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**Cost-effective safe motherhood
interventions in low-income countries:
a review**

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ABSTRACT

This paper reviews studies providing evidence of the cost-effectiveness of safe motherhood interventions in low-income countries. The economic case for investing in safe motherhood interventions is also examined. It is estimated that 1,600 women die globally each day as a result of problems during pregnancy or childbirth. A large proportion of these deaths is preventable. According to the World Bank, antenatal and maternal services comprise two of the six most cost-effective sets of health interventions in low-income countries. Due to the problem of linking programme interventions with outcomes however, few cost-effectiveness studies currently exist. Despite this certain interventions are more cost-effective than others, such as substituting manual vacuum aspiration for dilatation and curettage when dealing with incomplete abortion. It is estimated that 26% of maternal deaths are avoidable through antenatal/community-based interventions, costing around 30% of the World Health Organisation's Mother Baby Package. Ensuring access to high quality essential obstetric care can prevent a further 58% of maternal deaths, consuming 24% of total Mother Baby Package costs. Current evidence suggests that targeting investments on essential obstetric services would reap the greatest efficiency gains.

KEY WORDS

Safe motherhood; maternal mortality; cost-effectiveness.

Introduction

The International Safe Motherhood Initiative was launched in Nairobi, Kenya in 1987, and provided a focus for programmes and research concerned with the improvement of maternal health in low-income countries. In the following decade several key international conferences have given greater impetus to the movement. At the World Summit for Children in 1990 over 150 countries endorsed the Plan of Action including the goal of halving maternal mortality rates by the year 2000. Similar statements and declarations were made at the International Conference on Population and Development in Cairo in 1994, and at the Fourth World Conference on Women in Beijing in 1995. The World Health Organisation (WHO) made 1998 the Year of Safe Motherhood. Safe motherhood can be defined as a woman's ability to have a safe and healthy pregnancy and delivery.

Despite the increasing focus on maternal health in international health policy forums, there remains some debate over whether devoting greater resources to safe motherhood interventions is the best way to improve health given limited budgets. Whilst there is a strong moral case for greater investment in maternity services, most governments also state that resources will be allocated as efficiently as possible. Part 1 of this paper describes the magnitude of mortality and morbidity resulting from pregnancy-related causes in low-income countries, and looks at the key determinants. Part 2 examines the economic arguments for investing in safe motherhood services, and reviews key evidence of the relative cost-effectiveness of individual interventions. Part 3 further discusses the evidence presented, and concludes the main lessons learnt.

PART 1: The causes and consequences of unsafe motherhood

Maternal mortality and morbidity

Women are more likely to suffer premature death or illness from pregnancy-related causes than from any other health problem. It is estimated that some 1,600 women globally die each day as a result of problems during pregnancy or childbirth [1]. The lifetime risk of a woman dying from pregnancy-related causes also includes health problems caused by related complications that arise after the birth. Using this measure of risk it is estimated, for example, that one in ten women will die from pregnancy-related causes in Uganda, compared with one in five thousand women in the U.K [1].

The extent of premature death and illness resulting from pregnancy and childbirth is assessed using the composite disability adjusted life year (DALY) measure [2]. Table 1 shows that 18% of the total burden of disease for women of childbearing age in low-income countries results from problems related to maternity. This is by far the largest threat to women's health, with sexually transmitted diseases causing 8.9%.

TABLE 1: LEADING CAUSES OF DEATH AND ILLNESS IN WOMEN AGED 15-44 IN LOW-INCOME COUNTRIES, 1990

CAUSE	% total DALY loss
Maternal causes	18.0%
Sexually transmitted diseases	8.9%
Tuberculosis	7.0%
HIV/AIDS	6.6%
Unintentional injuries	6.4%
Intentional injuries	6.0%
Depressive disorders	5.8%
Malignant neoplasms	4.5%
Self-inflicted injuries	3.2%
Anaemia	2.5%
Respiratory infections	2.5%

Source: [2]

Extensive research has been conducted into the specific causes of maternal morbidity and mortality world-wide (see Table 2). The WHO found that over one quarter of

maternal morbidity resulted from unsafe abortion, making it the primary cause. Haemorrhage, indirect causes (e.g. malaria and anaemia) and sepsis together account for a further half of all maternal illness. In terms of maternal deaths, haemorrhage causes a quarter of all deaths, with indirect causes, sepsis and unsafe abortion leading to a further 50%.

TABLE 2: MAIN CAUSES OF MATERNAL DEATH AND ILLNESS WORLD-WIDE

MORBIDITY		MORTALITY	
Unsafe abortion	26%	Haemorrhage	25%
Haemorrhage	18%	Indirect causes	20%
Indirect causes	17%	Sepsis	15%
Sepsis	15%	Unsafe abortion	13%
Obstructed labour	9%	Eclampsia	8%
Hypertension disorders	8%	Other direct causes	8%
Other direct causes	5%	Obstructed labour	7%
Eclampsia	1%	Hypertensive disorders	4%

Source: [12]

The burden of disease pattern differs when data for sub-Saharan Africa are analysed separately (see Table 3). One third of all DALY loss is caused by sepsis, with obstructed labour accounting for one-quarter, and haemorrhage one-fifth. It is generally believed however that official statistics, based on maternal deaths occurring at or reported to government health facilities, considerably underestimate the true level. In addition figures usually exclude less common direct complications such as those resulting from anaesthesia, and ectopic pregnancies. In Ethiopia for example, whilst the official maternal mortality rate is 700 per 100,000 live births, the World Bank estimates the real figure to be 1,528 per 100,000 on the basis of survey data [3].

TABLE 3: CAUSES OF HEALTH PROBLEMS DURING CHILDBIRTH IN SUB-SAHARAN AFRICA

CAUSE	% total DALY loss
Sepsis	34%
Obstructed labour	24%
Haemorrhage	18%

Abortion	10%
Eclampsia	5%
Hypertension	3%

Source: [2]

Despite improvements in available information regarding the causes of pregnancy-related death and illness in low-income countries, and greater impetus at the international level, there is little evidence that greater resources have been committed to such services. Neither is there evidence that maternal mortality and morbidity rates have reduced as a result of improved organisation, or allocation of funds.

The determinants of maternal death and ill health are manifold. The position of women in society and within their own household [4] (often one of disadvantage), negatively influences access to food and education, two goods that have a significant impact on a woman's risk of pregnancy-related problems. Equally the quality of health service delivery and organisation can make the difference as to whether or not a woman with pregnancy-related complications dies. A useful framework for this broad range of determinants categorises three sets of interventions that target the causes. These include efforts that:

- reduce the likelihood that a woman will become pregnant
- reduce the likelihood that a pregnant woman will experience a serious complication during pregnancy or childbirth
- efforts that improve outcomes for women who suffer complications [5].

In order to deliver appropriate safe motherhood services, providers must understand the factors that influence demand i.e. why some women utilise the services and others do not. For example in Pakistan women must be delivered by women, and cannot

travel unaccompanied beyond their village [6]. In other cultures women are effectively secluded prior to childbirth, restricting their access to health services. In addition cultural taboos, such as changes in diet, can put women and their unborn child at greater risk of death or illness. In Kenya for example, food that is taboo during pregnancy include nutritious foods such as fresh milk, eggs, paw-paw, liver, mutton and some types of fish [7].

PART 2: The economics of making motherhood safe

Economic rationale for investing in safe motherhood interventions

The theory of health markets and market failure is well-documented [8]. Public financing is justified in the health sector for certain kinds of goods and services defined as:

- goods and services producing externalities
- merit goods
- public goods

Externalities result ‘*In markets where the costs and benefits derived from producing or consuming a particular good are not restricted to those engaged in trading in that good*’ [8]. Health sector examples include sexually transmitted diseases and tuberculosis, both of which result in high negative externalities when not treated, and thus high positive externalities when treated i.e. by treating an infected person, the risk of other individuals contracting the illness is reduced. Health services such as these thus tend to be subsidised by governments in an attempt to increase utilisation to a socially optimal level. If delivered through a private market, or charged for in a public health facility, utilisation of these services is likely to be sub-optimal. A safe

pregnancy has benefits not only for the mother but, clearly, for the as yet unborn child.

Merit goods are defined as '*Goods which the government feels that people will under-consume and which therefore ought to be subsidised or provided free.*' [10]. There are several reasons why such services might be consumed at a level that government considers sub-optimal. These include low levels of education (i.e. high levels of illiteracy resulting in the reduced impact of health education, and promotion campaigns), poor quality of care (resulting in low demand, particularly where user charges apply), and low effective demand (resulting from low levels of income). In a private market one would expect a supply-side response to the second two situations based on service-quality and price respectively. However given poor education levels and supply-side constraints in many low-income countries, merit goods are typically subsidised by governments. Safe motherhood services are a merit good (or service).

Even if information were equitably distributed, there is a further justification for government investment in maternity services and indeed health services generally. As a mechanism for supporting the poor, health services are extremely useful for governments, in particular when the provision of direct income support to this group is difficult to implement, due to weak administrative and tax-benefit systems. Government subsidisation of health and other social services thus constitutes an important strategy for poverty-alleviation. Finally a public good is defined as '*A good that no-one can be prevented from consuming, non-excludable, and that can be consumed by one person without depleting it for another, non-rival.*' [9]. Examples include clean air and water, and free information regarding health promotion.

There are several economic arguments in favour of investing in safe motherhood interventions, many outlined by the World Bank [17]. Maternal mortality and morbidity have a direct negative impact on the welfare of infants and children. Evidence from Bangladesh shows that children under 10 years of age without mothers, are 3-10 times more likely to die within 2 years, than those with a mother [17]. The death or illness of a mother also leads to a reduction in household income given the important role commonly played by women, for example, in agricultural production and trading. Improving the health of women thus contributes directly to the health of children and more broadly to poverty reduction.

Secondly an analysis of household expenditures is revealing; women are more likely than men to spend on welfare-improving goods and services such as food, education and medicine, with evidence from Tanzania showing that maternal death has a negative impact on a child's education, through lower levels of enrolment [17]. The psychological and emotional effects for women, who, for example, face and attempt to terminate an unwanted pregnancy are also considerable, though not easily quantified.

The World Development Report 1993 [2] includes an economic evaluation of a range of different health interventions. Calculating the cost-per DALY for each, it identifies the six most cost-effective clinical services for low-income countries. Two of the six are family planning and antenatal/delivery care¹. The World Bank estimates that in a

¹ The other interventions are short-course chemotherapy for tuberculosis, management of the sick child, treatment of STDs and limited care (which includes assessment, advice, pain alleviation and treatment of minor infection and trauma).

typical low-income country, family planning costs \$100 per DALY averted, whilst antenatal/delivery care costs \$60. The report also estimates that family planning services would avert 1% of the total disease burden, whilst antenatal and delivery care would avert 3%².

Given the variation in costs between countries it is important to recalculate these figures in individual settings. Few such attempts exist although in Guinea it was found that prenatal and delivery care at health centres cost \$109 per life-year saved (LYS), producing significant savings over outreach programmes at \$283 per LYS. The authors found however that safe motherhood interventions were significantly more expensive than others such as treatment of childhood pneumonia at \$3 per LYS, and short-course treatment of tuberculosis at \$12 per LYS [18].

Estimates of the costs and benefits of the MBP in a range of low-income countries, and conducted in 1998, found that the package will save one life for an average of \$230, lower than through measles immunisation, or the control of acute respiratory infections in children [19]. Whilst there is limited evidence regarding the cost-effectiveness of the different safe motherhood interventions highlighted in table 4, data on effectiveness are more readily available. Figure 1 represents one attempt to estimate the relative effectiveness of primary health care and first referral level interventions in reducing maternal mortality³.

² The estimate of reduced ill health is based on a scenario where 80% of the population, in a typical low-income country setting, are reached by the service being considered.

³ Figure 1 reproduces a chart prepared by WHO. The chart was not published and information regarding the assumptions and data underlying it are unavailable. However the chart provides the information critical for performing a cost-effectiveness analysis, and as such is unique. In the analysis

Figure 1 shows that with full access to quality primary services, levels of maternal mortality in a typical low-income country can be reduced from 450 to 350 per 100,000 live births, primarily through the prevention and treatment of abortions and infection. Once quality first level, referral services are made available it is estimated that the rate could fall to 65 per 100,000 live births. It is at this first stage of referral that the major reduction in maternal mortality occurs. The key causes of death that are effectively dealt with here are haemorrhage and eclampsia, with obstructed labour and abortion also significantly reduced.

These data allow some light to be shed on the relative cost-effectiveness of antenatal and essential obstetric services. Whilst 30% of the costs of the Mother Baby Package (MBP) are attributable to antenatal care (see Table 6), approximately 26% of the reduction in maternal mortality can be attributed to these interventions. On the other hand, maternal services delivered at the first referral level (equating approximately to essential obstetric care) comprise approximately 24% of total MBP costs. From Figure 1 it is estimated that these services account for a further 58% reduction in the maternal mortality rate when combined with primary health care.

Safe motherhood interventions and their cost

The lack of data on the costs of interventions is acknowledged by Koblinsky et al. in their estimate of the cost of delivering a safe motherhood programme in a variety of settings [11]. The report estimates that in low-income countries the cost of significantly reducing maternal mortality and morbidity through maternal health interventions would be \$1 per capita. Cost estimates also accompany the

a 'quality service' refers to one conforming to WHO recommended inputs in terms of staffing and

comprehensive Mother Baby Package (MBP) developed by WHO, which incorporates a set of key maternal health problems and interventions [12] presented in Table 4.

TABLE 4: ACTIVITIES BY INTERVENTION CATEGORY

ANTENATAL CARE	NORMAL DELIVERY CARE	ESSENTIAL OBSTETRIC CARE
Basic antenatal care	Clean and safe delivery	Management of eclampsia
Prevent and treat severe anaemia	Postpartum care	Management of sepsis
Prevent and treat syphilis, gonorrhoea and chlamydia	-	Management of haemorrhage
Prevent and treat malaria	-	Caesarean delivery
-	-	Post-abortion complications

Source: Adapted from [19]

According to WHO estimates, the MBP would cost approximately \$3 per capita to deliver in low-income countries, with the maternal component alone costing \$2 per capita. Tables 5 and 6 present data on both the input and intervention costs of the MBP. Personnel comprise the largest input cost at 40%, with capital costs comprising 15%, followed by drugs and consumables.

TABLE 5: WHO MOTHER AND BABY PACKAGE COST BY INPUT

INPUT	% TOTAL COST
Clinical personnel	40.4%
Annualised capital costs	15.0%
Drugs	11.8%
Consumable supplies	9.5%
Maintenance and utilities	6.1%
Bed costs	4.3%
Management and supervision	3.0%
Support salaries	2.7%
IEC and social marketing	2.6%

supplies at each facility level.

Blood supplies	2.1%
Transport (petrol)	1.3%
Laboratory supplies	1.1%

Source: [17]

TABLE 6: WHO MOTHER AND BABY PACKAGE COST BY INTERVENTION

INTERVENTION	% TOTAL COST
<i>ANTENATAL CARE</i>	
Antenatal care	27.8%
Syphilis	0.8%
Gonorrhoea etc.	0.7%
Severe anaemia	0.5%
<i>ESSENTIAL OBSTETRIC CARE</i>	
Haemorrhage	8.7%
Sepsis	5.8%
Caesarean section	5.0%
Abortion	3.6%
Eclampsia	1.0%
<i>OTHER</i>	
Normal delivery care	19.6%
Postpartum family planning	13.3%
Neonatal	13.1%

Source: Adapted from [7]

When the relative cost of different MBP interventions are considered, antenatal care together with the treatment of STDs and anaemia comprises almost 30% of the total package cost. Those interventions relating to essential obstetric care (including caesarean section, dealing with haemorrhage, eclampsia and sepsis, and complications related to abortion) comprise approximately 24%. Normal delivery, neonatal care and postpartum family planning make up the remaining 46% of costs, but do not fall within the scope of this review⁴.

⁴ The cost of normal delivery is excluded from this analysis which is concerned with the prevention and treatment of pregnancy-related problems, and hence includes costs related to antenatal care, and those interventions directly related to the management and treatment of pregnancy-related problems. Costs related to neonatal care and postpartum family planning are also excluded.

The following section summarises current available evidence on the relative cost-effectiveness of safe motherhood interventions, categorised by stage of intervention. Rather than providing a comprehensive review, the paper focuses on key studies and evidence. Further details are presented in Appendix 1. It is acknowledged that evidence is limited by the quality of individual studies, which is variable. Extensive work has also been conducted into the development of costing methodology adapted specially to safe motherhood services [13] [14], and economic evaluations [15] [16].

Cost-effective investments: the evidence

Antepartum / antenatal services

In terms of effectiveness, there is a growing body of research showing that a large proportion of obstetric complications cannot be predicted or prevented [20] [21] [22]. The main argument revolves around inappropriate focus on non-medical risk factors, and the greater need for trained midwives. The claim that screening women in order to identify high and low risk pregnancies is largely ineffective has led some commentators to question the role of prevention, which in turn has led to doubts over the role traditional birth attendants (TBAs) [23] [24] [25]. Research from Tanzania found that despite good access to health services, and a concerted effort to identify at-risk pregnancies, antenatal care has had only limited effect in ensuring that obstetric care is accessed by high-risk mothers, considered critical to the reduction of maternal mortality [26].

A study from Nepal concludes that women are more likely to deliver unattended at home as a result of poor education and multiparity rather than poverty per se, and consider that training TBAs in this setting would probably not be cost-effective. It is

proposed that community-based midwife-run delivery units could reduce the incidence of such unplanned home deliveries [27].

This criticism of TBAs results primarily from lack of progress in the reduction of maternal mortality statistics, but it is perhaps too easy to dismiss their role as ineffective. TBAs do offer broad support to pregnant women including distribution of medicines, psychological support and health education. As outlined earlier the determinants of pregnancy-related death and illness are extremely broad, and it is likely that as other dimensions of health systems begin to function more effectively, e.g. the quality of obstetric services, and general management and communication systems, so the effectiveness of TBAs work will increase. It is these system-wide problems that have led to poor quality services at the primary level, recently the focus of many debates regarding health sector reform.

Perhaps the most important role played by TBAs and ante-natal care is identifying, and teaching pregnant women to identify, complications that arise during pregnancy and responding immediately, i.e. encouraging women to seek care, and/or referring them to the appropriate health facility. There is contradictory evidence here however, with research from India showing that women who use substantial amounts of ante-natal care are more likely to use safe delivery care [28], whilst evidence from Tanzania finds that there is little relationship between the two [26].

Rooney specifically considers the effectiveness of antenatal interventions, and concludes that effective interventions include the prevention and treatment of anaemia, sexually transmitted diseases and hypertension, and the use of tetanus-

toxoid [29]. The cost-effectiveness of ante-natal interventions is the focus of an on-going research project⁵.

Intrapartum / essential obstetric care

Evidence that the current attempts to identify high-risk pregnancies do not effectively predict complications during pregnancy, has led to greater emphasis on assisting women to access appropriate services when complications arise. Certain studies claim that essential obstetric services are the only truly cost-effective interventions in reducing maternal mortality [25, 30]. A long-term research project in West Africa⁶ found that relatively small investments in obstetric services, typically through the renovation or upgrading of equipment and theatres in district hospitals and health centres, could have a significant impact on maternal mortality. After 10 years of research in three countries the study concluded that:

‘Almost as important as the success of these activities was their cost. People often assume that upgrading essential obstetric care will be too expensive. But most developing countries have extensive health systems, and these are often under-utilised resources. The Prevention of Maternal Mortality Network teams were often able to make substantial improvements, such as opening operating rooms and blood banks, for less than \$15,000. Moreover, in many cases this cost was shared among the Prevention of Maternal Mortality Network project, the government, the community

⁵ ‘A rational package for antenatal care: economic evaluation alongside the WHO multi-centre RCT’ is currently the subject of research being conducted by the University of East Anglia and the London School of Hygiene and Tropical Medicine.

⁶ The findings of the Prevention of Maternal Mortality Network (PMM) research programme in West Africa were particularly useful source of information for this paper. The PMM Network was established at Columbia University in New York, following the International Safe Motherhood Initiative in 1987. Research was conducted in Sierra Leone, Nigeria and Ghana. The project ended

and a variety of non-governmental organisations. The sharing of costs not only helped to make the activities feasible but also indicates the potential for long-term sustainability of the project interventions'. [31].

Improving a range of aspects in the health system and beyond are clearly important in reducing maternal mortality. Research in Jamaica prioritises improvements in clinical evaluation, finding that it has a more powerful effect on resultant birth weight in the population than upgraded facilities or equipment [32]. In Tanzania studies found that it was wrong decisions at the district level and lack of equipment at the referral centre that were the main reasons for inadequate care [33], with a further study warning against the costs and potential health complications of caesarean sections [34].

Magnesium sulphate is considered an effective treatment for pre-eclampsia which can lead to eclampsia during delivery [35], with additional research estimating that women receiving it have a 52% lower risk of recurrent convulsions than those prescribed diazepam [36] [37]. Whilst it was initially thought that low-dose aspirin had a positive impact in terms of preventing eclampsia, there is now evidence to counter this [38], with current research examining the preventive effect of calcium supplementation, plant and fish oils, diuretics, and oxidants [39].

Postpartum / post-abortion care

Perhaps the one area where considerable information regarding cost-effectiveness is available relates to the treatment of complications arising from abortion, in particular incomplete abortion resulting from unsafe, early abortion. There is substantial

with the reporting of results at an international conference in Accra in 1996, and published in a special

evidence that the use of manual vacuum aspiration (MVA), rather than dilatation and curettage (D&C), can make great savings to both health service providers and to patients themselves⁷ [40] [41] [42] [43]. Research from Kenya and elsewhere found that switching to the MVA technique made savings of 38% in equipment costs, reduced hospital stay by 41-76%, and reduced costs to the patient by 50-66% [44].

Research from other low-income countries confirm the substantial savings that can be made, with the cost-per-D&C patient estimated to be US\$ 78.81, compared with US\$ 8.50 for MVA patients [45]. In Brazil patients spent 77% less time in hospital and consumed 41% fewer hospital resources [46]. In Peru it was found that savings in service delivery costs could amount to \$50,000 per annum, through the introduction of MVA on an outpatient basis [47].

Other

A range of other studies have focused on systems performance issues within the health sector i.e. on the process of service delivery rather than the inputs [48]. The way in which the various inputs into health services (e.g. skilled human resources, equipment and pharmaceuticals) are employed is critical to improving the quality and hence the utilisation of health services. In terms of referral systems for example, research in West Africa found that radio communications and arrangements with owners of vehicles in the local community could improve functioning significantly, and at fairly low cost [49]. Evidence regarding the success of establishing maternity waiting homes where women stay, immediately prior to giving birth, is mixed [50]

issue of the International Journal of Gynaecology and Obstetrics (see references).

⁷ Manual vacuum aspiration should only be used to perform abortions at 12 weeks gestation or less and as such is not a perfect substitute for dilatation and curettage.

[51]. Whilst this arrangement allows rapid response to complications should they arise, they were not popular with women who must stay away from home, for an unpredictable and sometimes considerable length of time. Broader health system issues that relate to management, audit, accountability and staff motivation are also important factors in health system performance (see Appendix 1). The improved collection and use of information around maternal deaths has been shown to contribute significantly to preventing avoidable maternal deaths [52] [53], whilst apparently increasing mortality rates as a result of greater reporting in the short-term [54].

Improvements in systems management and staff motivation can reap significant improvements in health outcomes. Evidence from Kenya found that 85% women who died from pregnancy-related causes at a district hospital, had been admitted for at least 6 hours prior to treatment, and not in life-threatening conditions [55]. Despite the prompt arrival of the patient, the absence of the doctor led to late treatment. Whilst general underfunding, low wages and understaffing contributes to such problems, improved management and organisation in many instances can prevent such deaths. Whilst the focus of many health sector reforms is on raising greater revenue, such situations indicate that improving staff motivation and management can have positive effects. The employment of the necessary inputs in an appropriate and timely manner can be called the interaction quality. Poor interaction quality results from the absence of one or more of the inputs, such as late arrival of the patient, lack of pharmaceuticals, poorly-functioning equipment, or inadequately trained or absent health staff.

Further economic arguments

A further argument for investing in safe motherhood interventions is the potential effect of wider gains in terms of health service delivery. To improve a facility's capacity to respond to obstetric emergencies, it is necessary to have the skills and supplies to deal with trauma, give blood transfusions and anaesthesia, and have a functional operating theatre. Each of these aspects of the service are also important for treating other health problems such as road traffic accidents, which comprise an ever-greater proportion of the disease burden in many low income countries. Improving obstetric care can thus act as a useful entry point for wider health sector reform aimed at service improvements, and in the process can achieve significant economies of scope.

Investments both in antenatal services (in the long-term) and improved obstetric care (in the short-term) would also result in direct financial benefits to the health sector through reduced need for hospital beds, with some countries estimating that women with complications from unsafe abortion occupy 20-50% beds in gynaecology wards. Another estimate puts the cost of treating the complications of unsafe abortion as consuming up to 50% of hospital budgets [56]. The UK Department for International Development recently commenced two large-scale safe motherhood projects in Malawi and Nepal. The economic justification for the Nepal project highlighted the difficulty in measuring the relative cost-effectiveness of prevention and treatment, given problems in assessing their independent effect on outcomes. Whilst there are serious difficulties in linking the individual interventions in the MBP with direct benefits [57], there have been some attempts to estimate the overall impact of the

bundle of services delivered at different levels of the health system, as discussed in the next section.

Alternative strategies for increasing efficiency

In practice reallocating resources on the basis of economic analysis in order to improve efficiency of investments, tends to require strong political support, and is likely to face resistance from one of a variety of interest groups within the health sector. Alternative, less political strategies, can also contribute to the improved efficiency of maternal health interventions as outlined in the following section.

- ***Reducing/ceasing spending on interventions that may cause more harm than good:*** research and evidence has shown that procedures such as the administration of enemas, and withholding food and drink during childbirth are unnecessary and possibly harmful. Rigid adherence to certain birthing positions has also been condemned [58].
- ***Reducing/ceasing spending on interventions that are shown to be ineffective:*** an example of an ineffective intervention is the provision of routine episiotomy during childbirth [58].
- ***Reducing/ceasing spending on those interventions that are shown to be of low effectiveness:*** conducting risk-assessment is increasingly considered to be of low effectiveness, with TBAs having limited impact at the macro level without further improvements to the formal health system [21] [24]. One further example is the use of electronic foetal monitoring, which is more expensive but no more effective than simple foetal stethoscopes [59], and more likely to result in inappropriate interventions.

- ***Increase spending on interventions proven to be cost-effective:*** examples include the prevention and treatment of anaemia secondary to malaria, treatment of STDs, and tetanus toxoid vaccination. The use of manual vacuum aspiration rather than dilatation and curettage for the treatment of incomplete and septic abortion can significantly improve cost-effectiveness. Improvements in obstetric care for example through ensuring adequate equipment and supplies, audit, and additional obstetric training for general doctors may also provide efficiency gains. It has also been shown that giving psychological support to women during pregnancy can, through stress reduction, reduce perinatal mortality. Analysis conducted by the World Bank has shown antenatal and maternity services to be one of the five most highly cost-effective interventions in terms of cost-per-DALY [2].

PART 3: Conclusions

This paper has discussed the key causes of maternal death and illness, examined reviewed the theoretical economic arguments for investing in safe motherhood services, and reviewed empirical evidence of the cost-effectiveness of key interventions. Arguments in favour of public investment in safe motherhood services relate primarily to its merit good properties and the production of positive externalities. In terms of prioritising safe motherhood interventions for funding, over other health sector activities, the World Development Report 1993 identifies antenatal and maternal services as highly cost-effective. Whilst the calculations underpinning this analysis require revisiting for different countries and contexts, it remains an important source of information.

A review of the key literature found little research that specifically addressed the cost-effectiveness of safe motherhood interventions. In terms of effectiveness however there are some clear findings. There is a growing consensus that risk screening is not effective in preventing maternal mortality, although recognising and responding appropriately to complications can make a significant impact. Three antenatal interventions are considered highly effective and include treatment of STDs, tetanus toxoid immunisation and treatment of anaemia. Whilst these interventions are relatively low cost, their cost-effectiveness requires further investigation, and is currently the subject of a major research project. Significant savings can be made both to the health sector and to patients, through the introduction of manual vacuum aspiration for dilatation and curettage.

Greater evidence of the relative cost-effectiveness of different safe motherhood interventions is required, whilst recognising the difficulties in linking interventions with outcomes. On the basis of current information however two key observations are made:

- in low-income countries antenatal care can reduce maternal mortality by around 26%, costing approximately 30% of the total cost of the Mother Baby Package
- essential obstetric services can reduce maternal mortality by a further 58%, costing approximately 24% of the Mother Baby Package

The evidence suggests that improving access to essential obstetric care is the key to reducing maternal mortality and need not be of high cost. Increasing utilisation is the result of influences on both the demand and supply-side, which must be understood

and adapted to. For example demand for health services, such as cultural attitudes towards pregnancy, can pose significant barriers to the uptake of potentially life-saving services. Based on the evidence reviewed here however, it is improvements in the quantity and quality of service supply that can have greater effect. Research from several low-income countries shows that relatively small but targeted investments in obstetric services for example, can have a significant impact on the number of women suffering pregnancy-related illness and death.

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APPENDIX 1

ANTE-PARTUM / ANTENATAL CARE

Title of study	Study details/ interventions considered	Country	Key findings	Reference
Antenatal care and maternal health: how effective is it? A review of the evidence.	Review of the range of antenatal services.	Developing countries	No one has systematically assessed the potential of antenatal care to improve maternal health in developing countries. The most effective interventions are those that deal with chronic conditions rather than acute conditions which arise near delivery.	Rooney C. (1992) Geneva, Switzerland, World Health Organisation, Division of Family Health, Maternal Health and Safe Motherhood Programme.
Increasing the efficiency of antenatal care in identifying and referring women needing institutional deliveries in Bangladesh	The effectiveness of a single antenatal visit late in pregnancy in identifying high risk pregnancies. To identify factors influencing referral of high-risk pregnancies.	Bangladesh	Antenatal screening is not effective in identifying high-risk pregnancies. Priority must be given to improving access to emergency obstetric care in order to reduce maternal mortality.	Ronsmans C. 1997 Report on completed DFID HP ACORD project R6418
Rethinking the role of the risk approach and antenatal care in maternal mortality reduction	Screening of pregnant women for non-medical risk factors	Developing countries	Risk screening is not a cost-effective strategy for maternal mortality reduction. Moreover women identified as low-risk can be lulled into a false sense of security, receiving less attention from health workers. In contrast antenatal care allows for the early identification of complications and motivates them to seek appropriate hospital care.	E.A. Yuster International Journal of Gynaecology and Obstetrics, 50(2), 1995
Scientific basis for the content of routine antenatal care. Philosophy, recent studies, and power to eliminate or alleviate adverse maternal outcomes	Review of literature, in particular RCTs, to assess evidence of the impact of antenatal interventions on adverse maternal outcomes. Interventions include bleeding, anemia, preeclampsia, sepsis and genito-urinary infection and obstructed labour.	Developing countries	Fewer routine visits for low-risk women do not put pregnancies at increased risk but may lessen patient satisfaction, Bleeding in pregnancy cannot be prevented through antenatal care.	Villar J. Bergsjö P. Acta Obstetrica et Gynecologica Scandinavica, 76(1):1-14. 1997.
Intermittent sulphadoxine-pyrimethamine to prevent severe anaemia secondary to malaria in pregnancy: a randomised placebo-controlled trial	The efficacy of sulphadoxine-pyrimethamine in preventing malaria and severe anaemia in pregnancy	Kenya	Sulphadoxine-pyrimethamine treatment significantly reduces severe anaemia in primigravidae in malarious areas. The cost of preventing one case of anaemia is estimated at approximately just under \$US 5.	Schulman CE, Dorman EK, Cutts F, Kawuondo K, Bulmer JN, Peshu N, Marsh K. The Lancet, 353(953); 1999

Title of study	Study details/ interventions considered	Country	Key findings	Reference
Cost-effective on-site screening for anaemia in pregnancy in primary care clinics	Comparison of a copper sulphate solution and a portable haemoglobinometer and an automated analyser in detecting anaemia	South Africa	Combined use of copper sulphate solution and a haemoglobinometer is a feasible, accurate and cost-effective way of screening for and diagnosing anaemia in pregnant women, on-site, in primary care clinics.	Wilkinson D, Sach ME South African Medical Journal, 87(4), pp. 463-5, 1997.
Evaluation of maternal practices, efficacy, and cost-effectiveness of alternative antimalarial regimens for use in pregnancy: chloroquine and sulfadoxine-pyrimethamine.	Cost-effectiveness analysis of 3 regimens administered beginning during 16-32 weeks gestation and continuing throughout the pregnancy. The 3 regimens examined included chloroquine throughout the pregnancy (CQ/CQ), initial dose of sulfadoxine-pyrimethamine followed by CQ (SP/CG), and SP/SP.	Malawi	The placental malaria parasitemia rate for SP/SP was significantly lower than that for CQ/CQ and SP/CQ. The SP/SP regimen was also much more cost-effective in preventing infant deaths than the other regimens (US \$75 vs. \$542 for CQ/CQ and \$481 for SP/CQ). In fact, it remained most cost-effective when its cost was increased 3-fold and the efficacy was reduced to a level that 18% of the women on SP/SP had placental malaria at delivery. These findings suggest that the current CQ/CQ regimen that is popular in many countries with CQ-resistant Plasmodium falciparum is neither an effective or inexpensive intervention to prevent low birth-weight.	Schultz LJ, Steketee RW, Chitsulo L, Macheso A, Kazembe P, Wirima JJ. American Journal of Tropical Medicine and Hygiene; 55(1), pp. 87-94. 1996.

INTRA-PARTUM / OBSTETRIC SERVICES

Title of study	Study details/ Interventions considered	Country	Key findings	Reference
New push to reduce maternal mortality in poor countries	Overview of best strategies to reduce maternal mortality	Developing countries	Recent analysis suggests that EOC is affordable by all but the poorest countries and is one of the few truly cost-effective medical interventions. The barriers to the provision of this care have been political apathy and strategic misjudgement. Efforts to convince developing countries that women's health is worth the expenditure may be enhanced by data showing the adverse impact of maternal mortality and morbidity on a country's productivity and by the relatively low per capital cost of EOC and prenatal care.	Nowak R. SCIENCE. 1995 Aug 11; 269: pp. 780-2.
Hypertension in Jamaica	To assess: - the impact of low-dose aspirin to prevent hypertensive disorders in pregnancy - the impact of training on eclampsia prevention/ treatment - the impact of community education in the early identification of complications	Jamaica	- there is definitive evidence that low-dose aspirin has no part to play in the prevention of hypertensive disorders during pregnancy. - both eclampsia deaths and related bed-days can be reduced through more antenatal clinics, improved communications and instituting guidelines on detection and management of eclampsia. - simple educational interventions can increase awareness and referral of pregnancies with complications.	Golding J. 1996 Report on completed DFID HPD TDR project R4674
Improving quality of emergency obstetric care in hospitals	Emergency obstetric care at the hospital level	West Africa	Improving hospital obstetric services is feasible and affordable. However better services may not be sufficient to reverse declining hospital utilisation related to worsening economic conditions. Interventions included upgrading facilities, improving blood supply and equipment, improving access and reducing delay in seeking care. Admission to treatment intervals were considerable reduced, with a fall in case fatality rates.	Abstracts from the Prevention of Maternal Mortality Network Results Conference, Ghana 1996. Also reported in the International Journal of Gynaecology and Obstetrics. Vol. 59 Supplement 2. 1997.
Barriers to treatment of obstetric emergencies in rural communities of West Africa	Emergency obstetric services	West Africa	A generator and blood bank were installed and an unused operating theatre made functional at a hospital in Makeni, Sierra Leone. In addition, drugs and supplies were provided through a revolving fund, all for less than \$40,000. The number of women seeking care for obstetric complications increased by over 200%, and the case fatality rate among those women dropped from 32% to 5%.	Prevention Maternal Mortality Network. Studies in Family Planning 23(5), September-October 1992.

POST-PARTUM / POST-ABORTION CARE

Title of study	Study details/ interventions considered	Country	Key findings	Reference
The cost of treating incomplete abortion in Kenya: a cost-comparison of two treatment regimes	Manual vacuum aspiration vs sharp curettage, in two hospitals, Eldoret and Machakos	Kenya	MVA reduced equipment costs by 38% MVA reduced total stay in hospital by 41-76% MVA reduced patient costs by 50% and 66% in the two hospitals	J. Bradley, 1990 Unpublished (Popline search finding)
Socio-economic client characteristics and consequences of abortion in Nairobi	Review of 281 women admitted to Kenyatta National Hospital in a 4-week period in 1992.	Kenya	The cost of treating those women admitting illegal abortion, and those suspected of doing so, was 300 times greater than those with spontaneous abortion. The former groups were also more likely to have complications.	Sjostrand et al East African Medical Journal, 72(5), 1995
Linkages with treatment for incomplete abortions improve family planning services in Kenya	Analysing data from 6 hospitals, the study aimed to compare the cost, effectiveness and quality of alternative approaches to integrating emergency treatment of abortion complications with family planning.	Kenya	35% of gynaecology ward admissions resulted from incomplete abortion. The introduction of MVA required no anaesthetic, smaller operating theatres. This reduced waiting times, and in Mombasa average length of stay fell from 60 hours to 21 hours.	Solo J. and Billings D. Taken from Population Council website.
Hospitals reduce costs by improving post-abortion care	To cost post-abortion care in six countries in Africa and Latin America. Cost data for both MVA and D&C were collected.	Africa Latin America	Cost per patient for D&C = \$ 78.81 Cost per patient for MVA = \$ 8.50 89% lower median costs for MVA patients. Average length of stay was reduced from 36 to 15 hours. The bulk of costs for both interventions are salaries, and costs associated with inpatient overnight stays.	King TDN, Benson J, Stein K. 1998.
Use of manual vacuum aspiration in reducing cost and duration of hospitalisation due to incomplete abortion in an urban area of north-eastern Brazil	Comparison of MVA and sharp curettage interventions for post-abortion care.	Brazil	Patients treated for incomplete abortion with MVA spent 77% less time in the hospital and consumed 41% fewer resources than similarly diagnosed patients treated with SC. Recommendations are made as to the need of certain changes in patient management. Particularly necessary is information regarding cultural perception and concepts of abortion treatment.	Fonseca W, Misago C, Fernandes L, Correia L, Silveira D. Revista de Saude Publica, 31(5): 472-8, 1997.
Treatment of incomplete abortion: manual vacuum aspiration versus curettage in the Maternal Perinatal Institute in Lima, Peru.	Comparison of MVA and sharp curettage interventions for post-abortion care.	Peru	The total time (preoperative, operative, postoperative) was 271 minutes for MVA, 290 minutes for outpatient curettage, and 2638 minutes for curettage with hospitalisation. The total mean cost per patient (manpower, supplies, administration) was US\$16.30 for MVA, \$16.70 for outpatient curettage, and \$84.11 for curettage with hospitalisation. Given an average of 20 incomplete abortion cases per day, the Institute would save about \$50,000 a year by treating uncomplicated abortion cases on an outpatient basis.	Guzman A; Ferrando D; Tuesta L. 1995 Unpublished. Taken from Popline database.

MISCELLANEOUS STUDIES

Title of study	Study details/ Interventions considered	Country	Key findings	Reference
Reproductive health spending judged cost-effective	Range of reproductive health services	Developing countries	Lowering the MMR is cost-effective but not necessarily low cost. Antenatal care and obstetric care are the most cost-effective interventions.	Anonymous. Population Today, 25(6):4 1997
Cost-effectiveness of different Safe Motherhood programme options	Seven hypothetical programme models compared, in a high maternal mortality scenario, resulting primarily from direct obstetric causes.	Developing countries	WHO believes strengthening existing health centres and district hospitals is the most cost-effective method of providing essential obstetric care, and saving lives per dollar spent. It should also be factored in that improvements on transport for referral in turn increases the cost-effectiveness of upgrading health facilities.	Anonymous. Safe Motherhood Newsletter, 9; 1992
Costs, effects and cost-effectiveness analysis of a mobile maternal health care service in West Kiang, the Gambia	Comparison of the effects and costs of exiting facility-based maternal services with a mobile service	Gambia	The annual total cost of facility-based care was estimated as US\$ 64,800, compared with US\$ 25,300 for mobile care. Part of the differential was due to training. The incremental cost of expanding services however is lower for facility-based care. The cost per discounted life year gained for mobile services is estimated at between US\$ 42.9 and US\$ 206.3	Fox-Rushby JA & Foord F. Health Policy, 1996, 35(2), pp. 123-143
Reducing maternal mortality in Kigoma, Tanzania	Broad range of interventions aimed at improving management systems, and the quality of maternal health services in a Regional Hospital	Tanzania	A large reduction in maternal mortality was achieved (from 933 to 186 per 100,000) following an intervention programme. The key to improving maternal mortality was improved availability of drugs and equipment, staff availability through provision of accommodation in the hospital compound, and the morale of staff.	Mbaruku G. & Bergstrom G. Health Policy & Planning, 1995, 10(1), pp. 71-78
Improving access to services	Certain interventions were implemented and evaluated including maternity waiting home, transport and communications and community transport	West Africa	A motorbike system was discontinued following accidents and breakdowns. A four-wheel vehicles and radio communications were used instead, and the case fatality rate halved. Maternity waiting homes did not succeed, as they were unpopular with women. Mobilising existing local transport, with provision of emergency fuel was more successful, with the mean cost of referrals US\$ 6.	Abstracts from the Prevention of Maternal Mortality Network Results Conference, Ghana 1996. Also reported in the International Journal of Gynaecology and Obstetrics. Vol. 59 Supplement 2. 1997.

Title of study	Study details/ interventions considered	Country	Key findings	Reference
Improving access to quality maternal health services	Range of strategies to improve access	Developing countries	Strategies to overcome physical barriers include establishing maternity waiting homes, emergency transport and referral mechanisms, and enhanced communications systems. Another strategy is to authorise health care workers at the lowest level of the health care system to perform emergency obstetric services, such as Caesarean sections. Cost is also a barrier, and the institution of user fees has prevented many women from seeking care. In the long term, communities must be educated to recognise and respond to obstetric emergencies, and the quality of health care offered to women must be improved. Communication must also be improved between formal and informal health care systems, communities and health care facilities, and between women and providers.	AbouZahr C. Planned Parenthood Challenges. 1998;(1):6-9

Figure 1: Maternal mortality: the impact of interventions

