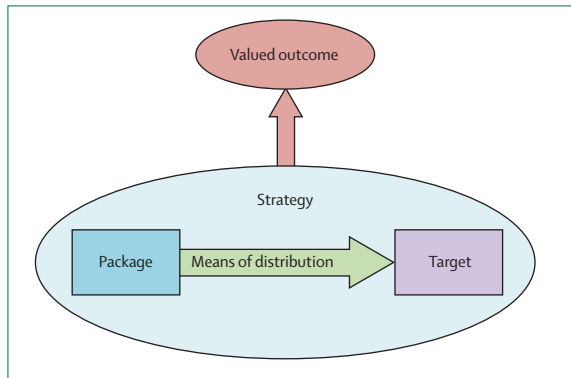


Figure 1: Schematic representation of a strategy aimed at a valued outcome

achieved by the means of distribution. In turn, the effectiveness of the package is dependent on the effectiveness of the component interventions. However,

owing to synergies and antagonisms between interventions, their individual benefits cannot simply be extrapolated to the package.

The costs of the strategy should encompass the costs of the package and of the means of distribution, but the cost of distribution is often typically represented only in terms of marginal costs. Simple strategies that require few health-system resources and are also low-cost are more likely to be adopted by governments and donors, and to be sustained. Generalisation across country contexts about the cultural, legal, and ideological acceptability and sustainability of strategies is more difficult, but these considerations are vital. We call a best bet strategy one that consists of an effective package of interventions, means of distribution that have the potential to achieve high coverage, and is bought into by populations and governments and is thus likely to be sustained.

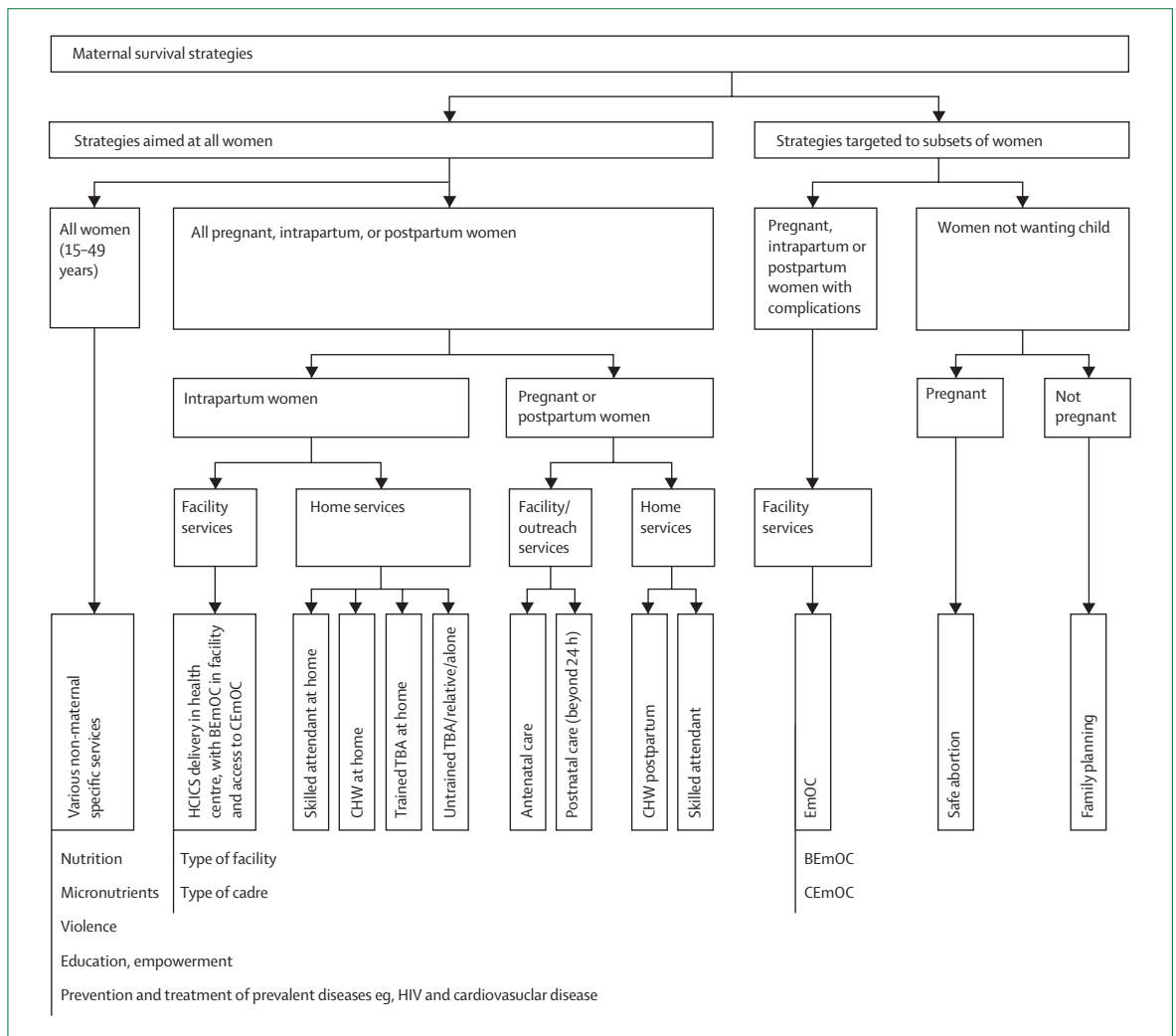


Figure 2: Strategic options for reducing maternal mortality

HCICS= health centre intrapartum-care strategy. BEmOC= basic emergency obstetric care. CEEmOC= comprehensive emergency obstetric care. CHW=community health worker. TBA=traditional birth attendant. EmOC=emergency obstetric care.

Intrapartum-care strategies must be the priority

Figure 2 shows the strategic options aimed at reducing maternal mortality. Some of these options share the same target group, whereas others are complementary and focus on different women.

Most maternal deaths occur during labour, delivery, or the first 24 h postpartum, and most complications cannot be predicted or prevented (see the first report in this series). Individual complications are quite rare, and timely diagnosis and appropriate intervention requires considerable skill to prevent death and to avoid introducing harm. The location of women when they deliver, who is attending them, and how quickly they can be transported to referral-level care are thus crucial factors in determining interventions that are needed and feasible.²³

Health centre intrapartum care

Recommendation of facility-based intrapartum care is anathema to some. However, evidence shows that the best intrapartum-care strategy is likely to be one in which women routinely choose to deliver in a health centre, with midwives as the main providers, but with other attendants working with them in a team; the options for such teams are discussed in the third report in this series. Such care is referred to as basic, primary, routine, basic essential obstetric care, and most recently skilled care at the first level.² We refer to it as a health centre intrapartum-care strategy.

Such a strategy would target all intrapartum women and aim to maintain the normality of the birthing process, with an emphasis on non-intervention and timely watchfulness, and on preservation of the psychosocial benefits of a positive birthing experience. Underlying this strategy, however, are important principals of safety, primary prevention where possible, and early detection and management of problems, including life-threatening ones, via the packages shown in table 1. The treatment component would include all basic emergency obstetric functions, apart from blood transfusions or surgery which would be available at the referral level as comprehensive emergency obstetric care.²⁴ The benefits of a health centre intrapartum-care strategy for other maternal outcomes and for neonates are discussed in paper five in this series.

Most of the interventions that make up the package supplied through a health centre intrapartum-care strategy have been assessed with robust experimental designs, and are widely regarded as being effective. Suggestions that such an intrapartum-care package can “prevent a large proportion of obstetric deaths”,¹³ and that “first level care does save lives and manage emergencies...and can bring maternal mortality below 200 per 100 000 live births”² are common. Some uncertainties about the effectiveness of a health centre intrapartum-care strategy could be allayed by clarifying what is being included—purely preventive best practices

Panel 3: Choices about cadre of skilled attendants and hospitals versus health centres role for comprehensive essential obstetric care

The cadre of professional attendant (midwife or doctor) presents an opportunity for choice. Where an option still exists and is viable, the evidence is strongly in favour of midwives as the main providers.²³ Although doctors can potentially distribute a more extensive package of care than can midwives, gains in effectiveness are limited if births are in health centres that do not have surgical and blood-transfusion capability. Additionally, the expectation that all births will be attended by a doctor is problematic if high coverage is to be attained, since deployment and retention might be more difficult, and because of higher salary and training costs. Moreover, doctors have been shown to over-medicalise childbirth and have proven difficult to hold to account.²³

Examples exist of many countries in which nearly all intrapartum care is provided in hospital through a hospital intrapartum-care strategy package of interventions including comprehensive emergency obstetric care capability (we would call this a hospital intrapartum-care strategy). There is no doubt that hospitals can provide more effective packages for emergencies than health centres, in part because they can provide surgical and blood transfusion functions. Few data are available for the relative merits of health-centre packages versus hospital packages for normal births, but the risks of unnecessary intervention for normal births are likely to be most extreme in hospitals, as are the costs of the care.²³

and the avoidance of iatrogenic procedures, and first line management of complications. No randomised controlled trials have been undertaken to indicate the size of effect on maternal mortality that such a strategy might achieve compared with the alternative intrapartum-care strategies discussed later.

Two cost-effectiveness analyses of maternal and neonatal care packages and means of distribution emphasised the potential of close-to-client care for normal and complicated cases—essentially encompassing basic essential obstetric care and basic emergency obstetric care, finding them among the most cost-effective options.^{13,14} Ensuring such services were close enough for women to deliver in would also ensure women were likely to be close enough if the need for emergency care arose in the antenatal or postpartum period. Moreover, because health centres are part of the health system, the affordability and sustainability of a health centre intrapartum-care strategy are likely to surpass those of strategies with means of distribution usually outside the health system, such as traditional birth attendants or volunteer community workers. Thus, there is little doubt that a health centre intrapartum-care strategy would be adequate to deal with most births, and that this level fits

well with the district approach to health systems. Minor variations on the strategy might be needed in some contexts. These relate to the cadre of skilled attendants (midwives or doctors), and the case for a hospital intrapartum-care strategy, as discussed further in panel 3. By contrast, although the provision of intrapartum care by skilled attendants in private clinics or maternity homes sometimes complicates planning and provision of government services, it is not fundamentally different to a health centre intrapartum-care strategy.

Of course the need to roll out this strategy and simultaneously ensure the availability of comprehensive emergency obstetric care presents a challenge to health systems, especially in view of the gap between universal coverage and the low current rates that can be projected from data for the proportion of births in health institutions, as discussed in the third paper in this series. Similarly, a health centre intrapartum-care strategy requires 24-h availability of service and this is not currently the case for many health centres. Reviews of preparedness show health centres to have the largest gap between service requirements and actual standards compared with other health-care facilities.^{25,26} Moreover, in many poor countries, women spend very little time in facilities²⁷ and this could seriously limit the effectiveness of a health centre intrapartum-care strategy; ideally a 24 h contact period is needed.²⁸

We assume that intrapartum women would opt for our best bet strategy in preference to alternatives, provided that barriers of distance, cost, and cultural acceptability are overcome, and if staff in facilities have the necessary interpersonal skills to support women. Evidence from urban areas in some of the poorest countries suggests that where geographical access is possible, most women do opt for this kind of intrapartum care, as discussed in the third report in this series. However, some women will choose other alternatives, including home birth with a skilled attendant, relative, or traditional birth attendant, particularly where there are strong beliefs in the normality of childbirth or cultural preferences for certain practices or delivery environments.²⁹ We do not advocate prohibition of women's choice; rather our best bet is about what the entitlement to care should be and to ensure that effective strategies are available to all women, especially those who are poor. Ensuring the availability of a package of effective intrapartum interventions in health facilities does not guarantee an effect on maternal mortality, which is contingent on uptake by the target population, the quality of implementation,³⁰ and the avoidance of harm introduction.^{31,32} Scaling-up and quality assurance of a health centre intrapartum-care strategy are discussed further in the third and fourth papers in this series. In recommending such a strategy as the best option, we are well aware of the substantial obstacles that need to be overcome for this ideal to become a reality, but regard overcoming these as no more

aspirational than a 75% reduction in maternal mortality, the target of MDG-5.

Since a health centre intrapartum-care strategy is not without its challenges, uncertainties, and limitations, alternative intrapartum-care strategies must also be considered. All three alternatives are home-based and hence need to also be coupled with strategies that remove community barriers to accessing emergency obstetric care, including recognition of danger signs by lay attendants (relatives and traditional birth attendants) and effective referral mechanisms.

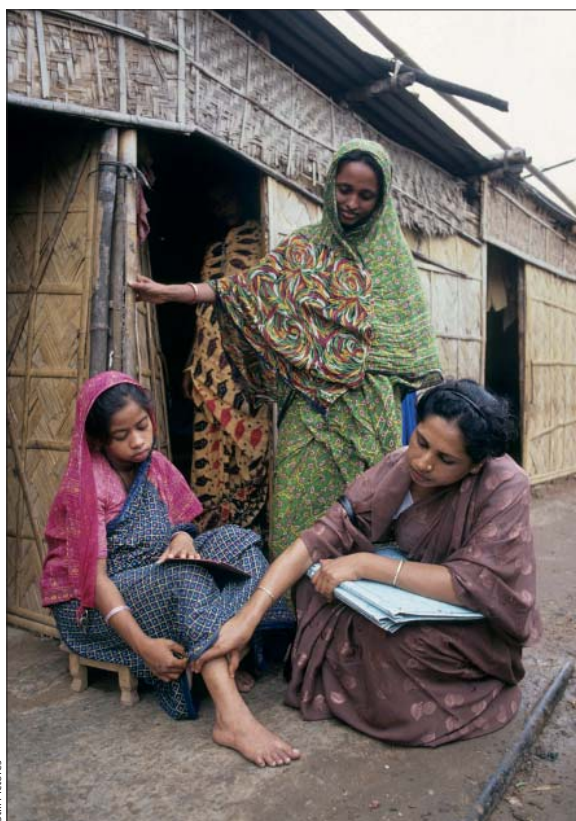
Skilled attendants at home

The normal delivery and preventive functions of basic care, including some emergency first aid, could be delivered by a skilled attendant in the home. Such strategies have been adopted successfully and have contributed to achievement of low maternal mortality ratios in countries such as Malaysia and the Netherlands.²³ Some argue that home births increase coverage of skilled attendance in remote areas and respond to women's demands for home-based care.²³ However, home conditions can be extremely basic.³³ Home-based intrapartum care is also inefficient in terms of the skilled attendant's time and ability to cope with emergencies. Such care requires the skilled attendant to deal with first-aid for complications on their own or with help only from the family, rather than from other providers such as auxiliaries or doctors in health centres or hospitals, and to arrange transport for referral.

Home-based care without assurance of links and transport to emergency obstetric care in facilities will also limit the effectiveness of this strategy and could compromise community confidence in the midwife. Supervision requirements are also more onerous. Data from Bangladesh indicate, for example, that midwives deployed in the community do not provide much outreach, preferring instead to serve those closest to them.³⁴ Although the third paper in this series indicates that home-based provision is less likely to be sustained in the long-term, nevertheless, any investment in training these skilled attendants is unlikely to be wasted since they could be redeployed in health facilities.

Community health workers at home

Interest at the international level in the role of community health workers has been renewed lately after falling out of favour as a result of negative experiences in the 1980s.³⁵ In particular, the idea of a community health worker attending homes the day after birth to provide care for the newborn baby is now being promoted as an effective complementary strategy to one based on health professionals at delivery.^{16,36} The essential question is whether this approach provides an opportunity to address maternal outcomes, particularly mortality.



Community health worker doing an antenatal check-up of a pregnant woman outside her home

Such a strategy assumes that community health workers are present at deliveries, which depends on families having informed them of the labour, and on their willingness to attend. If these health workers are not trained in delivery care and have little to offer, this assumption of attendance is unrealistic. Moreover, unless training is to the level of a skilled attendant, community health workers will not be able to provide most elements of an effective package of interventions. Thus the extent and content of current training, together with the degree to which the community health worker is a multipurpose worker, are important considerations. Implementation of a system and cadre of such health workers de novo and at scale would need large investment of resources, and thus presents opportunity costs to the drive to professional skilled attendants. We would also argue that the logistic and supervision requirements of community health workers would entail similar resources to those of skilled attendants at home, and thus would face the same problems of sustainability. If a country already has community health workers present at delivery, pragmatism would dictate including them, particularly to facilitate transport to emergency obstetric care, for example.

Relatives or traditional birth attendants at home

The default intrapartum-care strategy is lay (relatives or traditional birth attendant) home-based care, with little

government provision of services. This approach is typical in the poorest countries and in the poorest rural populations within countries, and is almost invariably associated with high maternal mortality. An intermediate approach is to train traditional birth attendants, acknowledging that in some settings they attend many births. There is a long history of traditional birth attendant training programmes. A systematic review^{37,38} lends support to early findings suggesting that trained traditional birth attendants without the support of skilled back-up services do not reduce the maternal mortality ratio.^{39,40} The review concludes that investment in such training is not warranted as a major stand-alone national strategy. In Pakistan, a randomised controlled trial showed that traditional birth attendant training and support to health facilities did not lead to a significant reduction in maternal mortality.²² However, in assessments in Indonesia, Guatemala, and Brazil, traditional birth attendants identified early signs of complications during labour and delivery, and successfully referred women for treatment.^{39,41,42}

Another variant of home-based intrapartum care would be to roll out resources and technologies via lay birth attendants or traditional birth attendants. Examples proposed include promotion of home-based use of misoprostol after delivery to reduce haemorrhage, and marketing of clean-birth kits. Misoprostol might be misused and its use in the home has not been assessed on a large scale, and the effect of clean-birth kits on reducing death from sepsis has never been shown to be significant. These technologies remain more of a hope than an effective actuality. Wide coverage with a cheap but ineffective technology or package of interventions will not reduce maternal mortality, although it might provide the illusion of doing something. Should new and effective technologies be developed that can be delivered by lay people in the home, wide distribution of them would be important, including distribution via community-based mechanisms and social marketing.

Emergency obstetric care strategies

An early review of options for reduction of maternal mortality⁴³ argued cogently for assurance that sufficient emergency obstetric care was available—both at the health centre (basic emergency obstetric care) and the referral hospital (comprehensive emergency obstetric care)—to treat the complications that cause most maternal deaths. Targeting of women with complications while making no particular provision for routine intrapartum care has been widely termed the emergency-obstetric-care strategy. We agree that emergency care is an essential requirement for reduction of a substantial proportion of maternal mortality,⁴⁴ and our recommended health centre intrapartum-care strategy incorporates it.

Ensuring a ready supply of the emergency-obstetric-care package requires that health centres and hospitals are equipped to deal with the emergencies that reach

them, and that timely care is not hindered by the need to pay in advance for lifesaving treatments, or to purchase essential supplies and drugs from outside the facility, or organise blood donations. All intrapartum strategies have these requirements. However, the success of emergency obstetric care alone is also dependent on a means of distribution to ensure that its target—women with complications, particularly rapidly fatal intrapartum complications—can access such care, ideally within a couple of hours. This means overcoming delays in recognition of complications (the so-called first delay) and in gaining timely access to appropriate emergency obstetric care facilities (the second delay).⁴⁵

Although some families can overcome delay without external input, this approach puts a considerable burden on those least equipped for it. Efforts to support an emergency obstetric-care strategy have mostly focused on raising families' awareness of danger signs with information, education, and communication, and on instituting birth preparedness. Assessments of information, education, and communication interventions suggest that this approach is not particularly effective at reducing delays, partly because danger-sign messages are complex.⁴⁶ Trained traditional birth attendants can effect better referral, and skilled attendants in the home are assumed to recognise complications and act on them quickly. We are unaware of any robust assessments of the effect of birth-preparedness packages implemented on a large scale. Other efforts have sought to improve transport, including through community mobilisation, but these are usually small in scale and have not been rigorously assessed.^{47,48}

No large-scale robust evidence is available to show that adequate provision solely of an emergency obstetric care package, with or without a strategy to remove barriers, can produce a substantial decline in maternal mortality. Capacity to provide adequate and timely emergency obstetric care is, however, the minimum standard a health system is ethically obliged to provide to begin to address maternal mortality.

Strategies that complement those targeted at the intrapartum period

Intrapartum-care strategies are acknowledged as the priority focus for reduction of maternal mortality, but the role of complementary strategies with different target groups, such as pregnant women or women not desiring pregnancy, are also important to consider. We recognise the potential for four such strategies—antenatal care, postpartum care, family planning, and safe abortion—but also comment on broader-based strategies which relate to women's health and development per se.

Whereas an intrapartum-care strategy is universally relevant, some complementary strategies vary more widely in their appropriateness across countries, according to health profiles as well as social, cultural, and

political factors. Moreover, some of these complementary strategies are valued on the basis of outcomes other than maternal mortality only, and have less potential to affect mortality than do intrapartum-care strategies.

Antenatal care

The nature of, and rationale for, antenatal care is described in panel 4. High-grade evidence is available for the efficacy of single interventions that can be delivered to antepartum women,⁴⁹ and for the effectiveness of four to five facility-based antenatal care contacts as a means of distributing them to most women.⁵⁰ However, antepartum packages of interventions have a limited potential to affect maternal mortality ratios. High-risk screening during antenatal care, as a means of identifying women for facility-based intrapartum care, is not effective, either for women who were at low or high risk when they first presented for antenatal care.⁵¹ Similarly, antepartum screening by traditional birth attendants, based on demographic risks—eg, age, parity—has been shown to be inefficient and could overwhelm referral sites.⁵²

The poor quality of routine antenatal care, in terms of preventing, diagnosing, or treating complications, has been widely noted from observational studies.⁵³ Despite this observation, high overall levels of antenatal care coverage exist, including in poor countries, with an average of 68% of pregnant women having at least one antenatal care visit.⁵⁴ Such high coverage is partly explained by the existence of multiple points for

Panel 4: What is the worth of antenatal care strategies?

Antenatal care has long been regarded as a core component of routine maternal and child health services, and receives the largest allocation of budgetary resource in many developing countries.¹¹ These strategies target a predominantly healthy population of pregnant women in order to screen and detect early signs of or risk factors for disease, followed by timely intervention,¹³ originally with the aspiration of reducing maternal and perinatal mortality and morbidity.

However, the contribution of antenatal care specifically to maternal mortality reduction has been challenged.⁴⁹ The acknowledged benefits to the baby of antenatal care in terms of growth, risk of infection, and survival, however, remain. The justification of the benefits to the mother has now shifted to emphasising the promotion of health and health-seeking behaviour, including birth preparedness. Furthermore, since antenatal care is one of the most widespread health services and coverage is often high, it increasingly serves as a means of distribution for other packages, for example, the roll-out of antimalarial drugs or of antiretroviral therapy for maternal HIV/AIDS. In view of this increasingly multipurpose role for antenatal care, the choice of outcomes with which to judge its success will remain a matter of contention.

provision, a fairly low cost, and a long window of time for seeking care. Moreover, although differences in uptake according to poverty levels exist,⁵⁵ these are rarely as marked as those for uptake of skilled attendants at delivery.^{56,57}

Postpartum care

During the postpartum period, physical, social, and mental problems can emerge, indicating a need for strategies that encompass both preventive and curative intervention packages. For life-threatening disorders during or after childbirth, strategies that encompass emergency obstetric care packages are the most effective and efficient approaches. The risk of death, however, decreases steadily by 2 days postpartum, and so the optimum means and timing of the distribution of routine postpartum care during the entire 6-week period is unclear, beyond recommendation that intrapartum-care strategies need to cover the very high-risk period up to 24 h postpartum.

Little evidence is available for the packaging of interventions for routine postpartum care for the mother, or on use of the means of distribution for neonatal care interventions as an opportunity to provide care for the mother.¹³ We suggest that these ideas should be explored as a research priority, and one that is particularly urgent in populations with a substantial burden of indirect maternal complications, such as HIV/AIDS.⁵⁸

Family planning

Primary prevention is often touted as the ideal public-health measure, yet its use in reducing maternal mortality is either under-emphasised (for family planning⁵⁹), politically unpalatable to certain governments and donors (for induced abortion), or uncertain in effectiveness (for intervention on general health). Most discussions of strategies to reduce maternal mortality concentrate on detection of problems early and provision of treatment to prevent them becoming life-threatening, or on treatment of life-threatening complications to prevent death. Adverse outcomes in pregnancy are conditional on pregnancy itself, so prevention can be separated into prevention of pregnancy and prevention of risk factors for complications and disease. To say that without pregnancy there would be no maternal death seems obvious, but since pregnancy is an absolute requirement for maternal mortality, prevention of pregnancy is an effective form of primary prevention, albeit one that applies to a restricted target group; that of women not wanting more children.

Births at high parity and births to very young or older women pose higher risks of maternal mortality. These patterns of fertility can be potentially altered through family planning, but the overall effect does not seem to be substantial.^{60,61} Results for whether 2–5 year birth intervals reduce maternal mortality are conflicting,^{62,63}

although they are definitely associated with improved fetal outcomes.⁶⁴

Family planning programmes consisting of a dozen or so effective contraceptive technologies (including emergency contraception) and a range of means of distribution, from traditional clinic-based strategies, to mobile clinics, community-based distribution, and social marketing, have been implemented all over the world.¹⁸ Although a small mortality risk is associated with contraception, all methods are safer than pregnancy and delivery. Globally, coverage of contraception is 61%, whereas unmet need for contraception ranges from 6% in Europe to 23% in sub-Saharan Africa.⁶⁵ 41% of pregnancies globally are unwanted, with 22% resulting in induced abortion.⁶⁶ These data suggest that between a quarter and two-fifths of maternal deaths could be eliminated if unplanned and unwanted pregnancies were prevented.

Safe abortion

Failing to prevent unwanted pregnancy leads some women to induce abortion. Mortality associated with medical termination of pregnancy in a safe environment is lower than that associated with delivery at term. By contrast, mortality owing to unsafe abortion can be substantial, and is estimated globally to be 330 per 100 000 induced abortions, contributing to about 13% of maternal deaths.⁶⁶ Safe technologies for inducing abortion are available, including medical abortions (eg, with mifepristone or misoprostol), vacuum aspiration, and curettage. Where legally, politically, and culturally acceptable, medical abortions could potentially be delivered at the household level, and attain high coverage, thereby averting a substantial proportion of maternal deaths.

Some developing countries, such as South Africa, have changed their laws to ensure wider access to safe abortion. In other countries, programmes focus on ensuring safe abortion can take place under specific circumstances, such as after rape or in the event of serious fetal malformation. Care for post-abortion complications should be covered within emergency obstetric care packages, irrespective of the legal status of induced abortion. Most women globally live in countries in which induced abortion is permitted on broad grounds, but a high unmet need remains within some of these countries, where women's rights to safe abortion are severely restricted.⁶⁶ If induced abortion strategies are acceptable in a country, they should be a priority secondary to family planning.

Broader health and non-health strategies

Pre-existing ill-health is a risk factor for maternal mortality, particularly from indirect causes, and thus improvements in women's general health status should help prevent some complications and deaths. These arguments are most widely made for nutritional status, where improvement of women's haemoglobin, calcium,

or iodine status, or of short stature is thought, for example, to reduce the risks of developing haemorrhage, eclampsia, or obstructed labour. The evidence, however, is weak,⁶⁷ and overnutrition, in the form of obesity, rather than undernutrition, is most problematic. The effect on mortality rates of prevention of these risk factors is thought to be small. However, in settings with high levels of maternal mortality, between about 1000 and 500 per 100 000 livebirths, with few intrapartum services, whether the variability in magnitude stems from variable access to emergency obstetric care or from a divergence in other factors, including broader health status, is uncertain. Improvement of vitamin A status has been shown in a randomised trial to reduce maternal mortality by 40% in deficient areas;¹⁹ this effect is as yet unverified. Finally, prevention or treatment of infections (eg, streptococcal infections that causes rheumatic heart disease, or HIV, syphilis, or malaria) or chronic disease (eg, diabetes and asthma) could help reduce indirect maternal deaths. The potential effect of such measures is also uncertain, although some historical series, in Malaysia and Sri Lanka, for example, hint at a part played by effective malaria-control programmes.⁶⁸

Conclusions

In this paper we aim to replicate for maternal survival what other specialties within international public health have done so well—to strip away the complexities about what to do, and thereby remove excuses for inaction. And like in other specialties, such stripping away involves simplification of the issues, making heroic assumptions, and use of bold claims and language. Of course the reality is more complex: decision-making for scarce health resources is a matter of politics, values, and resources, and not all the evidence needed is available.^{69–71} But acceptance of maternal mortality as the key outcome makes the issues and choices much clearer.

In view of the sequence of bold assertions we have made in panel 1, the decision-making process needs to grapple with relative priorities and the available timeframe. We propose that the main priority should be for women to have the choice to deliver in health centres, in other words via a health centre intrapartum-care strategy. Countries in which this approach has already been implemented have maternal mortality ratios of less than 200 deaths per 100 000 livebirths, with some even lower. We are not saying that the connection here is unreservedly and directly causal and that a health centre intrapartum-care strategy will alone achieve MDG-5. Rather, on the basis of current knowledge, we recommend this as the ideal or best bet strategy, and suggest that without such a strategy, substantial declines in maternal mortality rates are unlikely in the next 10–20 years.

Implementation of a health centre intrapartum-care strategy cannot be achieved overnight, and a legitimate question is what to do in the meantime. The role of complementary strategies is easier to address, since they

do not share the same target group and, apart from competing for resources, augment rather than undermine the progress of a health centre intrapartum-care strategy. If complementary strategies are already being implemented, the issue is the scale of further investment. With infinite resources, the recommendation would be to implement them all, accepting that the safe-abortion strategy is not acceptable in some countries. The more likely scenario is that of limited resources and thus inputs to one of these complementary strategies should be seen as an opportunity cost for both a health centre intrapartum-care strategy and other complementary strategies. In terms of maternal mortality, we suggest that evidence on the proportion of deaths prevented, the efficacy of the packages, and the ability to achieve high coverage indicates a crude prioritisation of family planning, followed by safe abortion (where possible), antenatal care, and postpartum care (beyond the first 24 h after delivery, which are included in intrapartum care).

Intrapartum-care strategies necessitate more trade-offs, since they target the same group; to increase the distribution of deliveries via one strategy (eg, health centre intrapartum-care strategy) without decreasing the share via another (eg, home deliveries with traditional birth attendants) is not possible. The issue then becomes again one of the amount of investment.

Ensuring appropriate provision of emergency obstetric care is an essential feature of all intrapartum-care



New mother and baby: beneficiaries of skilled attendance in an urban health centre, Burkina Faso

strategies, but timely access is crucial and thus physical, cultural, and financial barriers must be addressed. One option might be to invest in the content and quality of the associated package of interventions, rather than to shift coverage; however, this option is limited by the nature of the means of distribution. The potential effectiveness of intervention packages delivered by alternative means of distribution is highest for facility-based strategies, followed by skilled-attendant at home, and then community health workers, traditional birth attendants, and lay people. Fundamental change of the package of interventions (in view of available technologies) is unlikely for relatives or self-delivery, limited for traditional birth attendants, minor for community health workers, and moderate for skilled attendants at home. The main constraint is training and skills—the very feature that characterises the different birth attendants.

A second option is to increase coverage of more effective intrapartum strategies while falling short of adopting the most effective: the health centre intrapartum-care strategy. However, an intrapartum-care strategy that uses a skilled attendant at home needs more staff to be trained than a health centre intrapartum-care strategy, involves more complex deployment issues, and faces substantial supervisory and logistical constraints. An intrapartum-care strategy that uses a community health worker at home also requires many workers to be trained, although the requirements are less than when skilled-attendants are used. To be effective, such a strategy would also require considerable supervision and logistical input, and has the added disadvantage that unlike skilled attendants, community-health workers often cannot be readily redeployed at health facilities in the longer term. Home-based intrapartum care, particularly with lay people, traditional birth attendants, and community health workers, places most of the burden for recognition of complications and organisation of transport on families and thus on those least trained or skilled for these responsibilities. If these alternative strategies do not exist now, then we suggest that investment to set them up is not justifiable for the purposes of reduction of maternal mortality. Instead we advocate prioritisation of all further investment for maternal survival in a health centre intrapartum-care strategy. We recognise that stating such scenarios boldly also means doing so crudely, and that ultimately the primary stakeholders—women and their families—must be engaged, and that national governments need to be pragmatic and balance many factors in order to adopt such a vision for the future.

The key word is vision. In signing-up for MDG-5, countries have indicated their vision. But it is meaningless unless it is translated into a clear strategy for achieving it. During the 20 years of international and national advocacy for safe motherhood, an estimated 10 million women have died of maternal causes. For this to happen in a

world where we state that “we know what works”⁷¹ and that “88–98% of maternal deaths are preventable”⁷² is obscene. Other specialties of public health have not been so timid about following up on the language of advocacy with clear recommendations on what to do, albeit at times glossing over important issues such as how to implement effective interventions. For maternal mortality, the very safe motherhood community so committed to progress has been too diligent with these uncertainties. But enough is enough. If maternal mortality is the agreed priority, then what are we waiting for?

The Lancet Maternal Survival Series steering group

Carine Ronsmans, Jo Borghi, Oona Campbell, Veronique Filippi, Wendy Graham, Marge Koblinsky, and Anne Mills.

Conflict of interest statement

We declare we have no conflict of interest.

Acknowledgments

We thank Zoe Matthews for her rigorous and insightful review of an earlier version of this paper; all the participants at the Maternal Survival Series review meeting in Geneva in January, 2006, for helpful comments; Julia Hussein, Rudolf Schumacher, Liliana Risi, Rajesh Khana, Francois Couturier, Holmfridur Gardarsdottir, and Vincent de Brouwere for clinical and programmatic insights; and Emily Freeman, Lauren Foster, and Yadigar Coskun for help in preparing the manuscript.

Additional work for the series was supported directly by the UK Department for International Development through a grant to the London School of Hygiene and Tropical Medicine, and by the Initiative for Maternal Mortality Programme Assessment. The funding sources did not influence the content of this article, and have no responsibility for the information provided or views expressed in this paper.

Oona Campbell is funded by the London School of Hygiene and Tropical Medicine, and Wendy Graham by the University of Aberdeen and by the Initiative for Maternal Mortality Programme Assessment.

References

- 1 Safe Motherhood Initiative. Announcing the partnership for safe motherhood and newborn health. May, 2004: http://www.safemotherhood.org/partnerships/Partnership_Brochure.pdf (accessed on Sept 5, 2006).
- 2 WHO. The world health report 2005: make every mother and child count. Geneva: World Health Organization, 2005.
- 3 Sachs JD, McArthur JW. The Millennium Project: a plan for meeting the Millennium Development Goals. *Lancet* 2005; **365**: 347–53.
- 4 Weil O, Fernandez H. Is safe motherhood an orphan initiative? *Lancet* 1999; **354**: 940–43.
- 5 Maine D, Rosenfield A. The safe motherhood initiative: why has it stalled? *Am J Public Health* 1999; **89**: 480–82.
- 6 Freedman, LP. Using human rights in maternal mortality programs: from analysis to strategy. *Int J Gynecol Obstet* 2001; **75**: 51–60.
- 7 Milne L, Scotland G, Tagiyeva-Milne N, Hussein J. Safe motherhood program evaluation: theory and practice. *J Midwifery Womens Health* 2004; **49**: 338–44.
- 8 Miller S, Sloan NL, Winikoff B, Langer A, Fikree FF. Where is the “E” in MCH? The need for an evidence-based approach in safe motherhood. *J Midwifery Womens Health* 2003; **48b**: 10–18.
- 9 Hodnett ED, Gates S, Hofmeyr G J, Sakala C. Continuous support for women during childbirth. *Cochrane Database Syst Rev* 2003; **3**: CD003766.
- 10 WHO. Reproductive Health Library, version 9. World Health Organization. <http://www.rhlibrary.com/default.asp> (accessed Sept 5, 2006).
- 11 Gay J, Hardee K, Judice N, et al. What works: a policy and program guide to the evidence on family planning, safe motherhood, and STI/HIV/AIDS interventions: safe motherhood module 1. Washington, DC: Policy Project, 2003.
- 12 WHO Managing complications of pregnancy and childbirth (IMPAC): a guide for midwives and doctors. Geneva: World Health Organization, 2000.

- 13 Bale J, Stoll B, Mack A, Lucas A. Improving birth outcomes: meeting the challenges in the developing world. Washington, DC: National Academy of Sciences and Institute of Medicine, 2003.
- 14 Adam T, Lim SS, Mehta S, et al. Cost-effectiveness analysis of strategies for maternal and neonatal health in developing countries. *BMJ* 2005; **331**: 1107.
- 15 Graham WJ, Cairns J, Bhattacharya S, et al. Disease control priorities in developing countries, 2nd ed. New York: Oxford University Press, 2006: 499–529.
- 16 Darmstadt DL, 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.
- 17 Jamison DT, Breman JG, Measham AR, et al. Disease control priorities in developing countries, 2nd Edn. New York: Oxford University Press, 2006.
- 18 Hatcher RA, Rinehart W, Blackburn R, Geller JS, Shelton JD. The essentials of contraceptive technology. Baltimore: Johns Hopkins Bloomberg School of Public Health Population Information Program, 1997.
- 19 West KP Jr, Katz J, Khattry SK, et al on behalf of the NNIPS-2 study group. Double blind, cluster randomised trial of low dose supplementation with vitamin A or β carotene on mortality related to pregnancy in Nepal. *BMJ* 1999; **318**: 570–75.
- 20 The Maggie Trial Collaborative Group. Do women with pre-eclampsia, and their babies, benefit from magnesium sulphate? The Maggie Trial: a randomised placebo-controlled trial. *Lancet* 2002; **359**: 1877–90.
- 21 Manandhar DS, Osrin D, Shrestha BP et al. Effect of a participatory intervention with women's groups on birth outcomes in Nepal: cluster-randomised controlled trial. *Lancet* 2004; **364**: 970–79.
- 22 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.
- 23 Koblinsky MA, Campbell O, Heichelheim J. Organizing delivery care: what works for safe motherhood? *Bull World Health Organ* 1999; **77**: 399–406.
- 24 Nirupam S, Yuster EA. Emergency obstetric care: measuring availability and monitoring progress. *Int J Gynaecol Obstet* 1995; **50**(Suppl 2): S79–88.
- 25 Ross JA, Begala JE. Measures of strength for maternal health programs in 55 developing countries: the MNPI study. *Matern Child Health J* 2005 **9**: 59–70.
- 26 Pearson L, Shoo R. Availability and use of emergency obstetric services: Kenya, Rwanda, Southern Sudan, and Uganda. *Int J Gynaecol Obstet* 2005 Feb; **88**: 208–15.
- 27 Gozum S, Kilic D. Health problems related to early discharge of Turkish women. *Midwifery* 2005; **21**: 371–78.
- 28 Li XF, Fortney JA, Kotelchuck M, Glover LH. The postpartum period: the key to maternal mortality. *Int J Gynaecol Obstet* 1996; **54**: 1–10.
- 29 Seone G, Kaune V, Cordova V. Diagnostico: barreras y viabilizadores en la atencion de complicaciones obstetricas y neonatales. La Paz: MotherCare Bolivia, John Snow, Inc. and Marketing SR,C, 1996.
- 30 Filippi V, Brugha R, Browne E, et al. Obstetric audit in resource-poor settings: lessons from a multi-country project auditing 'near miss' obstetrical emergencies. *Health Policy Plan* 2004; **19**: 57–66.
- 31 Choices and Challenges in Changing Childbirth Research Network. Routines in facility-based maternity care: evidence from the Arab World. *BJOG* 2005; **112**: 1270–76.
- 32 Buekens P. Over-medicalisation of maternity care in developing countries. *Stud Health Serv Organ Policy* 2001; **17**: 195–206.
- 33 Blum LS, Sharmin T, Ronsmans C. Performing home facility-based deliveries: understanding the perspective of skilled birthing attendants. *Reprod Health Matters* 2006; **14**: 51–60.
- 34 Chowdhury ME, Ronsmans C, Killewo J, et al. Equity in use of home-based or facility-based skilled obstetric care in rural Bangladesh: an observational study. *Lancet* 2006; **367**: 327–32.
- 35 Walt G, Perera M, Heggenhougen K. Are large-scale volunteer community health worker programmes feasible? The case of Sri Lanka. *Soc Sci Med*. 1989; **29**: 599–608.
- 36 Bang AT, Bang RA, Baitule SB, Reddy MH, Deshmukh MD. Effect of home-based neonatal care and management of sepsis on neonatal mortality: field trial in rural India. *Lancet* 1999; **354**: 1955–61.
- 37 Sibley L, Ann Sipe T. What can a meta-analysis tell us about traditional birth attendant training and pregnancy outcomes? *Midwifery* 2004; **20**: 51–60.
- 38 Sibley L, Sipe TA, Koblinsky M. Does traditional birth attendant training improve referral of women with obstetric complications: a review of the evidence. *Soc Sci Med* 2004; **59**: 1757–68.
- 39 Alisjhabana A, Williams C, Dharmayanti R, Hermawan D, Kwast BE, Koblinsky M. An integrated village maternity service to improve referral patterns in a rural area in West-Java. *Int J Gynaecol Obstet* 1995; **48**(Suppl): S83–94.
- 40 Greenwood AM, Greenwood BM, Bradley AK, et al. A prospective survey of the outcome of pregnancy in a rural area of the Gambia. *Bull World Health Organ* 1987; **65**: 635–43.
- 41 Schieber B, Delgado B, Delgado H. An intervention to reduce maternal and neonatal mortality. Quetzaltenango, Guatemala: MotherCare and Instituto de Nutrición de Centro América y Panamá, 1993.
- 42 Janowitz B, Wallace S, Araujo G, Araujo L. Referrals by traditional birth attendants in northeast Brazil. *Am J Public Health* 1985; **75**: 745–48.
- 43 Maine D. Safe motherhood programs: options and issues. New York: Center for Population and Family Health, Columbia University, 1991.
- 44 Paxton A, Maine D, Freedman L, Fry D, Lobis S. The evidence for emergency obstetric care. *Int J Gynaecol Obstet* 2005; **88**: 181–93.
- 45 Thaddeus S, Maine D. Too far to walk: maternal mortality in context. *Soc Sci Med* 1994; **38**: 1091–110.
- 46 Stanton CK. Methodological issues in the measurement of birth preparedness in support of safe motherhood. *Eval Rev* 2004; **28**: 179–200.
- 47 Essien E, Ifenne D, Sabitu K, Met al. Community loan funds and transport services for obstetric emergencies in northern Nigeria. *Int J Gynecol Obstet* 1997; **59**(Suppl. 2): S237–44.
- 48 Jahn A, De Brouwere V. Referral in pregnancy and childbirth: concepts and strategies. In: De Brouwere V and Van Lerberghe W, eds. Safe motherhood strategies: a review of the evidence. Antwerp: ITG Press, 2001.
- 49 Carroli G, Rooney C, Villar J. How effective is antenatal care in preventing maternal mortality and serious morbidity? An overview of the evidence. *Paediatr Perinat Epidemiol* 2001; **15**(Suppl 1): 1–42.
- 50 Villar J, Ba'aqel H, Piaggio G, et al. 2001. WHO antenatal care randomized trial for the evaluation of a new model of routine antenatal care. *Lancet* 2001; **357**: 1551–64.
- 51 Graham W J. Every pregnancy faces risks. *Plan Parent Chall* 1998; **1**: 13–14.
- 52 Sibley LM, Sipe TA, Koblinsky M. Does traditional birth attendant training increase use of antenatal care? A review of the evidence. *J Midwifery Womens Health* 2004; **49**: 298–305.
- 53 McDonagh, M. Is antenatal care effective in reducing maternal morbidity and mortality? *Health Policy Plan* 1996; **11**: 1–15.
- 54 AbouZahr C, Wardlaw T. Maternal mortality at the end of the decade: signs of progress? *Bull World Health Organ* 2001; **79**: 561–73.
- 55 Gwatkin DR. Health inequalities and the health of the poor: What do we know? What can we do? *Bull World Health Organ* 2000; **78**: 3–18.
- 56 Graham WJ, Bell J, Bullough CHW. Can skilled attendance at delivery reduce maternal mortality in developing countries. *Studies Health Serv Organ Policy* 2001; **17**: 97–130.
- 57 Kunst AE, Houweling T. A global picture of poor-rich differences in the utilisation of delivery care. *Studies Health Serv Organ Policy* 2001; **17**: 297–316.
- 58 Graham WJ, Newell ML. Seizing the opportunity: collaborative initiatives to reduce HIV and maternal mortality. *Lancet* 2001; **353**: 1836–39.
- 59 Cleland J, Sinding S. What would Malthus say about AIDS in Africa? *Lancet* 2005; **366**: 1899–901.
- 60 Winikoff B, Sullivan M. Assessing the role of family planning in reducing maternal mortality. *Stud Fam Plann* 1987; **18**: 128–43.

- 61 Trussell J, Pebley AR. The potential impact of changes in fertility on infant, child, and maternal mortality. *Stud Fam Plann* 1984; **15**: 267–80.
- 62 Conde-Agudelo A, Belizan JM. Maternal morbidity and mortality associated with interpregnancy interval: cross sectional study. *BMJ* 2000 **321**: 1255–59.
- 63 Ronsmans C, Campbell O. Short birth intervals don't kill women: evidence from Matlab, Bangladesh. *Stud Fam Plann* 1998; **29**: 282–90.
- 64 Conde-Agudelo A, Rosas-Bermudez A, Kafury-Goeta AC. Birth spacing and risk of adverse perinatal outcomes: a meta-analysis. *JAMA* 2006 **295**: 1809–23.
- 65 UN. Press Release: majority of world's couples of reproductive age are using contraception. New York: Department of Public Information, News and Media Services Division, April 21 2004: http://www.un.org/esa/population/publications/contraceptive2003/WallChart_CP2003_pressrelease.htm (accessed Sept 5, 2006).
- 66 The Alan Guttmacher Institute. Sharing responsibility: women, society and abortion worldwide. New York: The Alan Guttmacher Institute, 1999: <http://www.guttmacher.org/pubs/sharing.pdf>. (accessed Sept 5, 2006).
- 67 Ronsmans C, Collin S, Filippi V. Maternal mortality. In: Semba R, Bloem M (eds). Nutrition and health in developing countries, 2nd Edn. <http://doi.contentdirections.com/mr/humana.jsp?doi=10.1226/1592592252> (accessed Sept 5, 2006). The Humana Press, 2006.
- 68 Pathmanathan I, Liljestrand J, Martins JM, et al. Investing in maternal health learning from Malaysia and Sri Lanka. Washington DC: The World Bank Washington, 2003.
- 69 Graham W, Campbell O. The measurement trap. *Soc Sci Med* 1992; **35**: 967–76.
- 70 Campbell, O. What are the maternal health policies in developing countries and who drives them? A review of the last half century. *Studies Health Serv Organ Policy* 2001; **17**: 415–48.
- 71 Graham WJ. Now or never: the case for measuring maternal mortality. *Lancet* 2002; **359**: 701–04.
- 72 WHO. Maternal mortality: helping women off the road to death. *WHO Chronicle* 1986; **40**: 175–83.