

**Barriers to the Implementation of Effective Maternal Health Care
in the Developing World: Views from the Frontline**

**A thesis submitted for the degree of Master of Science (by Research) in Obstetrics
and Gynaecology to the University of Oxford**

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Abstract

Background

Over the past few decades, the scientific community has tested interventions which, when implemented successfully, have resulted in significant reductions in maternal mortality and morbidity. Unfortunately, these have not been consistently used in regions with the highest maternal mortality and morbidity rates. The 'three delays' model has been used to explain delays in women accessing emergency obstetric care as the result of barriers to: I) decision-making, II) accessing services and III) receipt of appropriate care. The importance of the third delay has been downplayed in many previous studies of maternal mortality; however, it is likely to be a source of considerable inequity in access to emergency obstetric care in developing countries. The perspectives of, and pragmatic input from, health care providers in developing countries concerning these health-system failures have rarely been sought on a large scale or sufficiently considered in planning global efforts to improve maternal health.

Methods

A systematic literature review was conducted to identify and categorise phase III barriers to the provision of effective and timely maternal health care in developing countries. Following this review, an extensive online survey was conducted between July 2010 and March 2011. The target audience were facility-based maternal health care providers working in developing countries. Participants were randomised to one of five condition-specific surveys on the five major causes of maternal mortality: postpartum haemorrhage; sepsis; pre-eclampsia/eclampsia; obstructed/prolonged labour and complications of termination of pregnancy. For each survey, seven internationally recommended interventions were selected based on a review of current practice guidelines. Participants were asked to rate the availability of these interventions in their facility, and to identify specific barriers to their implementation. Participants were also invited to contribute to an online 'crowdsourcing' forum where they submitted, discussed and ranked ideas to overcome the barriers identified.

Findings

Forty-two eligible studies were included in the literature review. Thirty-two conceptually unique facility-level barriers were identified and categorised into six themes (drugs and equipment; policy and guidelines; human resources; facility infrastructure; patient-related and referral-related). The five most commonly cited barriers were inadequate training/skills mix (86 per cent of articles); drug procurement/logistics problems (67 per cent); staff shortages (60 per cent); lack of equipment (52 per cent) and low staff motivation (45 per cent).

A total of 1,479 direct care providers from 99 developing countries completed the online survey. Participants were drawn from 963 facilities, which together deliver over 3 million women annually. Of the 35 key interventions evaluated, participants reported that 15 were routinely implemented in at least 70 per cent of the facilities surveyed. The 20 interventions with <70 per cent routine coverage included assisted vaginal delivery (24 per cent of facilities); post-termination of pregnancy vacuum

aspiration (41 per cent); screening for proteinuria (57 per cent); blood transfusion for postpartum haemorrhage (59 per cent); clean delivery practices (60 per cent); partogram use in labour (67 per cent), and magnesium sulphate for pre-eclampsia (67 per cent). The most common intervention-specific barriers identified were: the inadequate content, dissemination and enforcement of clinical guidelines; inadequate pre-service and in-service training; lack of authorisation for certain procedures; lack of specific resources; staff preference for less effective or non-recommended practices, and the cost of treatment for patients. A total of 132 solutions were submitted via the 'crowdsourcing' forum and the 'crowd' voted for twelve winning ideas that they would like to see implemented.

Interpretation

This project highlights how a focus on patient-side delays in the decision to seek care can conceal the fact that many health facilities in the developing world are still chronically under-resourced and unable to cope effectively with serious obstetric complications. A wide range of facility-level barriers to emergency obstetric care is in operation, which may result in many thousands of avertable maternal deaths worldwide. Both the literature review and the survey highlighted human resources issues as a major barrier leading to delays in women receiving timely and appropriate obstetric care. These included both the number of staff available and issues relating to training and skills-mix and access to evidence-based guidelines.

The results of this study suggest that more emphasis needs to be put on addressing supply-side health systems barriers alongside demand-side factors if further reductions in maternal mortality are to be achieved. This project also demonstrates that a large-scale consultation of frontline health workers using online technologies is feasible in developing country settings. In the future, the views of these direct health care providers should be routinely included in the development of strategies to implement best practices in maternal health care.

Acknowledgements

This project has been possible because of the contribution of almost 1,500 healthcare providers around the world, who all took time out of their busy clinical schedules to participate in this research. Those who wished to be named are acknowledged at: <http://www.obs-gyn.ox.ac.uk/omphi>. I would specifically like to thank the following ‘country champions’ for their enormous help in promoting the survey and forum in their countries: Edgar Kestler (Guatemala), Pang Ruyan (China), Raymundo Canales de la Fuente (Mexico), Karim Abawi (Afghanistan), Okay Ikpeze (Nigeria), Laila Al-Zaghal (Jordan), Yetnayet Asfaw (Ethiopia), María Eugenia García Monge (Nicaragua), Rabir Chahine (Lebanon), Mariana Romero (Argentina), Samir El Feky (Egypt), Mario Castro Rumiche (Peru) and Sakar As’ad (Yemen).

I would like to express my thanks to the institutions and organisations that promoted the project within their global networks: The International Federation of Gynecologists and Obstetricians; The International Confederation of Midwives; The International Council of Nurses; The Maternal Health Task Force; The Royal College of Obstetricians and Gynaecologists International Office; Geneva Foundation for Medical Education and Research, The Epidemiological Research Center in Sexual and Reproductive Health, Guatemala; IMMPACT; The Population Council Reproductive Health Program; The White Ribbon Alliance; The WHO Partnership for Maternal, Newborn and Child Health and The London School of Hygiene and Tropical Medicine.

I would also like to thank the members of the external survey review panel for their helpful feedback on the draft surveys: Chris Redman, Michael Gravett, Gwyneth Lewis, Jennifer Blum, Ana Langer and Ann Blanc.

I am extremely grateful to the following members (both current and former) of the Nuffield Department of Obstetrics and Gynaecology at the University of Oxford for their generous support throughout the project: Shona Kirtly, Aris Papageorgiou, Eric Ohuma, Lucy Hoch and Annabel Charnock. Last but not least, I would like to thank my two co-supervisors, Stephen Kennedy and José Villar, for their expert guidance and for entrusting me with this ambitious and exciting project.

Funding Source:

This research was generously funded through a grant from the Maternal Health Task Force, an initiative funded by the Bill and Melinda Gates Foundation.

Table of Contents

Abstract	ii
Acknowledgements	iv
List of Tables and Figures	vi
Frequently Used Abbreviations	vii
1.1 Aims and Objectives.....	8
2 Introduction	9
2.1 The scale of the problem	10
2.2 The direct causes of maternal mortality	13
2.3 Effective interventions to reduce maternal mortality	15
2.3.1 PPH.....	16
2.3.2 Puerperal sepsis	19
2.3.3 Complications of unsafe TOP	21
2.3.4 Pre-eclampsia/eclampsia.....	23
2.3.5 Obstructed or prolonged labour	25
2.4 Summary	28
3 Barriers to effective maternal health care.....	32
3.1 The three delays model	33
3.2 A systematic review of the third delay.....	35
3.2.1 Methods	35
3.2.2 Description of studies	38
3.2.3 Review findings	44
3.2.4 Contextualisation of findings	52
3.2.5 Discussion	62
3.2.6 Conclusion.....	68
3.3 Summary and further research questions	70
4 Methods.....	72
4.1 Global Voices for Maternal Health survey	73
4.1.1 Participants and sampling.....	74
4.1.2 Survey design.....	79
4.1.3 Data analysis.....	82
4.2 The crowdsourcing forum	83
4.2.1 What is crowdsourcing?	83
4.2.2 What makes a crowdsourcing initiative successful?	86
4.2.3 Adapting these lessons to solve challenges in maternal health.....	88
5 Results.....	92
5.1 Characteristics of survey participants and their health facilities	92
5.1.1 Survey participants	92
5.1.2 Facilities.....	93
5.2 Implementation of key interventions	98
5.3 Implementation barriers	101
5.3.1 Barriers identified by providers	101
5.3.2 Providers' overall priorities.....	106
5.4 Crowdsourcing forum	109
6 Discussion and Conclusion.....	118
6.1 Interpretation of findings.....	118
6.2 Strengths and limitations of the research	120
6.3 Final thoughts	130
6.4 Key Recommendations	131
References	134
Appendices	144

List of Tables and Figures

Tables

Table 1-1 Estimated incidence of major complications and main maternal sequelae.....	13
Table 1-2 Summary of key, internationally recommended obstetric interventions, by condition.....	29
Table 2-1 Characteristics of studies included in the review	40
Table 2-2 Frequency of Phase III barriers reported in articles	45
Table 2-3 Components of Basic and Comprehensive EmOC	59
Table 3-1 Target countries	75
Table 3-2 Application of the critical success factor model.....	89
Table 4-1 Characteristics of survey respondents, by region	93
Table 4-2 Characteristics of surveyed birthing facilities, by geographical region.....	95
Table 4-3 Coverage of key obstetric interventions, by condition and geographical region	99
Table 4-4 Perceived barriers to the implementation of low coverage obstetric interventions.....	105
Table 4-5 Summary of winning crowdsourcing submissions, by topic.....	111

Figures

Figure 1 Equal area cartogram showing maternal mortality ratios.....	11
Figure 2 Progress towards the Millennium Development Goals (2007).....	12
Figure 3 Maternal mortality ratios by medical cause and world region (2000).....	15
Figure 4 The three delays model.....	33
Figure 5 Literature review: identification, screening and selection of articles	39
Figure 6 Crowdsourcing – the process.....	84
Figure 7 Critical success factor model	88
Figure 8 Survey participation flow chart	92
Figure 9 Global distribution of birthing facilities included in the survey	94
Figure 10 Survey coverage: breakdown by geographical region.....	95
Figure 11 Within-country distribution of survey responses in a) India, b) Brazil.....	96
Figure 12 Percentage of birthing facilities by ‘facility complexity score’ category and geographical region.....	97
Figure 13 Participants’ priorities for improving the overall management obstetric complications in their facilities.....	106
Figure 14 Open-ended question responses: word cloud.....	107
Figure 15 Participants’ priorities on levels at which action must to be taken to address implementation barriers, by condition.....	108
Figure 16 Crowdsourcing forum activity: joins, votes, comments and submissions	109

Frequently Used Abbreviations

AMDD	Averting Maternal Death and Disability
AMTSL	Active Management of the Third Stage of Labour
BEmOC	Basic Emergency Obstetric Care
CCT	Controlled Cord Traction
CEmOC	Comprehensive Emergency Obstetric Care
CHW	Community Health Worker
CI	Confidence Interval
D&C	Dilatation and Curettage
DFID	Department for International Development (UK)
EmOC	Emergency Obstetric Care
FIGO	International Federation of Gynecology and Obstetrics
HIV	Human Immunodeficiency Virus
ICD-10	International Classification of Diseases, 10th edition
ICM	International Council of Midwives
ICN	International Confederation of Nurses
IU	International Units
IM	Intramuscularly
IV	Intravenous
MDG	Millennium Development Goal
MgSO ₄	Magnesium Sulphate
MD	Mean Difference
MeSH	Medical Subject Headings
MHTF	Maternal Health Task Force
MMR	Maternal Mortality Ratio
MVA	Manual Vacuum Aspiration
NASG	Non-pneumatic Anti-Shock Garment
NICE	National Institute for Health and Clinical Excellence (UK)
PEPFAR	The U.S. President's Emergency Plan for AIDS Relief
PPH	Postpartum Haemorrhage
RCOG	Royal College of Obstetricians and Gynaecologists
RCT	Randomised Controlled Trial
RPOC	Retained Products of Conception
SPSS	Statistical Package for the Social Sciences
SSA	Sub-Saharan Africa
STI	Sexually Transmitted Infection
TBA	Traditional Birth Attendant
TOP	Termination of Pregnancy
UN	United Nations
UNICEF	United Nations International Children's Emergency Fund
UNFPA	United Nations Population Fund
WHO	World Health Organization
WISN	Workplace Indicators of Staffing Needs

1.1 Aims and Objectives

The aims and objectives of this project were:

- a. To identify key, internationally recommended interventions for the prevention and treatment of the five major causes of maternal mortality and severe morbidity, based on a review of current clinical guidelines.
- b. To conduct a literature review of the 'third delay' in order to identify barriers that prevent women in developing countries receiving timely and effective maternal health care once they reach a medical facility.
- c. To determine the extent to which maternal health care providers in developing countries report implementing key internationally-recommended interventions, via an online survey.
- d. To identify specific barriers impeding the use of these interventions (e.g. lack of supplies, human resources, or poor policy environment), from the perspective of frontline health care providers.
- e. To source potential solutions to these barriers, via an online 'crowdsourcing' forum.

2 Introduction

“Women are not dying because of diseases we cannot treat. They are dying because societies have yet to make the decision that their lives are worth saving.”

Professor Mahmoud Fathalla

Former President of the International Federation of Gynecology and Obstetrics

2.1 The scale of the problem

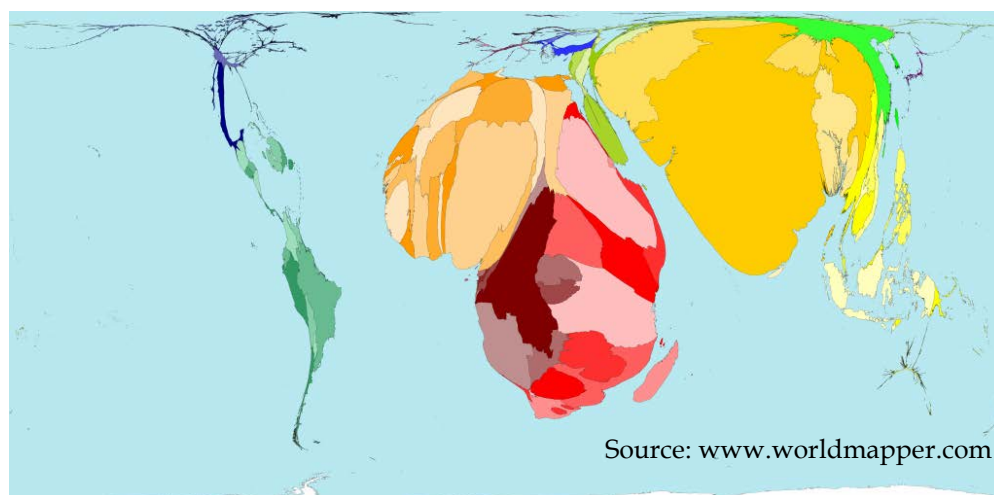
There is widespread evidence in the scientific literature of a chronic failure to implement health interventions that have been demonstrated to be safe, effective and affordable by high-quality research, particularly in the developing world (Sanders and Haines 2006). Unfortunately, the field of maternal health is by no means an exception (Villar 2001).

In 1985, a seminal paper in the *Lancet* drew international attention to the neglect of maternal health by policy makers, politicians and health professionals themselves (Rosenfield and Maine 1985). This was followed in 1987 by the launch of the World Health Organization (WHO) Safe Motherhood Initiative, which was created in response to the growing recognition that primary health care programmes in many developing countries were not adequately focused on maternal health (Mahler 1987). The focus on maternal health continued with the signing of the United Nations (UN) Millennium Declaration and the creation of eight Millennium Development Goals (MDGs), the fifth of which was to achieve a 75 per cent reduction in maternal mortality by 2015 (UN 2000).

In the last five years, several high-profile campaigns have also served to keep maternal mortality high on the development agenda, notable examples being The White Ribbon Alliance and Women Deliver. In June 2010, The Bill and Melinda Gates Foundation announced an additional \$1.5 billion of funding specifically earmarked for maternal health programmes (Gates 2010), followed two weeks later by a pledge of \$7.3 billion by G8 leaders at the 2010 Summit (Argitis and Rastello 2010).

Despite the increased attention and funding in the last two decades, the most recent estimates suggest that somewhere between 342,900 and 358,000 maternal deaths occur every year, 99 per cent of these in the developing world (Hogan, Foreman et al. 2010; WHO 2010). Many in the field agree that these latest estimates are likely to be conservative due to the well-documented problems of under-reporting maternal deaths, and that the true figure is likely to be much higher (Deneux-Tharaux, Berg C et al. 2005).

Figure 1 Equal area cartogram showing maternal mortality ratios.

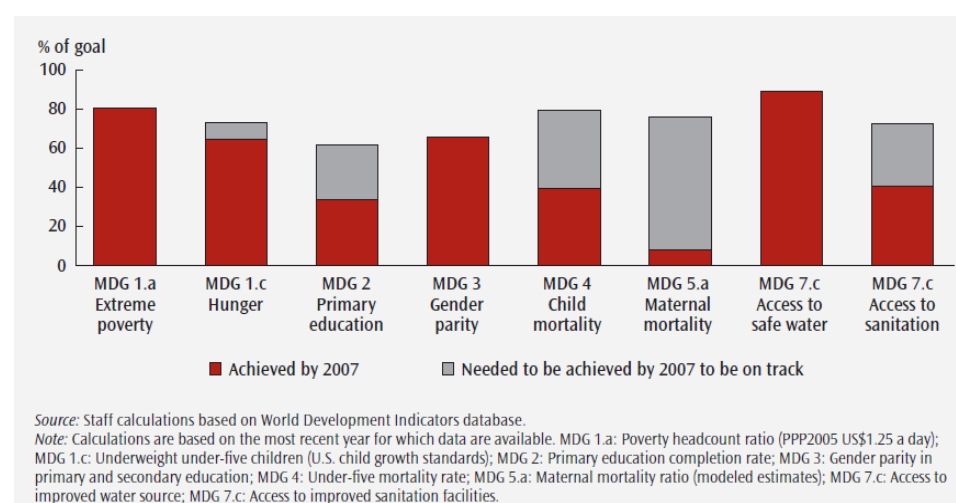


The most commonly used indicator of maternal death is the maternal mortality ratio (MMR), which is defined as the number of maternal deaths per 100,000 live births. The difference in the MMR between rich and poor continues to be one of the largest disparities of any public health statistic, including under-five mortality (Hogan, Foreman et al. 2010). In the poorest parts of the world, the lifetime risk of a woman dying from pregnancy-related causes is as high as 1 in 6, compared with just 1 in 30,000 in Northern Europe (Ronsmans and Graham 2006). Figure 1 represents these figures graphically, with countries resized according to their MMR. In India alone, where

almost one quarter of all maternal deaths take place, over two thousand women die every week from pregnancy-related causes (Countdown 2010).

While there has been real progress in reducing mortality rates in children under five (MDG-4) (Rajaratnam, Marcus et al. 2010), reduction in MMR has fallen well short of the MDG-5 goals (Figure 2). Paradoxically, it is not for a lack of effective, evidence-based interventions that this problem persists. Unlike other major global killers such as HIV/AIDS, safe and effective treatments for the major causes of maternal death have already been developed. WHO estimates that 88-98 per cent of maternal deaths can be prevented with timely access to existing emergency obstetric care interventions (EmOC), most of which have been known about for many decades (WHO 1994).

Figure 2 Progress towards the Millennium Development Goals (2007)



Source: World Bank Global Monitoring Report 2009: A Development Emergency

The major factor responsible for the lack of progress towards reaching MDG-5 is the continued presence of glaring gaps between evidence and clinical practice (Villar 2001; Countdown 2010). The focus of new research should therefore be on finding ways to bridge the gap between research and practice, based on an understanding of the fact that having the tools to tackle a problem is not sufficient; to be effective, tools need to

be usable within the existing health system framework with available resources. In short, the problem lies not in a lack of knowledge about how to prevent maternal deaths, but rather in “a lack of resources and health systems needed to deliver this care in the prevailing social and cultural attitudes” (Crisp 2010).

2.2 The direct causes of maternal mortality

According to the International Classification of Diseases, 10th edition (ICD-10), a maternal death is defined as the death of a woman while pregnant or within 42 days (or 1 year for late maternal deaths) of delivery, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes (WHO 1992).

Table 1-1 Estimated incidence of major complications and main maternal sequelae

Complication	Incidence (% of live births)	Estimated annual cases (‘000s)	Case fatality rate (2000)	Maternal deaths in 2000	Main sequelae
Post-partum haemorrhage	10.5	13,795	1.0	132,000	Severe anaemia
Sepsis	4.4	5,768	1.3	79,000	Infertility
Pre-eclampsia/ eclampsia	3.2	4,152	1.7	63,000	Eclampsia
Obstructed/ prolonged labour	4.6	6,038	0.7	42,000	Urinary incontinence/ fistula
Complications of unsafe termination of pregnancy	14.8	19,340	0.3	69,000	Infertility

Source: AbouZahr 2003

In practice, given the extreme paucity of data for many regions due to inadequate hospital record-keeping and poor civil registration systems, WHO has developed estimates of mortality and morbidity related to just five direct obstetric conditions: post-partum haemorrhage (PPH), puerperal sepsis, pre-eclampsia and eclampsia,

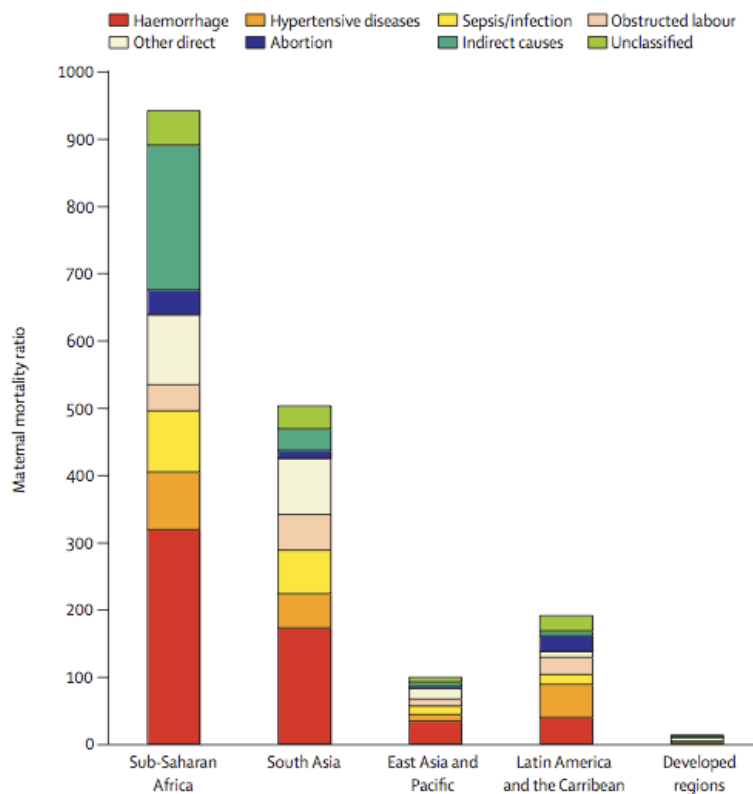
obstructed labour and unsafe termination of pregnancy (TOP) (Table 1-1). It is estimated that together these five conditions account for around 60 per cent of all maternal mortality (Khan, Wojdyla et al. 2006). However, obtaining reliable information on the individual medical causes of maternal mortality is extremely difficult, especially for the often large proportion of maternal deaths that occur at home, or on route to a health facility (Ronsmans and Graham 2006).

In a 2006 analysis of maternal mortality, haemorrhage, hypertensive disorders and infections emerged as the dominant direct causes in developing countries, with some variation by region (Figure 3) (Khan, Wojdyla et al. 2006). In Sub-Saharan Africa (SSA), the combined MMR for these three conditions is almost 500, compared with fewer than 300 in south Asia, just over 100 in Latin America and the Caribbean and 4 in developed nations. Haemorrhage alone is thought to be responsible for over one quarter of all maternal deaths.

It is estimated that around 8 per cent of all maternal deaths in developing countries are due to obstructed or prolonged labour; however, this figure is likely to be an underestimate because deaths due to this cause are often classified under other associated complications, for example sepsis, PPH or ruptured uterus (Ronsmans and Graham 2006).

Deaths attributable to complications of unsafe TOP are particularly hard to estimate since, whether legal or illegal, induced TOP is usually stigmatised and frequently censured by political, religious, or other leaders. Hence, under-reporting is routine even in countries where TOP is legally available (Fu, Darroch et al. 1998; Grimes, Benson et al. 2006).

Figure 3 Maternal mortality ratios by medical cause and world region (2000)



Source: Ronsmans and Graham 2006

Despite these problems with obtaining reliable information, there is general consensus between all the major providers of maternal mortality statistics that progress towards MDG-5 has been slow, and in some regions non-existent. Although the statistics published in the last two years do seem to suggest some improvement, almost 1,000 women still die every day of maternity-related causes, and the annual rate of decline is less than half of what is needed to achieve MDG-5 (WHO 2010) (Figure 2).

2.3 Effective interventions to reduce maternal mortality

During the last few decades, the clinical and academic communities have developed and tested safe, effective and affordable interventions which, when implemented successfully, have resulted in significant reductions in the number of maternal deaths.

These include both drugs and procedures that enable health care providers, with appropriate training, to manage a variety of common obstetric complications.

This section will provide a summary of the aetiology of the five major causes of maternal mortality, as well as a brief summary of the evidence-base for some of the recommended clinical interventions for the prevention and management of each condition. Key interventions were selected based on a thorough review of recent WHO publication, Green-Top Guidelines from the Royal College of Obstetricians and Gynaecologists (RCOG) and Cochrane systematic reviews. Interventions were selected on the basis of their potential to avert maternal death and disability, their applicability to developing country settings, the strength of recommendations and the quality of evidence. Table 1-2 lists selected interventions, by condition, detailing the strength of the recommendation and quality of evidence where available.

Of course, no single intervention alone can reduce the rate of maternal mortality in a population; rather, the emphasis should be on packages of care which prioritise the intrapartum period (WHO 2010). These interventions do not function in isolation from the wider health system and the communities in which they are provided, and the barriers to their implementation will be addressed in Chapter 2.

2.3.1 PPH

As described above, PPH plays a prominent role in maternal mortality, especially in developing countries where it accounts for over one-third of all maternal deaths (Table 1). An estimated 14 million women worldwide develop PPH annually with a case fatality rate of around 1 per cent, making PPH the leading cause of pregnancy-related mortality worldwide (WHO 2004). Analysis of disease-specific morbidity patterns

has shown that PPH is also a leading cause of severe obstetric morbidity (Waterstone, Bewley et al. 2001).

The most widely used definition of PPH is blood loss after childbirth of more than 500mL. Severe PPH is defined as more than 1,000mL blood loss. The aetiological causes of PPH include: uterine atony; retained placenta, membranes, or blood clots; genital tract trauma, and coagulation abnormalities.

Evidence from randomised controlled trials (RCTs) supports the need for several key interventions to prevent and manage the condition. These include both preventative measures and treatments for active PPH (Mathai and Gülmezoglu 2007; WHO 2009).

Preventative measures

Predicting which women will develop PPH is extremely difficult. Although risk factors include high parity and multiple fetuses, the majority of women who experience PPH have no identifiable risk factors. Once the condition occurs, it quickly becomes life threatening. A Cochrane Review of five RCTs involving over 6,000 women shows that a series of three simple preventative measures, collectively known as active management of the third stage of labour (AMTSL), reduces the occurrence of PPH by 38 per cent (95 per cent confidence interval (CI) 32 to 46) and the need for blood transfusion by 34 per cent (95 per cent CI 22 to 53) compared with expectant management (Prendiville, Elbourne et al. 2000). Furthermore, it is inexpensive and does not require the supervision of a doctor, making it highly applicable to low-resource settings with limited access to skilled providers. AMSTL consists of three interventions designed to facilitate the delivery of the placenta: the individual contribution of the three components to the reduction in PPH is not yet known.

Although the precise definition of what constitutes AMTSL can vary, for instance whether early cord clamping is included as a component, the International Federation of Gynecology and Obstetrics (FIGO), the International Council of Midwives (ICM) and the RCOG all promote the following three steps:

1. Administration of uterotonic drugs immediately following delivery

The uterotonic drug recommended by FIGO and the ICM is oxytocin (10 international units (IU) intramuscularly (IM) (FIGO 2003). Oxytocin is the preferred uterotonic as it is effective 2-3 minutes after injection, has minimal side effects and can be used in all women. Where oxytocin is not available, other uterotonic drugs such as syntometrine and ergometrine may be used (WHO 2006).

2. Controlled cord traction (CCT) to remove the placenta

Controlled cord traction (CCT) involves traction on the umbilical cord, combined with counter-pressure on the uterus to remove the placenta. The technique is currently the subject of a non-inferiority RCT to test whether a simplified package of AMTSL without CCT might be possible (Gulmezoglu, Widmer et al. 2009), the results of which have yet to be published.

3. Uterine massage after delivery of the placenta

A 2008 Cochrane review found only one trial which reported an 80 per cent reduction in the need for additional uterotonics in women who received routine AMTSL plus uterine massage, compared with those receiving routine AMTSL without uterine massage (Hofmeyr, Abdel-Aleem et al. 2008). The mean blood loss was also significantly less in the uterine massage group at 30 minutes (mean difference (MD) -41.60, 95 per cent CI -75.16 to -8.04) and 60 minutes after

enrolment (MD -77.40, 95 per cent CI -118.71 to -36.09 ml). Further evidence is needed to confirm this benefit.

Treatment

Once active PPH has been diagnosed, steps to identify the cause of bleeding and interventions to stop it must begin as quickly as possible. As the first line treatment, WHO strongly recommends administration of oxytocin over a fixed-dose combination of ergometrine and oxytocin, carbetocin, or prostaglandins, e.g. misoprostol. A fixed-dose combination of ergometrine and oxytocin is the recommended second-line treatment. WHO recommends the use of misoprostol to treat PPH only in the absence of any other uterotonic or if all other measures fail (WHO 2009).

If bleeding does not stop in spite of treatment with uterotonics, other conservative interventions (e.g. balloon tamponade), or pressure on the uterus, WHO guidelines strongly recommend that surgical interventions be initiated:

“Conservative approaches should be tried first, followed – if these do not work – by more invasive procedures. For example, compression sutures may be attempted first and, if that intervention fails, uterine, utero-ovarian and hypogastric vessel ligation may be tried. If life-threatening bleeding continues even after ligation, subtotal (also called supracervical or total hysterectomy) should be performed.”

(WHO 2009)

2.3.2 Puerperal sepsis

Puerperal sepsis is any bacterial infection of the genital tract occurring between the onset of labour and the 42nd day postpartum. It is usually more than 24 hours after delivery before the symptoms and signs (fever, pelvic pain and/or offensive vaginal discharge) appear, making postnatal supervision of women key to ensuring a timely diagnosis. Around 10 per cent of all maternal deaths and 26 per cent of neonatal

deaths in developing countries are due to puerperal sepsis and the risks are significantly increased in cases of prolonged and/or obstructed labour (Khan, Wojdyla et al. 2006).

If it does not cause death, puerperal sepsis can cause long-term health problems such as chronic pelvic inflammatory disease (PID) and infertility. Medical treatment is often straightforward and inexpensive.

Preventative measures

The primary means of preventing infection and sepsis is through high standards of hygiene by medical practitioners. According to WHO's six principles of cleanliness at birth:

"The hands of the birth attendant must be washed with water and soap, as well as the perineum of the woman. The surface on which the infant is delivered must be clean. Instruments for cutting the cord and cord care (razor blade, cutting surface, cord ties) should be clean. Nothing should be applied either to the cutting surface or to the stump. The stump should be left uncovered to dry and to mummify."

(WHO 1994)

Isolation and barrier midwifery care should be practised to prevent the spread of infection to other women. Women with sepsis should be cared for in a separate room or a corner of the ward and, when treating infected women, extra care should be exercised in hand hygiene; the use of dedicated gloves, gowns, and equipment, and careful disposal of soiled dressings and linen. If possible, a nurse/midwife should be specifically allocated to the care of the infected woman (WHO 2008). No evidence from RCTs is available to support the use of these hygienic principles, as to withhold these practices from a control group of women for the purposes of re-confirming an already well-established clinical benefit would be against all ethical principles.

Treatment

Without antibiotic treatment of the infection, sepsis will cause death (Stade, Shah et al. 2004). A Cochrane Review found that for endometritis, intravenous gentamicin plus clindamycin were more effective than other antibiotic regimes (French L.M. 2007), although for general sepsis WHO still recommends a regime of ampicillin (2 g IV every 6 hours), and gentamicin (5 mg/kg body weight IV every 24 hours), and metronidazole (500 mg IV every 8 hours) until the woman is fever-free for 48 hours (WHO 2008).

Rehydration (oral or IV) for women with sepsis is also a key component of managing puerperal sepsis. Where the cause of sepsis is suspected to be retained placental tissue, a digital examination should be performed and any fragments removed, using forceps or a large curette if necessary. In severe cases, a laparotomy or hysterectomy may become necessary (WHO 2008).

2.3.3 Complications of unsafe TOP

WHO defines unsafe TOP as:

“a procedure for terminating an unintended pregnancy either by individuals without the necessary skills or in an environment that does not conform to minimum medical standards, or both” (WHO 1993).

Where carefully performed, TOP is one of the safest procedures in contemporary clinical practice. Under safe and legal conditions, the case-fatality rate is less than one death per 100,000 procedures; however, under clandestine and unsafe conditions, the estimated case-fatality rate rises to 367 deaths per 100,000 unsafe TOPs (WHO 2004). In an article for the Lancet series on sexual and reproductive health, Grimes et al. report that every year, about 19-20 million unsafe TOPs take place, nearly all (97 per cent) in developing countries. An estimated 68,000 women die as a result, and millions more

have complications such as chronic PID and infertility, many permanent (Grimes, Benson et al. 2006)

Preventative Measures

From both a physical and mental health perspective, the prevention of unwanted and unplanned pregnancies is a far better option than TOP, and is more cost effective for the health system (Prata, Sreenivas et al. 2010). According to WHO, family planning has the potential to prevent 71 per cent of unwanted pregnancies: eliminating 53 million unintended pregnancies, 22 million fewer unplanned births, 25 million fewer induced TOPs, 32 per cent of maternal deaths and 10 per cent of neonatal, infant and child deaths (WHO 2010). In addition, contraception is much more acceptable than TOP (which is illegal for the 26 per cent of the world's population who live in countries where TOP is prohibited altogether or allowed only to save the woman's life) (CRR 2009) and has a number of other health benefits for the woman and her children. The integration of post-TOP care and family planning services, including contraceptive counselling and provision, are recommended to reduce the risk of future unwanted pregnancies (RCOG 2011); however, this is often overlooked, particularly for unmarried women and adolescents (Grimes, Benson et al. 2006).

Treatment

It is estimated that between 10 and 50 per cent of all women who experience unsafe TOP need medical care for complications such as retained products of conception (RPOC), sepsis, haemorrhage and intra-abdominal injury (e.g. puncturing and tearing of the uterus) (Shaikh, Abbassi et al. 2010).

Manual vacuum aspiration (MVA) is a simple, cost-effective procedure for managing

incomplete TOPs involving the use of suction to remove the RPOC through a cannula into a syringe. It does not require general anaesthesia and does not need to be performed in an operating room. The technique has been shown to be highly effective in removing RPOC from the uterus and has been repeatedly associated with a lower complication rate than dilatation and curettage (D&C), an alternative technique (Greenslade 1993). Nurses and midwives can safely provide first-line post-TOP care services, even in outpatient settings, provided they receive appropriate training and support (Tsu and Coffey 2009).

Other key components of emergency post-TOP care include: management of shock; control of bleeding; treatment of sepsis, and surgical procedures for intra-abdominal injuries (WHO 2008) It is also vital that maternal health care providers are trained to recognize the signs and symptoms of TOP complications, as women may be reluctant to reveal their attempts at termination in contexts where TOP is legally restricted and/or stigmatized.

2.3.4 Pre-eclampsia/eclampsia

Pre-eclampsia, commonly defined as hypertension of $\geq 140/90$ mmHg and proteinuria $\geq 0.3\text{gm}/24\text{hours}$, which appears at ≥ 20 weeks' gestation, is a multi-organ disease, affecting the liver, kidneys, brain and blood clotting system. Without treatment, severe pre-eclampsia often results in the more life-threatening eclampsia, the hallmark symptoms of which are seizures and coma. Together, pre-eclampsia and eclampsia are responsible for between 40 and 63 thousand maternal deaths every year (Duley 1992; AbouZahr 2003). Pre-eclampsia is estimated to complicate around 4 per cent of all deliveries in the developing world, and up to 18 per cent in parts of Africa (Maharaj 1994).

Early diagnosis

Several studies have shown that the risk of developing eclampsia is elevated in women without access to antenatal care (Abi Said, Annegers et al. 1995 ; MacKay, Berg et al. 2001). The essential antenatal activities for the screening and early detection of pre-eclampsia are routine blood pressure monitoring and testing urine for traces of protein after 20 weeks' gestation (Milne, Redman et al. 2005).

Treatment

Strong evidence of the effectiveness of magnesium sulphate (MGgSO_4) for the treatment of eclampsia has been available since 1995 (ETCG 1995); however, the drug is still not on the essential medicines list in many developing countries while less effective and higher-risk drugs, for example diazepam and phenytoin, are still being widely used (Aaserud, Lewin et al. 2005).

Until ten years ago, there was little reliable evidence regarding the effectiveness of MGgSO_4 for preventing the onset of eclampsia in women with pre-eclampsia. However, the results of the Magpie Trial, published in 2002, now provide convincing evidence that MGgSO_4 is also effective for the prevention of eclampsia (Altman, Carroli et al. 2002).

Several questions remain regarding the best regimen to use for MGgSO_4 administration. Some evidence suggests that a purely IM can be safely used in places where skills and equipment for IV use are not available (Begum, Begum et al. 2001); however, these data need to be validated by a larger trial. Another outstanding question is whether a loading dose of MGgSO_4 alone may be sufficient for the majority

of women with pre-eclampsia, as two initial studies from Bangladesh suggest (Begum, Begum et al. 2002; Shamsuddin, Nahar et al. 2005).

Ultimately, delivery is the only effective treatment for pre-eclampsia/eclampsia and is recommended by WHO in the following cases:

- All women with preeclampsia at >37 weeks' gestation.
- All women with severe pre-eclampsia, within 24 hours of the onset of the symptoms, regardless of gestational age.
- All women with eclampsia, within 12 hours of the onset of convulsions, regardless of gestational age.

If the cervix is favourable (soft, thin, partly dilated), induction of labour and vaginal delivery should be possible. However, if the cervix is unfavourable, delivery should be by Caesarean section (WHO 2008).

2.3.5 Obstructed or prolonged labour

Eight per cent of maternal deaths worldwide are believed to be the result of obstructed or prolonged labour (Khan, Wojdyla et al. 2006). The term 'obstructed labour' indicates a failure to progress due to mechanical problems - a mismatch between the size of the presenting part of the fetus, and the mother's pelvis. Defining 'prolonged labour' is more difficult as definitions of normal length of labour are vague, with a resulting variation in hospital guidelines. WHO recommends that labouring women are referred to a health facility if regular uterine contractions and progressive cervical dilatation proceed for more than 12 hours without delivery (WHO 2008).

Obstructed or prolonged labour often leaves those who survive with a fistula, an anatomical communication between the birth canal, the urethra and/or the rectum resulting in the leakage of urine and/or faeces. It is estimated that more than 2-3 million women around the world are currently living with untreated obstetric fistulae, which result in health complications of different degrees of severity, great social stigmatization, and often, isolation (WHO 2006).

Some cases of obstructed or prolonged labour will unavoidably end in death unless the woman receives a Caesarean section but, in other cases, obstructed labour can be avoided by timely detection of prolonged labour and effective management and treatment.

Early diagnosis

Use of the partograph or partogram can aid the timely identification of prolonged labour and obstructed labour and prevention of fistula formation. This simple pre-printed paper form provides a graphic depiction of the progress of labour using a number of simple measures and typically includes 'action' and 'alert' lines to ensure the timely diagnosis of prolonged labour.

Its use is recommended by WHO, with evidence from a large 1990-91 trial in Indonesia, Malaysia, and Thailand showing a reduction in prolonged labour, operative vaginal deliveries by forceps and Caesarean section rates (WHO 1994; WHO 2009). However, a 2009 systematic review found inconclusive evidence to support the use of the partograph, but did note its particular relevance for low-resource settings as the two studies included in the review that were conducted in low-income countries did show a reduction in Caesarean rates with its use (Lavender, Hart et al. 2008). Further

research to establish its efficacy is required, but the systematic review does not advocate the non-use or removal of the partograph and WHO continues to recommend its use.

Treatment

Standard measures to prevent prolonged labour include augmentation of labour by amniotomy (rupturing of membranes) or IV oxytocin where indicated. A 2009 Cochrane Review concludes that “a policy of early routine augmentation for mild delays in labour progress resulted in a modest reduction of the Caesarean section rate compared with expectant management” (Wei, Wo et al. 2009). Recent RCOG guidelines recommend the use of oxytocin over amniotomy (RCOG 2011).

In some cases of prolonged labour, instrumental vaginal delivery by forceps or vacuum extraction is necessary for a timely, safe delivery. Both are internationally accepted methods of assisted vaginal delivery (RCOG 2011). Use of vacuum extraction is associated with lower risk of severe maternal injury (odds ratio 0.41, 95 per cent confidence interval 0.33 to 0.50) and the need for Caesarean sections, while use of forceps is associated with a lower risk of certain adverse neonatal outcomes (Johanson and Menon 2000).

In a proportion of cases of obstructed labour, the only way to save the mother’s life is to perform a Caesarean section. While the relatively complex health system requirements of this surgery can make this procedure difficult in low-resource settings, it is possible to increase the ease with which Caesareans can be performed and thus extend access by utilizing a number of adaptations. Foremost amongst these are simplified surgical (‘Joel-Cohen based’) techniques, which have been shown to have a number of

advantages including reduced blood loss, operating time, use of pain killers and fever (Hofmeyr, Mathai et al. 2008). Training appropriate personnel in these techniques is crucial: experience in Mozambique suggests that not only obstetricians, but also assistant medical officers, can be trained to perform these techniques safely, although further research is needed (Pereira, Bugalho et al. 1996).

Following a prolonged or obstructed labour, there is an increased risk of fistula formation. A careful regimen (including continued use of the indwelling bladder catheter, twice daily cleansing of the perineum and vagina, and gentle excising of any necrotic tissues) can result in spontaneous closure of around 15-20 per cent of simple or small fistulae (Lewis 2006). For other fistulae, reparative surgery is the only treatment. WHO's IMPAC manual on fistula prevention and management highlights the need for a dedicated national strategy for the prevention and treatment of obstetric fistulae (WHO 2006). To support progress in this field, efforts are also being made at an international level to develop universally-accepted fistula classification and standardized training programmes (Elneil and Browning 2009).

2.4 Summary

The key to further reductions in maternal mortality will be to find more effective ways of promoting and facilitating the uptake of the evidence-based interventions described in Section 1.3. As I will describe in the next chapter, there are many barriers in operation that prevent women in developing countries having timely access to these life-saving interventions, even once they reach a health facility. Given the proven effectiveness of existing obstetric interventions, there is great potential for near-term improvements in maternal health. Finding solutions to these implementation barriers “should be a priority for researchers, practitioners and policy-makers” (Haines 2004)

Table 1-2 Summary of key, internationally recommended obstetric interventions, by condition

Condition	Type of intervention	Intervention	Strength of recommendation/quality of evidence	Source of recommendation
PPH	Prevention	AMTSL *	Strength of recommendation: Strong; Quality of Evidence: Moderate	(WHO 2006)
	Management	First-line: 20 IU oxytocin (IV)	Strength of recommendation: Strong; Quality of Evidence: Low	(WHO 2009)
		Second-line: 0.2mg fixed-dose combination (IM or IV)	Strength of recommendation: Strong; Quality of Evidence: Low	(WHO 2009)
		Third-line: 200-800mg misoprostol orally	Strength of recommendation: Strong; Quality of Evidence: Low	(WHO 2009)
		IV fluids to treat shock	N/A	(WHO 2008)
		Conservative surgical procedures	Strength of recommendation: Strong; Quality of Evidence: N/A	(WHO 2009)
Sepsis	Prevention	Clean delivery practices (infection prevention)	Strength of recommendation: Strong; Quality of evidence: N/A	(WHO 1994; WHO 1998)
	Management	Barrier midwifery care for women with sepsis	Strength of recommendation: Strong; Quality of evidence: N/A	(WHO 2008)
		Antibiotic regime (preferably combination of gentamicin and clindamycin)	N/A	(French L.M. 2007; WHO 2008)
		IV fluids to treat shock	N/A	(WHO 2008)

		Digital removal of retained fragments of placenta	N/A	(WHO 2008)
		Laparotomy if general peritonitis develops	N/A	(WHO 2008)
		Hysterectomy if the uterus becomes necrotic and septic	N/A	(WHO 2008)
Complications of unsafe TOP	Prevention	Post-TOP contraception provision	Strength of recommendation: B Quality of evidence: 1a	(RCOG 2011)
		Post-TOP counselling	Good practice point	(RCOG 2011)
	Management	Vacuum aspiration to remove RPOC	Strength of recommendation: A Quality of evidence: 1a	(RCOG 2006; Tunçalp 2010)
		Antibiotic regime for post-TOP sepsis	N/A	(French L.M. 2007; WHO 2008)
		IV fluids to treat shock	N/A	(WHO 2008)
		Surgical repair of intra-abdominal injuries	N/A	(WHO 2008)
		Screening for STIs including HIV/AIDS	Strength of recommendation: A Quality of Evidence: N/A	(RCOG 2011)
Pre-eclampsia/ eclampsia	Prevention (i.e. early diagnosis)	Blood pressure monitoring in the third trimester	N/A	(NICE 2008); (Milne, Redman et al. 2005); (RCOG 2006)
		Detection of proteinuria in the third trimester	N/A	(NICE 2008); (Milne, Redman et al. 2005); (RCOG 2006)

	Management	MGgSO ₄ for prevention of convulsions in women with severe pre-eclampsia	Strength of recommendation: A Quality of evidence: 1a	(RCOG 2006)
		MGgSO ₄ for control of convulsions in women with eclampsia	Strength of recommendation: A Quality of evidence: 1a	(RCOG 2006)
		Antihypertensive treatment for management of acute hypertension	Strength of recommendation: C Quality of evidence: 1a	(RCOG 2006)
		Delivery of women with severe pre-eclampsia within 24 hours	N/A	(WHO 2008)
		Delivery of all women with eclampsia within 12 hours	N/A	(WHO 2008)
Obstructed/ prolonged labour	Prevention (i.e early diagnosis)	Use of partograph to monitor labour	Strength of recommendation: A Quality of evidence: 1b	(RCOG 2011)
		Augmentation of labour	Strength of recommendation: A Quality of evidence: 1b	(RCOG 2011); (ACOG 2003)
	Management	Assisted vaginal delivery	Strength of recommendation: A Quality of evidence: 1a	(RCOG 2011)
		Caesarean section	N/A	(WHO 2008)
		Simple fistula repair	N/A	(WHO 2006)

* The strength of recommendations and quality of evidence for the individual components of AMTSL are documented in WHO guidelines for the prevention of PPH (WHO 2006).

N/A indicates no strength of recommendation or quality of evidence information available

3 Barriers to effective maternal health care

"By the time they struggled to get her an admission card, by the time she was admitted, by the time her file was made up, by the time the midwife was called, by the time the midwife finished eating, by the time the midwife came, by the time the husband went and bought some gloves, by the time the gloves were brought to the hospital, by the time the midwife was called, by the time the midwife came, by the time the midwife examined the woman, by the time the doctor could be found, by the time the husband went out to buy drugs, IV set, drip and bottle of ether, by the time the husband went round to look for blood bags all round town, by the time the husband found one and by the time the husband begged the pharmacist to reduce the prices since he had already spent all his money on the swabs, dressings, drugs and fluids... by the time the haematologist was called, by the time the haematologist came and took blood from the poor tired husband, by the time the day and night nurses changed duty, by the time the day and night doctors changed duty...by the time the t's had been properly crossed and all the i's dotted and the husband signed the consent form, the woman died."

Tahzib F. College of Health Sciences, University of Sokoto, Nigeria, 21 March, 1989.

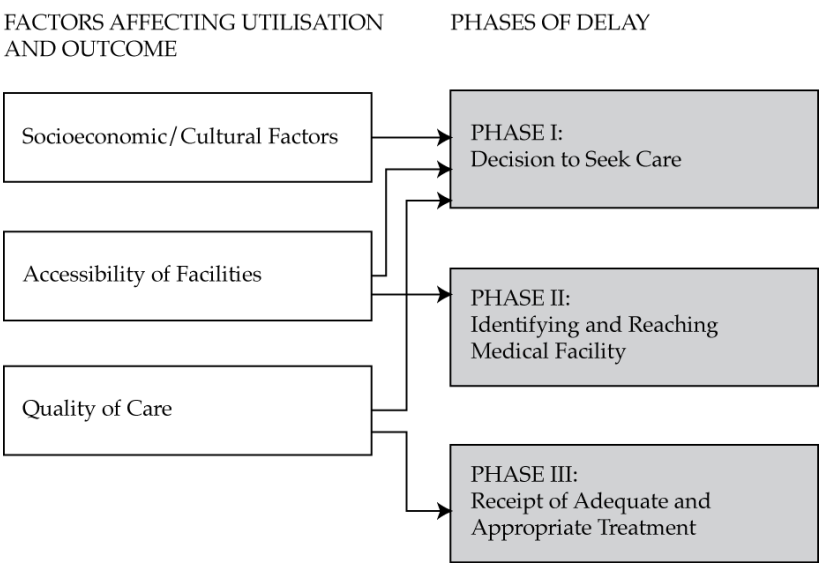
Cited in Thaddeus and Maine (1994) (Thaddeus 1994)

3.1 The three delays model

Although it was written over 20 years ago, this powerful excerpt serves to illustrate some of the numerous, persistent barriers that prevent women receiving effective and timely care, even once they reach a health facility. In this chapter, I will explore some of these facility-level barriers in greater detail, and present the results of a systematic literature review that I conducted to identify and categorise these barriers thematically, as well as to identify attempts that have been made to assess their relative importance in different settings.

Much has been written about the types of delay that can prevent women accessing high quality obstetric care, as well as the barriers that explain these delays. In their seminal 1994 paper, Thaddeus and Maine group these into three broad categories using a classic pathways-based framework, which is rooted in the perspective of the service user (Thaddeus 1994). This framework is known as the three delays model (Figure 4).

Figure 4 The three delays model



(Thaddeus 1994)
33

Phase I: delays in deciding to seek care (examples include the actors involved in decision-making (individual, spouse, relative, family); the status of women; illness characteristics; distance from the health facility; financial and opportunity costs; previous experience with the health care system, and perceived quality of care).

Phase II: delays in identifying and reaching a health facility (examples include physical accessibility factors, such as distribution of facilities, travel time from home to facility; availability and cost of transportation, and condition of roads).

Phase III: delays in receiving adequate care at the facility (examples include adequacy of the referral system; shortages of supplies, equipment, and trained personnel, and competence of available personnel).

Since 1994, the three delays framework has been used extensively in studies of maternal mortality in developing countries. Much of the recent literature focuses on Phase I and II delays “demand-side” barriers, including three systematic reviews (Say 2007; Gabrysch 2009; McNamee 2009). Less has been written, however, about the barriers that prevent the receipt of timely and appropriate obstetric care once a woman reaches a health facility (Phase III delays). Although these ‘supply-side’ factors (for example, lack of drugs; lack of adequately trained personnel) are often major factors contributing to maternal deaths, no systematic review has yet dealt comprehensively with the barriers to care that exist once a woman reaches a health facility.

An in-depth understanding of the barriers that contribute to Phase III delays across the developing world could lead to interventions that effect change toward evidence-based practice and better quality of care, and would be of great relevance for priority setting

and advocacy purposes, both at the national and international level.

3.2 A systematic review of the third delay

3.2.1 Methods

In order to address this gap, I searched 5 electronic databases (PubMed, CINAHL, CABI Global Health, Global Health Library (Medline) and WHO Publications) to identify original research articles that explore reasons for Phase III delays, or attempt to measure them. A 4-way strategy was developed with the guidance of an information scientist, Mrs Shona Kirtley. The search strategy combined search terms and synonyms related to:

- 1) maternal health care (e.g. obstetric care, perinatal care, maternal mortality/morbidity);
- 2) facility-level (e.g. health facility, hospital, clinic);
- 3) barriers (e.g. treatment delay, obstacles, quality of care etc.);
- 4) developing countries (low-income countries, Africa, Asia, Latin America etc).

A detailed example of the search strategy used is given in Appendix 1.

Expert recommendations were sought to identify relevant papers to ensure that these were included in the search results. The bibliographies of retrieved articles deemed eligible for inclusion in the study were also screened to identify additional articles.

After removing duplicates, I screened titles, then abstracts, to identify candidate articles and retrieved full-text copies of the selected articles for further assessment. Uncertainties were discussed and resolved my supervisor (Stephen Kennedy (SK)).

Inclusion and exclusion criteria

Articles were shortlisted if the title and abstract indicated that they reported the results of original research studies using quantitative, qualitative or mixed method approaches in the English language, were undertaken in developing countries and reported the association between barriers or types of delay at the facility level and maternal mortality or severe morbidity. Research published or including data before 1994 was excluded, because the 'three delays' model was first published in this year, and because the rapid development of maternal health care in the 1990s reduced the relevance of data from earlier decades.

A 6th year medical student with experience of practising obstetrics in the developing world (Alice Self (AS)) was identified to assist with the full text eligibility assessment and data extraction phase. AS and I independently reviewed the shortlisted full-text articles for relevance. Articles were excluded if the research examined patient-side or community-level barriers rather than facility-level factors that led to treatment delays; if only the clinical causes of maternal death were reported, or if the article reported improvements in the quality of maternity care without having first identified what the problems were prior to the intervention.

Differences of opinion were resolved by reviewing the articles again together and, if disagreement still existed, with SK. We then independently extracted the following information from each article: country/ies, type of research (quantitative, qualitative or mixed), methodology (survey, interview, other), sampling strategy, number of facilities/districts covered, interventions covered, and individual barriers cited, including whether the researchers made any attempts to quantify the barriers. SK resolved any differences.

A qualitative approach produced the data extraction framework, which was then used to record the individual barriers cited in the selected articles. Thematic analysis techniques were used to identify and categorise barriers into emerging themes. Starting with a selection of the richest texts, AS and I used an inductive analytic process to record all barriers either implicitly or explicitly cited in articles as being responsible for facility-level treatment delays, noting recurrent patterns. Barriers that were closely related conceptually were merged. For example, some articles referred to clinical guidelines as out of date and others referred to them being ambiguously worded: these were both classified under the theme of 'inadequate *content* of clinical guidelines'. Alternatively, barriers related to poor dissemination of guidelines on the labour ward or a lack of enforcement of guidelines were classified as 'inadequate *dissemination* of clinical guidelines'.

The resulting framework was used in a first round of data extraction. The frequency with which each barrier was explicitly reported in articles was recorded in a spreadsheet so as to map trends in the literature (Table 3). In addition, references to factors that we interpreted as being barriers were recorded, even if they were not explicitly stated as such by the authors (Table 3, column 3). When a new, conceptually unique barrier emerged during the first round of data extraction, this was noted and included in the data extraction spreadsheet for a second reading of all papers. Appendix 2 shows the barriers cited by each of the articles reviewed after differences between the two data extractors were resolved.

3.2.2 Description of studies

A total of 3,375 papers were retrieved and imported into reference management software (RefWorks, Bethesda, USA). Fourteen additional records were identified from other sources.

Of the 3,189 articles deemed ineligible on the basis of title and abstract, most were excluded because the article did not report original research, the research was from a developed country context or the data concerned barriers to care at the community rather than the facility level.

In total, we assessed 52 full-text articles for eligibility; of these, 10 were excluded. Five were merely commentary pieces (Thaddeus 1994; Maine D 1999; Travis P 2004; Mavalankar DV 2005; Paxton A 2006); 3 proposed new evaluation instruments (Gill Z 2005; World Health Organization 2009; Morestin, Bicaba et al. 2010); one dealt with barriers to evidence-based interventions for normal labour (Khalil K 2005), and one reported improvements in the quality of maternity care as a result of an intervention without reporting baseline barriers (Borchert M 2010) (Figure 5).

Of the 42 studies included in the review (Table 2-1) 29 were conducted in Africa, 4 in Asia, 4 in Latin America, and 5 in more than one region. The research methods used were quantitative (n=15), qualitative (n=9) and mixed (n=18). Methodologies used to assess Phase III barriers included surveys of health care practitioners, in-depth interviews with stakeholders, focus groups, facility-based audits, district-based maternal mortality reviews, and needs assessments based on indicators and signal functions.

Figure 5 Literature review: identification, screening and selection of articles

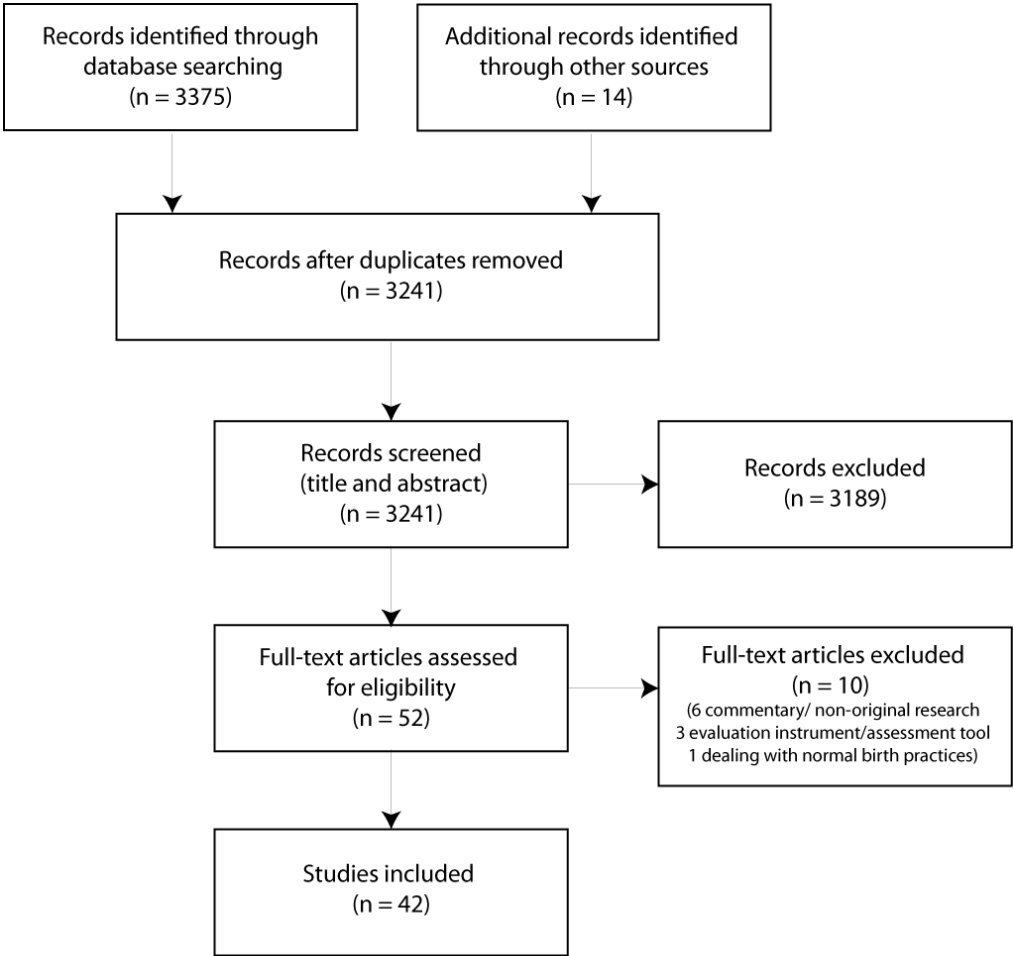


Table 2-1 Characteristics of studies included in the review

Author (year)	Country/ies	Study Design	Setting	Sample	Adequate reporting of methods to assess barriers
Gohou (2004)	Cote d'Ivoire	Hospital audit	2 hospitals	37 severe obstetric emergencies	Yes
Ijadunola (2007)	Nigeria	Needs assessment	26 health facilities	26 heads of facility	Yes
Okonoua (1992)	Nigeria	Hospital audit	1 hospital	35 maternal deaths	Yes
Shah (2007)	Pakistan	Hospital audit	1 hospital	152 maternal deaths	No
Supratiko (2002)	Indonesia	District-based audit (medical records and verbal autopsies)	3 rural provinces	130 maternal deaths	Yes
D'Ambrusso (2010)	Indonesia	Qualitative review of maternal deaths: verbal autopsy	2 rural districts	104 maternal deaths	Yes
Kongnyuy (2009)	Malawi	Needs assessment	73 hospitals	Unknown	Partial
Ansong-Tourni (2007)	Ghana	Confidential enquiry	6 hospitals in 2 regions	20 maternal deaths	Partial
Belizan (2007)	Argentina and Uruguay	Qualitative (focus groups/in-depth interviews)	10 hospitals	31 physicians and midwives; 16 pregnant women	Yes
Hailu (2009)	Ethiopia	Hospital audit	5 hospitals	34 maternal deaths	Yes
Hoerstermann (1996)	Gambia	Hospital audit	1 hospital	78 maternal deaths	Partial
Mills (2007)	Ghana, India, Kenya	Mixed: household & facility survey, in-depth interviews, verbal autopsy, focus groups	Ghana – 25 facilities; India – 10 districts; Kenya – 25 facilities	One member of staff at each facility, plus focus groups (16 in Kenya and 20 in India), in-depth interviews (15 in Kenya; 28 in Ghana; 49 in India) and household surveys (1927 in Kenya; 3433 in Ghana; 13,645 in India)	Partial
Nyamtema (2009)	Tanzania	Needs assessment	16 health facilities and 6 dispensaries	48 midwives	Yes
Olukoya (1997)	Nigeria	Hospital level confidential enquiry / needs assessment	1 hospital	Unknown	No

Author (year)	Country/ies	Study Design	Setting	Sample	Adequate reporting of methods to assess barriers
Aaeserud (2005)	South Africa, Nigeria, Uganda, Egypt, Ghana, Malawi, Sierra Leone, Zimbabwe, Argentina, Brazil, Mexico, India, Pakistan, Bangladesh, Yemen, UAE, Singapore	Case study: surveys, focus groups and interviews	Various	Magpie study collaborators, drug information officers, obstetricians in 33 countries.	Yes
AMDD (2004)	Benin and Chad	Needs assessment	Benin - 48 potential CEmOC facilities and >200 potential BEmOC facilities; Chad - 40 hospitals	Unknown	Partial
AMDD	Bhutan, Cameroon, India	Needs assessment	Bhutan - 31 facilities; Cameroon - 487 facilities; India - 82 facilities	Unknown	Partial
AMDD	Bolivia, El Salvador, Honduras	Needs assessment	Bolivia - 85 facilities; El Salvador - 33 facilities; Honduras - 27 facilities	Unknown	Partial
AMDD	Gabon, Guinea-Bissau, Gambia	Needs assessment	Gabon - 77 facilities; Guinea-Bissau - 107 facilities; Gambia - 47 facilities	Unknown	Partial

Author (year)	Country/ies	Study Design	Setting	Sample	Adequate reporting of methods to assess barriers
AMDD	Morocco, Nicaragua, Sri Lanka	Needs assessment	Morocco – 510 facilities; Nicaragua – 112 facilities; Sri Lanka – 115 facilities	Unknown	Partial
AMDD	Niger, Rwanda, Tanzania	Needs assessment	Niger – 85 facilities; Rwanda – 3 facilities; Tanzania – 4 facilities	Unknown	Partial
AMDD	Peru, Pakistan, Vietnam	Needs assessment	Pakistan – 70 facilities; Peru – 31 facilities; Vietnam – 5 facilities	Unknown	Partial
Barnes-Josiah (1998)	Haiti	Qualitative review of maternal deaths: verbal autopsy	10 rural districts	Relatives and care providers of 12 deceased women	Yes
Cham (2005)	Gambia	Qualitative review of maternal deaths: verbal autopsy	1 rural district	Relatives and care providers of 42 deceased women	Yes
Cham (2009)	Gambia	Qualitative review of near misses: in-depth interviews	1 hospital	30 maternity service users	Yes
Choo (2010)	Ghana	Needs assessment	17 hospitals	Unknown	Partial
Conde-Agudelo (2008)	Colombia	Mixed methods	15 hospitals	Quantitative arm: 1767 pregnant women Qualitative arm: 36 intrapartum care providers	Yes
Fikree (2006)	Pakistan	Cross-sectional study	52 public facilities in 1 district	17 doctors and 55 midwives	Yes
Kawuwa (2006)	Nigeria	Staff survey	1 hospital	10 members of healthcare staff	No
Kongnyuy (2008)	Malawi	Facility assessment survey	73 health facilities in 3 districts	73 heads of maternity unit	Yes
Mfinanga (2009)	Tanzania	National survey	National maternity service	National representative sample of 251 vaginal deliveries	Yes
Nyamtema (2008)	Tanzania	Needs assessment	9 health facilities and 6 dispensaries	397 mothers, 53 service providers and 16 administrators	Yes

Author (year)	Country/ies	Study Design	Setting	Sample	Adequate reporting of methods to assess barriers
Nyango (2010)	Nigeria	Needs assessment	1 state	54 maternal health providers	Partial
Orij (2006)	Nigeria	Descriptive cross-sectional study	1 hospital	98 mothers	No
Pearson (2004)	Kenya, Rwanda, Soutern Sudan, Uganda	Needs assessment	Uganda – 197 facilities; Kenya – 17 facilities; Southern Sudan – 15 facilities; Rwanda – 28 facilities	Unknown	Yes
Pitchforth (2006)	Bangladesh	Qualitative study: ethnographic observation	1 government hospital	25 women and 14 staff	Yes
Pitchforth (2010)	Ethiopia	Mixed methods	1 teaching hospital	6 staff interviews; 10 1hr observations; 12 in-depth service user interviews; 6 group interviews with key stakeholders	Yes
Ridge (2010)	Zambia	Case study	National health system	Archival materials	Partial
Sevene (2005)	Mozambique, Zambabwe	Case study and policy review	National health systems	12 clinicians, 6 senior officials, 4 Therapeutic Commission representatives, 4 Medicine Control Authority representatives, 4 pharmacists, 3 pharmaceutical company representatives	Yes
Tita (2005)	Cameroon	Population-based study	118 health facilities in 1 province	328 reproductive health workers	Yes
Urassa (1997)	Tanzania	Qualitative review of maternal deaths: verbal autopsy	1 district	117 maternal deaths	Yes
Ziraba (2009)	Kenya	Qualitative review of maternal deaths: verbal autopsy	Informal settlements	29 maternal deaths	Yes

3.2.3 Review findings

Thirty-two conceptually unique Phase III barriers were identified, which were categorised into six themes (Drugs and equipment; Policy and guidelines; Human resources; Facility infrastructure; Patient-related and Referral-related).

Although some authors classify referral-related barriers as primarily transport-related and therefore Phase II delays, for the purpose of this review I consider these Phase III barriers since a well-functioning network of primary care integrated with hospital services is a key important component of health service delivery (WHO 2010).

Human resources

Human resource issues were the most common delays across the literature, mentioned by 40 of the 42 papers. Within this category, it would seem the greatest problems relate in one way or another to training of personnel, as this barrier was cited by 36 (86 per cent) articles. There were many examples of inadequate training resulting in fatalities or near-miss events cited in the articles. Education and training of health workers were overwhelmingly deficient due to the absence of continuing education programmes, adequate formal training and a habit of self-learning, as well as poor access to up-to-date educational resources. A midwife taking part in one of the studies remarked: *"I am just happy with these few minutes we have spent today because for me this is my midwifery revision after 34 years."* She was the midwife in charge of a district hospital maternity unit in Cameroon (Tita, Selwyn et al. 2005).

Table 2-2 Frequency of Phase III barriers reported in articles

	Explicit barriers count (max = 42)	Implicit barriers count (max = 42)	Grand Total
Human Resources	39	1	40
Staff shortages	18	7	25
Issues related to quality of training/skills mix	32	4	36
Staff motivation issues	16	3	19
Inadequate supervision	5	5	10
High workload	5	1	6
Authorisation to perform certain tasks	2	2	4
Absenteeism	1	1	2
24-hour availability of staff	8	3	11
Management issues	3	0	3
Drugs and Equipment	33	5	38
Cost issues	7	1	8
Inadequate drug supply/logistics problems	26	2	28
Lack of appropriate storage (e.g. fridge/secure cabinet)	2	3	5
Not on essential medicines list/registered for indication	3	0	3
Lack of equipment	18	4	22
Equipment available but not used/faulty	5	1	6
Lack of blood	13	0	13
Guidelines/Policy	24	4	28
Inadequate content of clinical guidelines	7	1	8
Inadequate dissemination of clinical guidelines	6	3	9
Poor hospital policy/record keeping	13	0	13
Preference of staff for non-evidence based treatment/s	8	2	10
Facility Infrastructure	17	8	25
Lack of beds/ward space	2	2	4
Power/water shortages	8	1	9
Surgical facilities	6	10	16
Transfusion facilities	6	2	8
Laboratory facilities	1	1	2
Referral	13	2	15
Distance-related	3	3	6
Road infrastructure	0	2	2
Inadequate emergency transport	11	0	11
Fuel availability	3	0	3
Poor communication	4	1	5
Patient-side	12	0	12
Cost-related	8	0	8
Social/cultural/religious	4	1	5

The next most cited human resources barrier were staff shortages, with 25 mentions, followed by staff motivation issues. Nineteen (45 per cent) papers stated that low motivation causes delays. In one hospital in Côte d'Ivoire, the good will of

administrative staff was a major factor in whether or not surgical kits could be purchased on credit for critically ill patients, despite the pleas of doctors (Gohou, Ronsmans et al. 2004). Staff were variously identified by authors as overworked and underpaid (Barnes-Josiah 1998); misusers of limited health resources for private practice (Hoestermann, Ogbaselassie et al. 1996); lacking motivation to change the way they practise (Pitchforth, Lilford et al. 2010), and down-right dishonest (Cham 2005; Pitchforth, van Teijlingen et al. 2006). Motivation levels also affected the availability of staff in many of the studies. In some instances, both doctors (Belizan, Meier et al. 2007) and midwives (D'Ambruso, Byass et al. 2009) were found to be more motivated by their private practices, with low wages and poor conditions incentivising staff to work elsewhere, often in cities rather than rural communities (Pearson and Shoo 2005). One paper stated: *"the staff had such a low salary that they could not concentrate on their work, but had to spend most of their time in income generating activities."* Such poor motivation was confirmed by medical officers as an important contributor towards poor patient management (Urassa, Massawe et al. 1997) and one article recommended extra incentives should be put in place to retain staff in rural or marginalised areas (Pearson and Shoo 2005).

Eleven (26 per cent) of the articles suggested that staff were not available 24 hours a day inadequate. Staff shortages and absenteeism almost certainly contributed towards cases of sub-optimal supervision (23 per cent of articles) and high workloads (14 per cent of articles). Staff shortages were compounded by managerial issues. In Gondar, Ethiopia, the region's only obstetrician was often taken from the wards to teach and examine trainees (Pitchforth, Lilford et al. 2010), whilst in rural Gambia only one doctor remained on the unit because the other three had been allowed to go on leave at the same time (Cham 2005).

Drugs and equipment

Issues relating to the availability of essential drugs, equipment and blood were cited in 38 (90 per cent) articles. Interestingly, 28 (67 per cent) articles referred specifically to inadequate supply and distribution of drugs and equipment, compared with only 8 (19 per cent) that mentioned cost as a prohibitive factor. Twenty-two (52 per cent) articles referred to essential equipment that was lacking altogether (including surgical equipment and vacuum aspirator pumps), as well as very basic equipment such as surgical gloves and cannulae, and a further 6 (14 per cent) articles made reference to existing equipment that was either broken or poorly maintained.

Lack of safe blood supplies for transfusion was also a major problem identified in 13 (31 per cent) articles. In one Nigerian tertiary hospital over 20 per cent of the maternal deaths were due to delays in acquiring blood (Orji, Ojofeitimi et al. 2006). In some cases, blood had to be obtained from hospitals that were many kilometres away (Gohou, Ronsmans et al. 2004); had to be bought by the family at great expense (Cham 2005; Pitchforth, van Teijlingen et al. 2006), or donated by relatives or friends (Cham, Sundby et al. 2009). Family members were often expected to undertake long journeys to obtain blood products (D'Ambruoso, Byass et al. 2009), sometimes taking several days (Cham 2005).

Five (12 per cent) articles stated that appropriate storage facilities for drugs and blood were not available, and so products became spoiled due to storage at incorrect temperatures. A national survey in Tanzania found that uterotonic drugs (which should be kept refrigerated) were stored at room temperature in 28 per cent of the facilities (Mfinanga, Kimaro et al. 2009). During an interview, one Gambian woman recounted:

"My husband managed to buy two bottles of blood for me yesterday. The morning ward staff collected the blood from the lab and put them on top of the ward refrigerator for cooling. The following morning my husband was again told to replace the two bottles as the previously acquired blood was 'spoiled,' as the nurse put it."

(Cham, Sundby et al. 2009)

Finally, 3 (7 per cent) articles reported that important drugs were either missing from the country's 'essential medicines list', or not registered for a particular indication. This was a particular issue for MgSO_4 . For example, in one study, the drug was not licensed for the treatment of pre-eclampsia in 7 out of 13 low-income countries studied (Aaserud, Lewin et al. 2005); in Zimbabwe, it had not been registered for eclampsia either (Sevene, Lewin et al. 2005). One reason offered was that the low cost of the drug removes any incentive on the part of manufacturers to maximize its use (Sevene, Lewin et al. 2005).

Guidelines and policy

Twenty-eight (67 per cent) of the papers identified inadequate clinical guidelines or poor policy environment as a factor contributing to sub-standard maternal care in the population being studied. Issues relating to poor policy at the level of the individual facility (for example, bad record keeping) were reported in 13 (31 per cent) articles. One of the most common examples of poor policy at the hospital level was the lack of partograph use, which was specifically mentioned in 5 articles (Ansong-Tornui J 2007; Ijudunola KT 2007; Mills 2007; Ziraba AK 2009; Pitchforth, Lilford et al. 2010). In one hospital, staff understood the importance of using partograms to monitor the progress of labour but were left to make their own bespoke charts in the medical notes as the hospital did not supply them (Pitchforth, Lilford et al. 2010). Another example was cited in Nairobi, where a policy which dictated that all patients must obtain antenatal

cards and pay cash deposits before being eligible for delivery services led to recurrent treatment delays (Mills 2007).

The inadequate content and dissemination/enforcement of national clinical guidelines was mentioned in 8 (19 per cent) and 9 (21 per cent) articles, respectively. The article by Aaserud et al. found that national clinical guidelines for pre-eclampsia were absent in 8 out of 13 low and lower-middle income countries, leading to a failure to provide MgSO_4 when necessary. Those based in Latin America expressed a contrary concern: the over-use of MgSO_4 in situations in which it was not supported by the latest research, similarly indicating a failure to disseminate best-practice guidelines effectively (Aaserud, Lewin et al. 2005).

Ten (24 per cent) articles also reported that staff preferred to use less effective or non-evidence based interventions. These included a preference for expectant management of the third stage of labour rather than AMTSL (Mfinanga, Kimaro et al. 2009); treatment of eclampsia with diazepam (Ridge, Bero et al. 2010) (Tita, Selwyn et al. 2005); routine use of enemas (Conde-Agudelo 2008), and a lack of compliance with recommendations to deliver HIV positive women routinely by Caesarean section (Pitchforth, Lilford et al. 2010). In reference to external cephalic version, a recommended practice for breech presentation at term, one article quoted a medical officer as saying, *"I not only don't do it; I actively discourage it because it is very dangerous"* (Tita, Selwyn et al. 2005).

Legal policy constraints also operate in many countries that prevent mid-level providers from performing particular functions, such as assisted vaginal delivery and vacuum extraction (AMDD 2004; Fauveau 2007; Pitchforth, Lilford et al. 2010).

Facility infrastructure

Poor hospital infrastructure was identified in 25 (60 per cent) articles and the most frequent barrier explicitly reported within this category was a shortage of power and/or water. Nine (21 per cent) papers stated that such shortages delay treatment in emergency situations.

Orji et al. concluded that the major factor causing delay to treatment is theatre-related (Orji, Ojofeitimi et al. 2006). Indeed, 6 studies explicitly stated that theatre space and surgical facilities were a problem, and a further 10 implied this. Not all hospitals have a theatre but even in those that do, surgical services may be irregular and not accessible in an emergency. Delays understandably occur when theatres are already being used, but even when extra theatre space is made available it is not always possible to mobilise staff and so treatment is delayed (Gohou, Ronsmans et al. 2004).

Another delay related to transfusion facilities. Many hospitals stated that the lack of blood delayed treatment, but 8 (19 per cent) papers found that a number of referral hospitals did not have a functioning blood bank. In one paper, only 9 per cent of the district hospitals in Dar Es Salaam had a blood bank (Urassa, Massawe et al. 1997) and the proportion in another article looking at obstetric care in poor regions of Ghana, India and Kenya found equally poor availability (Mills 2007). Lack of ward space and inadequate laboratory facilities were less commonly reported as barriers to care, with only 4 (10 per cent) and 2 (5 per cent) citations respectively.

Referral-related

Eleven of the 15 articles that highlighted referral-related issues reported that

inadequate emergency transport contributed towards maternal mortality. Various reasons were cited such as the ambulance had broken down and there was no replacement (Cham 2005); was being used for an alternative purpose (Nyamtema, Urassa et al. 2008), or was under-staffed and ill-equipped (D'Ambruoso, Byass et al. 2009). Car ambulances were only available in 7-31 per cent of facilities in three districts of Malawi (Kongnyuy, Hofman et al. 2009). Further delays occurred in three of the papers because the ambulance had no fuel (Barnes-Josiah 1998; Cham 2005; Nyamtema, Urassa et al. 2008), meaning at times that the woman's relatives had to be sent to purchase more (Cham 2005). In one case, providers were unable or unwilling to arrange a referral because of a patient's HIV positive status (Barnes-Josiah 1998).

Eight (19 per cent) articles mentioned difficult journeys mothers undergo when referred to higher levels of care due to long distances between facilities (6 articles) and the poor condition of the roads (2 articles). Five (12 per cent) articles stated that communication between facilities was sub-standard because of non-functioning radios and telephones, or a complete lack thereof.

Patient-side factors

Twelve (29 per cent) articles reported that patient-side barriers contributed to maternal deaths once women reach a medical facility. These included cost-related factors related to compulsory user-fees that hospital staff demand prior to providing treatment/surgery (19 per cent articles), particularly in relation to emergency Caesarean section. Even if financial issues had not delayed or prevented a family from bringing the mother to the hospital (Phase I and II delays), any treatment requiring out of pocket expenses could delay treatment at the facility whilst funds were being raised (Pitchforth, van Teijlingen et al. 2006). The cost of antibiotics and Caesarean sections

were both cited as prohibitive (Tita, Selwyn et al. 2005) and one relative was quoted as saying:

"...as I had no money with me I went back home to look for more money. It was not until the following day that I raised some money enough to buy only one of the medicines prescribed."

(Cham, Sundby et al. 2009)

In 5 (12 per cent) articles, religious beliefs and negative socio-cultural attitudes towards biomedicine were reported to impede the use of certain medical interventions. These interventions included HIV testing and administration of peripartum antiretroviral treatment, companionship during labour because of concerns about witchcraft, privacy and gossip, (Tita, Selwyn et al. 2005) and taboos surrounding blood donation that prevented family members from providing or obtaining blood supplies for emergency transfusion (Olukoya AA 1997; Belizan, Meier et al. 2007).

3.2.4 Contextualisation of findings

In this section I will examine the six different categories of barrier that emerged as primarily responsible for the third delay from the literature review in more detail, and discuss how these relate to other publications in the wider field of health systems research in developing countries. I will also highlight some key actions that have been put forward to overcome these barriers.

Human Resources

The global shortfall in human resources for health is on a massive scale (Chen, Evans et al. 2004). According to WHO, there is a critical shortage of health care workers in 57 countries, 36 of which are in SSA (WHO 2006). Key issues in this field include:

Inadequate numbers being trained: In order to increase the number of doctors and nurses, more training facilities are needed. This is particularly necessary in countries where deaths resulting from the HIV/AIDS epidemic have significantly reduced the number of health workers. WHO estimates that the 36 countries in SSA must train and deploy an additional 800,000 health workers in order to meet the health-related MDGs, which would mean expanding the current health workforce by 139 per cent (WHO 2006). However, in SSA, two-thirds of countries have just one medical school, and some countries have none (Narasimhan, Brown et al. 2004). Efforts to support an increase in the volume of health care professionals have recently received backing from major international agencies, including WHO and PEPFAR (WHO 2009).

Quality of training and continuous learning: The quality of both pre-service and in-service training is often highlighted in the literature as a key barrier to the use of evidence-based maternal health interventions (Chen, Evans et al. 2004; Narasimhan, Brown et al. 2004; Tita, Selwyn et al. 2005). A key reason why clinical practice often remains outdated for many years after new evidence is available is the fact that opportunities for continuing education, part of mandatory professional development in most high-income countries, are often rare in low-income countries.

Skill-mix and distribution: Sharp regional differences exist in the ratio of doctors to nurses, both within and between countries, with a resulting impact on the capacity and function of the health care system. In Bolivia, Brazil and Peru, there are two to four times more physicians than nurses, while in Burundi, Ghana and Kenya, nurses outnumber doctors by a factor of 10:1 (Buchan 2006). In many countries, highly skilled providers are concentrated solely around the capital. This imbalance is of particular significance when considering barriers to providing access to complex interventions

such as Caesarean sections, and points to a need to match the skill-mix to demand, as well as consider what training can be provided to upgrade the skills of non-physicians so that they can perform these interventions. This process of delegating tasks to less-specialised health workers is sometimes known as task-shifting and is a topic that has received renewed attention in recent years (WHO 2008).

WHO also now produces guidance for the optimal allocation and deployment of staff for different types of health facility depending and taking into account differing population needs (e.g. local economic circumstances, patterns of morbidity, patient attitudes). The Workload Indicators of Staffing Need (WISN) method is a human resources management tool that determines how many staff of each type are needed to cope with the workload of a particular facility and assesses the workload pressure of health workers in order to assist managers to make better human resources decisions (Kolehmainen-Aitken 2010)

Brain-drain: Precise numbers of trained health care personnel working outside their country of birth or training are difficult to obtain, but it is clear that numbers have increased, and that the impact on developing countries has been significant (Stilwell, Diallo et al. 2004). Factors contributing to health workers' decisions to move abroad include financial incentives, better training opportunities and more desirable working environments. The complexity of 'push-and-pull' factors requires action from both source and destination countries to mitigate the detrimental effects of this phenomenon.

Absenteeism: In much of the developing world, absenteeism is a readily identified but poorly quantified problem. A 2004 study of health workers in Bangladesh concluded

that absenteeism can reach 74 per cent or higher in small rural posts (Chaudhury 2004). In a survey of health clinics in Bangladesh, Ecuador, India, Indonesia, Peru, and Uganda, 35 per cent of health workers were found to be absent (Chaudhury 2005). In many countries with the highest burden of infectious diseases such as HIV/AIDS and malaria, many health workers require extended periods of leave as a result of ill-health (Chaudhury 2005).

Drugs and equipment

Ensuring the availability of effective drugs and equipment for priority health problems remains a key public health issue in many low-resource countries (WHO 2001). Even when evidence-based, low-cost interventions exist, the availability of such health commodities remains poor in many settings. The poor availability of MgSO_4 in many developing countries well-illustrates these government and market failures, even though the drug has appeared on WHO's essential medicine's list since 1996 (Duley 1992; Aaserud, Lewin et al. 2005; Sevene, Lewin et al. 2005). Failures in the registration, procurement and distribution mechanisms have been cited as the major factors contributing to the poor availability of this drug. In addition, the very low cost of MgSO_4 means that market forces cannot be relied upon to ensure its availability as pharmaceutical companies have very little incentive to commercialise the drug (Langer 2008).

In many countries, the distribution of health commodities in the public sector is ad hoc, posing considerable difficulties to implementing certain maternal and newborn health interventions. In the private sector, medicines are often sold in unauthorized places and counterfeit medicines circulate due to poor distribution networks. There may be no accountability by manufacturers, importers or retailers on the disposal of medicines

(DFID 2004).

Key components of a successful supply chain include the number of levels in the network; the number and location of warehouses; the adequacy of the transport equipment and transportation routes, and the inventory quantities. The difficulties of managing and coordinating such networks varies depending on the number of differing product requirements (short shelf-life, cold chain, limited suppliers) and sophistication of any pre-existing infrastructure, especially to remote communities (Rao 2008).

Key actions required by governments to improve the supply and distribution of maternal health commodities include allowing price competition in the market; promoting bulk procurement; negotiating equitable pricing for newer essential medicines; reducing mark-ups through more efficient distribution and dispensation, and encouraging local production of essential medicines (Travis, Bennett et al. 2004). Unfortunately, case studies such as MgSO_4 illustrate how many governments are failing to intervene to ensure that even low-cost health commodities are available.

Policy and guidelines

One of the crucial steps in translating evidence into clinical practice is through the production, dissemination and enforcement of evidence-based health policies and clinical guidelines (Haynes and Haines 1998). To be both evidence-based and clinically useful, guidelines must balance the strengths and limitations of all relevant research evidence with the practical realities of the health care settings.

A comprehensive national framework for how to approach a certain condition can be

vital to ensure that the resources, personnel and facilities exist to provide the necessary treatment, while also demonstrating that crucial political will is present. At the micro-level, an efficient and effective system for setting and disseminating policies on specific aspects of treatments is of great importance, as well. A key example is the role of a country's essential medicines' list. WHO provides Model Lists of Essential Medicines, updated every two years. National adoption of these evidence-based recommendations is not, however, always timely or universal.

A major problem in many developing countries is the lack of access to relevant and up-to-date information upon which to base these policies. As a result, too often the government's maternal health policy framework is inadequate, out of date, ambiguous, or incomplete. If their information needs are not met, health care workers in many developing countries have little or no access to basic, practical information to enable them to deliver safe and effective care (Pakenham-Walsh and Bukachi 2009). Even in countries where adequate clinical guidelines are produced, poor dissemination and enforcement strategies mean that they do not reach many facilities, or that health care providers opt instead for their preferred, non evidence-based treatments (Aaserud, Lewin et al. 2005).

The gap between policy and practice was again highlighted by a 1999-2000 survey of 1,037 experts in 49 developing countries (Bulatao and Ross 2002). It showed that policy was not perceived as a major barrier, with the statement "Ministry of Health policies toward pregnancy and delivery services are adequate" being rated as 72 per cent true. When asked how true it is that "policies are vigorously implemented through regular high-level reviews and updated action plans", experts' ratings of the situation in their country dropped to 54 per cent.

In discussing priority-setting, Prata et al. argue that a major barrier to effective policy is the fact that *“developing countries... lack the information required to mobilize commitment to improving maternal health and effect policy making for this goal”* (Prata, Sreenivas et al. 2010). The broader political framework and policy environment, beyond the field of health, can also act as a significant barrier: Travis et al. state that *“in certain countries these broad policy and institutional constraints pose greater barriers than resource constraints”* (Travis, Bennett et al. 2004).

Facility infrastructure

One way to measure a facility's complexity is to determine whether it is able to provide each of the components of EmOC, otherwise known as signal functions. This process indicator has been used to assess the availability of effective maternity care, at both facility and population levels (AMDD 2002; AMDD 2002; AMDD 2003; AMDD 2003; AMDD 2004; Shah, Faundes et al. 2008).

There are two levels of EmOC: basic (BEmOC), which includes six essential signal functions, and comprehensive (CEmOC) which requires two more complex signal functions in addition, namely surgical and blood transfusion services (Table 2-3). Recommendations for the number of basic and comprehensive EmOC facilities per capita are inconsistent, even within the relevant UN agencies. UNICEF recommends a minimum of five EmOC facilities per 500,000 people (UNICEF 2008) whereas WHO recommends 2-3 per 120,000 (WHO 2005). EmOC facility density has the potential to be a useful monitoring tool; however, there is a need for a standardised denominator, preferably using births rather than population size, as well as for clearly defined benchmarks about which there is a consensus (Gabrysch, Zanger et al. 2011).

Table 2-3 Components of Basic and Comprehensive EmOC

Basic Services	Comprehensive services
(1) Administer parenteral antibiotics	(7) Perform surgery (e.g. Caesarean section)
(2) Administer uterotonic drugs (i.e. oxytocin)	(8) Perform blood transfusion
(3) Administer parenteral anticonvulsants for pre-eclampsia and eclampsia (i.e. MgSO ₄)	
(4) Manual removal of the placenta	
(5) Remove retained products (e.g. manual vacuum extraction, D&C)	
(6) Perform assisted vaginal delivery (e.g. vacuum extraction, forceps delivery)	

Note: A basic emergency obstetric care facility is one in which all functions 1-6 are performed. A comprehensive emergency obstetric care facility is one in which all functions 1-8 are performed.

One of the major findings from the series of Averting Maternal Death and Disability (AMDD) papers is that whilst most of the 20 countries surveyed had an adequate number of CEmOC facilities, many had far fewer BEmOC facilities than required for the population size (AMDD 2002; AMDD 2002; AMDD 2003; AMDD 2003; AMDD 2004; Bailey 2005; Fauveau 2007). Another finding was that rural subnational areas were much more poorly served in terms of both BEmOC and CEmOC facilities than urban areas.

Referral-related

Referral of patients from basic to more well-resourced levels of care is an essential element of any successful health system. All levels of health care provider, from senior doctors to health care assistants, must be trained to recognize risk factors for appropriate upward referral. Likely requisites for successful maternity referral systems

include: a referral strategy informed by the assessment of population needs and health system capabilities; CEmOC facilities that function 24 hours/day; active collaboration between referral levels and across sectors; formalized communication and transport arrangements; adequate road infrastructure, and agreed setting-specific protocols for referrer and receiver (Murray and Pearson 2006). Many health care systems in developing countries fail to optimize women's rapid access to EmOC and, unfortunately, the poor and marginalized are disproportionately affected.

Patient-side

User fees are a major barrier to health service access in countries with health systems that operate on out-of-pocket payments rather than social security or health insurance models. There is increasing recognition that user fees at the point of care are an inefficient and inequitable health financing mechanism (Yates 2009). There is a growing movement towards trying to reduce financial barriers to health care in many developing countries, with particular emphasis on high priority services and vulnerable groups such as women and children. In 2009, at the UN General Assembly, the British Prime Minister, the Director-General of WHO and the President of The World Bank all gave their public support to the concept of free services at the point of delivery for women and children (Yates 2010).

National policies to remove user fees for maternal health care have since been implemented in Ghana, Liberia, Sierra Leone and Nepal. Evidence from Ghana suggests that such exemptions can be both effective and cost-effective without, as has sometimes been claimed, creating 'frivolous' demand for health care. Nevertheless, commentators agree that for these policies to be successful there is a need for adequate funding and strong institutional ownership, as well as proper monitoring (Witter, Adje

et al. 2009).

Non-financial barriers also play a large role in limiting women's access to effective maternal care in many parts of the world. Tackling local taboos surrounding childbirth and negative attitudes towards biomedicine in general requires community education and engagement. There are many examples of programs that have successfully collaborated with community health workers (CHWs) and traditional birth attendants (TBAs) towards this end. The largest and most successful programme to date is the Brazilian Family Health Programme, which has effectively integrated CHWs into the municipal health service so that community participation becomes an integral component rather than an alternative. If further efforts are not made to integrate CHWs into maternal mortality reduction programmes, some in the field believe that there is "a danger of throwing out the 'community' with the 'community health worker'" (Sanghvi 2010).

Another approach that has been taken to increase community engagement is to establish participatory women's groups. In Jharkhand and Orissa, India, a cluster-RCT found that such groups were successful in improving birth outcomes and rates of maternal depression in these poor rural communities (Tripathi, Nair et al. 2010). A final example of successful community engagement is an imaginative scheme that resulted from a FIGO collaboration between the UK and Pakistan. One of the barriers to providing emergency obstetric care identified was a lack of blood donors in the region. The solution implemented saw trained CHWs conducting outreach work in the community and blood-type all young people in the area. Now, when a particular blood type is needed, the local Imam makes an announcement over the mosque's loud-speaker asking donors to come forward (Lodhi, Sohail et al. 2004). The scheme has

since been extended to many other countries with Muslim majorities, including Iraq and Malaysia.

3.2.5 Discussion

Phase III delays, although previously neglected, are still a source of considerable inequity in access to obstetric care. Although there is a vast body of literature on health systems barriers in high-income country contexts, the same cannot be said of low-resource settings.

By systematically searching five electronic databases for original research articles, 42 were identified that examined Phase III delays in a developing country context. Several of the studies aimed to assess the relative impact of the three phases of delay on maternal mortality. In some articles, Phase III delays were found to contribute significantly more to maternal mortality than either Phase I or II delays. In a facility-based audit in Tigray, Ethiopia, 87.5 per cent of the maternal deaths could be attributed to medical failures (Hailu 2009). In a hospital-based case-control study of maternal mortality in Southern Nigeria, *“the most striking difference between the groups was in the Phase 3 delays”* (Okonofua, Abejide et al. 1992). In another facility-based maternal death review in Malawi, 20 out of 28 maternal deaths were associated with health care worker factors, and a further six with administrative failures (Kongnyuy 2009). Moreover, these findings are not unique to facility-based studies. In a district-based audit in Indonesia, 60 per cent of maternal deaths involved a Phase III delay (Supratikto, Wirth et al. 2002). In a cohort study of pregnant Haitian women from 10 rural districts, inadequate care at a medical facility was a factor in seven of the 12 maternal deaths that occurred during the study period (Barnes-Josiah 1998). Finally,

an audit into maternal deaths in a Zimbabwean province found that 87 per cent were avoidable; of these, 57 per cent involved the health services and 33 per cent patient-related delays (De Muylder 1990). The findings of these studies are supported by WHO, which estimates that access to good obstetric care could prevent 88-98 per cent of global maternal deaths and substantially reduce the number of women living with sequelae of obstetric complications (WHO 1994).

A major strength of this systematic review was its focus on the importance of examining what happens once a woman arrives at a health facility. Previous reviews have focused on Phase I and II delays such as women's autonomy and ability to recognise danger signs (Gabrysch 2009). Whilst these topics are also important, in terms of policy relevance, it is essential to investigate factors that are amenable to change in the short and medium term, for example the quality of maternal health services. Without well-functioning health facilities that are able to treat obstetric emergencies effectively and in a timely manner, other efforts to reduce maternal mortality through education and improving women's standing in the community will be in vain.

The categorisation of barriers encountered at the facility level into six groups seems to me a helpful way of thinking about the third delay and determining where solutions should be sought as a priority. The framework should inform those conducting future studies in this area, in particular those involved in confidential enquires into maternal deaths or 'near-misses' which are now being conducted in an increasing number of developing countries. The results of this review should provide direction regarding the facility-level factors that should be included in the list of areas to examine.

As Crisp notes:

“Pregnant women need a health system that functions well across the whole range of services from community care to the most specialised hospital treatment ... improving the system for pregnant women is [therefore] likely to improve it for everyone else”

(Crisp 2010).

The findings of this review are therefore not limited only to reducing maternal mortality and morbidity, but may also be applicable to the many other clinical areas in which similar health service failures lead to poor clinical outcomes and preventable deaths

There were several methodological limitations to this systematic review. Ideally, two people would have independently screened titles and abstracts to identify relevant articles, however, as it was not possible to identify a second reviewer for this stage of the project, I proceeded to screen the titles and abstracts alone, discussing any queries with my supervisor. In all but a few instances, it was immediately obvious based on the title and abstract whether an article was likely to be relevant and therefore whether the full text article should be assessed for eligibility. A second reviewer was identified to assist with the full-text review and data extraction phases.

Another methodological limitation of this literature review was that study quality was not included as an eligibility criterion. This decision was taken for two reasons. Firstly, the review was qualitative in nature and meta-analysis of the data was not performed, reducing the need for strict quality inclusion criteria. Secondly, whilst there are clear tools for the assessment of RCTs and other experimental studies, there is little guidance concerning analysis of the quality of qualitative observational studies, which is a category that many of the identified articles come under. Although assessment scales

and checklists have been used (Altman 2001; Wells, Shea et al. 2011), they have not been validated and are inappropriate for non-intervention studies. As a result of the decision not to screen articles for quality, many included in the review were methodologically weak, with several of the papers failing to explain their methodology in sufficient detail for their quality to be assessed. Despite these problems, it was doubtful whether a systematically applied subjective judgment about the general quality of the studies reviewed would be helpful in making the review more informative (Greenland 2001) and was felt that all the articles included in the review made relevant observations about Phase III barriers that were worthy of comment.

Another problem encountered was related to defining appropriate search terms that would identify all articles relating to phase III delays. For example, no medical subject headings (MeSH) were available that fully encapsulated treatment delays at the facility level. Instead, free-text search terms had to be developed, which may not have returned as many search results as would have been if more appropriate MeSH were available. Articles about facility-level barriers to the provision of maternal health care do not necessarily refer explicitly to the 'third delay' or use other easily predictable terminology. Moreover, there are so many wide-ranging barriers that could impact upon the quality of obstetric care, not all of which are immediately obvious to someone without first-hand experience of trying to provide care in a developing country context, that it was not possible to anticipate all possibilities. Nor did I wish to pre-empt which barriers were extracted by second-guessing appropriate search terms. Generic search terms such as 'delay', 'barrier' and 'shortage' were therefore used rather than search terms related to individual types of barrier. The breadth of the topic and resource limitations means that some important original articles may have been missed. Nonetheless, I believe that the overview of factors provided in this review is

comprehensive but unlikely to be completely exhaustive of the literature on each barrier.

A limitation of the search strategy was that it only included articles published in peer-reviewed journals and not the “grey literature” i.e. publications issued by organisations including government agencies, professional associations, special interest groups, public institutions or research centres that are not distributed or indexed by commercial publishers. This may have excluded from the review a number of rich sources of information about the third delay (for example, facility-based obstetric audits and confidential enquiries into maternal deaths) as many journal editors do not unfortunately accept this type of article. Another rich source of information about the causes of maternal death can be found in the confidential enquiries into maternal death, which are now conducted in an increasing number of developing countries.

A major challenge related to data extraction was that barriers were often poorly defined: for example, many of the articles attributed maternal deaths to the ‘lack of’ a specific drug or resource. With a few exceptions (Gohou, Ronsmans et al. 2004; Aaserud, Lewin et al. 2005; Sevene, Lewin et al. 2005) the reasons underlying the poor availability were not explored in any depth, making it difficult to classify whether this was due to cost, supply and distribution problems, or a combination of factors. Another commonly used yet ambiguous phrase was ‘a shortage of adequately trained staff.’ Is the emphasis here on the number of personnel or the quality of their training, or both? For consistency, such instances were recorded as both ‘issues related to quality of training/skills mix’ and ‘staff shortages.’

In some articles, the root cause of poor quality of care was left unexplained. For

example, in one article, a woman with a diagnosed head presentation was observed for over 48 hours, following which an attempt at external cephalic rotation failed, a Caesarean section was then performed and she died. However, no reasons were given by the authors as to why she was not attended sooner by staff (Cham 2005). Was it a case of staff not knowing that they should intervene sooner? Was the doctor unavailable? Could the woman not afford this surgery? Or were there other factors at work? A related issue was that often factors were mentioned that were considered by the data extractors to be Phase III barriers, but were not discussed explicitly as such by the authors. These were documented separately as 'implied barriers' (Table 2-2, column 3).

Finally, information about which barriers are more or less important to the provision of high quality care was rarely given. With the exception of one article (Kawuwa, Mairiga et al. 2006), studies did not attempt to assess the *magnitude* of various barriers in the local context. This type of assessment would be useful for both short and long-term priority setting purposes. A related point is that the synthesis of results from the reviewed articles (i.e. the frequency counts in Table 2-2) should be interpreted with some caution, and not extrapolated to represent the true magnitude or relative importance of the various barriers in the developing countries. The results of the articles are in fact very hard to compare due to the differences in study design, sampling strategy and the analysis techniques employed. Currently, no standard methodology exists for researchers wishing to compare the relative magnitude of these barriers. Furthermore, context specificity means that synthesis is extremely problematic. As Gabrysch and Campbell highlight in their review of delays I and II:

"Even if all methods were identical, it would be naïve to expect the effect of, say, distance in Malawi and Peru to be the same, given that infrastructure, transport options, education level, norms around place of delivery and many other factors

differ."

(Gabrysch 2009)

As this review highlights, a highly complicated web of reasons, many of which are interdependent, can be used explain treatment delays, ranging from behavioural factors such as staff motivation to material factors such as the availability of specific resources. Many of these factors are hard to measure, often not reported, and therefore extremely hard to control for to allow context to be taken into account when synthesising results.

3.2.6 Conclusion

From an economic perspective alone, global maternal health outcomes would be greatly improved if ways to overcome obstacles to the widespread use of safe and effective interventions that are already available could be found. This review highlights the importance of addressing both supply- and demand-side barriers in any effort to reduce maternal mortality. The studies included in the review document the severity of facility-level failures and serve to highlight that a focus on patient-side delays can sometimes conceal the fact that many health facilities in the developing world are still chronically under-resourced and cannot cope effectively with serious obstetric complications.

Moreover, as Thaddeus and Maine state in their original article:

"[The] three phases of delay rarely operate in isolation...indeed the factors are likely to be interactive and multiplicative. Thus, barriers and poor care encountered at Phase II and III feed back into subsequent decision-making at Phase I"

(Thaddeus 1994).

For this reason, Phase III barriers are likely to influence decisions to seek care and thus have an impact on maternal mortality at the facility-level and in the community. In other words, women and their families will be even further disinclined to travel to facilities if they have a reputation for providing poor quality care.

The focus in the past few decades on encouraging a shift from home-based to institutional delivery will have been misplaced if efforts to improve the quality of care women receive once they come through the doors of health facilities are not enhanced. Indicators such as the 'time from arrival to definitive treatment' (Maine, Akalin et al. 1997) or the 'percentage of women with obstetric complications treated within 2 hours at a health facility' (Bertrand 2002) have been proposed. However, few studies reported these outcomes as the data are rarely available from routine medical records (Gohou, Ronsmans et al. 2004). Those who call for the introduction of benchmark indicators that assess the *content* and the *quality* of maternal care, rather than just the rates of skilled attendance at birth, (as currently published by 'Countdown to 2015'), make an important case (Hodgins 2011). Efforts to incorporate cost-effectiveness into assessments would also be valuable.

Simple, replicable tools to assess facility-level barriers are badly needed to assist health managers in identifying facilities that deliver sub-optimal care, and in making and monitoring the required improvements. No generally accepted methodology exists and this makes comparisons between countries very difficult (Morestin, Bicaba et al. 2010). Efforts by Pitchforth et al. to incorporate social science methodology into their evaluations and use mixed-method designs to build a consensus amongst a variety of stakeholder groups are commendable and may yield more useful results (Pitchforth, Lilford et al. 2010).

Full list of studies included in the review:

(Okonofua, Abejide et al. 1992; Hoestermann, Ogbaselassie et al. 1996; Olukoya AA 1997; Urassa, Massawe et al. 1997; Barnes-Josiah 1998; AMDD 2002; AMDD 2002; Supratikto, Wirth et al. 2002; AMDD 2003; AMDD 2003; AMDD 2004; Gohou, Ronsmans et al. 2004; Aaserud, Lewin et al. 2005; Bailey 2005; Cham 2005; Pearson and Shoo 2005; Sevene, Lewin et al. 2005; Tita, Selwyn et al. 2005; Fikree FF 2006; Kawuwa, Mairiga et al. 2006; Orji, Ojofeitiimi et al. 2006; Pitchforth, van Teijlingen et al. 2006; Ansong-Tornui J 2007; Belizan, Meier et al. 2007; Fauveau 2007; Ijudunola KT 2007; Mills 2007; Shah N 2007; Conde-Agudelo 2008; Nyamtema, Urassa et al. 2008; Nyamtema, Urassa et al. 2008; Cham, Sundby et al. 2009; D'Ambruoso, Byass et al. 2009; Hailu 2009; Kongnyuy 2009; Kongnyuy, Hofman et al. 2009; Mfinanga, Kimaro et al. 2009; Ziraba AK 2009; Choo S 2010; Nyango D 2010; Pitchforth, Lilford et al. 2010; Ridge, Bero et al. 2010)

3.3 Summary and further research questions

This literature review uncovered several gaps in scientific knowledge about the barriers preventing the timely access to high quality, effective obstetric care in developing world health facilities. Although organizations such as WHO and RCOG produce evidence-based practice guidelines for maternity care, little is known about levels of adoption or adherence to these internationally. There therefore remains considerable uncertainty about which recommended interventions are being widely implemented in the developing world, and which are not. Furthermore, there are important questions left unanswered about which particular barriers impede the use of recommended interventions at health facilities, as well as questions about the relative importance of these barriers. To ensure that information on facility-level barriers contributes to improved responsiveness to obstetric emergencies, specific reasons for the third delay need to be identified before truly effective solutions can be implemented.

A key failure has been that the perspectives of, and pragmatic input from, providers at a local level have rarely been sought on a large scale, and have not been sufficiently

considered in planning global efforts to improve maternal health. Seldom do the individuals involved in delivering front-line care for women seem to be asked for *their* views about which barriers need to be overcome in order to implement best-practice obstetric care, in the context of local conditions (Graham 2010).

The second stage of my research project was therefore designed to study in detail some of the issues surrounding the third delay, by contacting frontline maternal health care providers in developing countries. Specifically, the aims of the project were threefold:

- a. To determine the extent to which maternal health care providers in developing countries report implementing key internationally-recommended interventions.
- b. To identify specific barriers impeding the use of these interventions (e.g. lack of supplies, knowledge, training, human resources, policy environment), from the perspective of frontline health care providers.
- c. To source potential short and long-term solutions to these barriers.

The secondary objectives of the project were to obtain providers' views on:

- The level at which barriers should be tackled (community, facility, national, international).
- Which barriers should be addressed as a priority.

4 Methods

To address the specific research questions outlined in Section 2.3, a mixed-methods approach comprising an online survey and ‘crowdsourcing’ forum was employed to obtain the perspectives of facility-based maternal health care providers working in developing countries about:

- a. The extent to which effective obstetric practices are currently being implemented in their facilities
- b. Perceived barriers to the routine implementation of these practices
- c. Potential short- and long-term solutions to these barriers

Ethical approval for the study was granted by the University’s Medical Sciences Division Research Ethics Committee. Informed consent was gained from all respondents via the sign-up page (Appendix 3). This included an explanation of the study and a guarantee of anonymity (Appendix 4). Participants were not obliged to answer questions, and could discontinue their participation in the survey or forum at any time and for any reason.

An online approach was chosen for several reasons. First, the rapid increase in Internet accessibility across the developing world allows rapid consultation on a global scale. The latest statistics suggest that there are approximately 1,017, 236, 140 and 77 million Internet-users¹ in Asia, Latin America, Africa and the Middle East respectively (Miniwatts 2012). Secondly, Internet-based surveys have the potential to allow a large amount of data to be collected in a relatively short time frame and at minimal cost.

¹ An Internet-user is defined as someone aged 2 years and above, who has been online in the past 30 days.

Third, the privacy afforded to the participant by a computer eliminates the potential for researcher bias to influence the results and increases the likelihood of frank responses, particularly when dealing with sensitive issues such as maternal mortality and hospital practice. Lastly, online data collection and management systems facilitate rapid response collection, instant data validation, and prompt analysis and dissemination of results.

The disadvantage of using online data collection methods in this context is that use of the Internet in the Global South is far from universal. Despite the rapid improvement of Internet accessibility across the Global South, participants from well-resourced, urban areas of higher-income developing countries are still more likely to be over-represented. Nevertheless, it was felt that the benefits of online data collection methods described above would outweigh these disadvantages. Moreover, rates of connectivity are likely to be higher than average amongst the educated professionals that made up the target population of this study.

4.1 Global Voices for Maternal Health survey

The main aim of the survey was to capture information from maternal health care providers about the coverage, or lack thereof, of internationally recommended interventions for the management of the five main causes of maternal mortality in their facilities, with a particular focus on phase III barriers. The survey was administered online between June 2010 and March 2011.

4.1.1 Participants and sampling

The participants were facility-based maternal health care providers in developing countries. These eligibility criteria therefore included health care professionals of all cadres working in hospitals, maternity units or clinics (doctors, nurses, midwives, clinical officers, health care assistants) but not CHWs such as community midwives or traditional birth attendants who assist women delivering at home.

The classification of countries as '*developing*' or '*developed*' is recognised as crude and over-simplistic. According to the UN Statistics Division, "there is no established convention for the designation of '*developed*' and '*developing*' countries or areas" (UN 2008). The Division's website also notes that the designations '*developed*' and '*developing*' "*are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process*" (UN 2010). However, the UN does state that, "*in common practice, Japan in Asia, Canada and the United States in Northern America, Australia and New Zealand in Oceania, and Europe are considered "developed" regions or areas.*" For convenience, and because it was felt that adopting an inclusionary approach was preferable in this research context, providers from all countries were deemed eligible to participate with the exception of the countries listed above, leaving 192 eligible '*developing*' countries.

From this pool, target nations were selected so as to focus promotional activities and to ensure that the global burden of maternal mortality was reflected in the sample. The latest available UN indicators of maternal mortality were used to select target countries from the pool of 192 on the basis of their size, total number of maternal deaths and MMR (Say 2005). Cut-offs were developed for each geographical region separately due

to the vast differences in population size and MMR between Asia, Africa, Latin America and the Middle East (Appendix 5). The resulting list of target countries is reproduced in Table 3-1.

Table 3-1 Target countries

Africa	Asia	Latin America	Middle East
Angola	Bangladesh	Brazil	Afghanistan
Burkina Faso	China	Guatemala	Iran
Cameroon	India	Mexico	Iraq
Cote d'Ivoire	Indonesia	Peru	Saudi Arabia
Democratic Rep. of Congo	Pakistan		Syria
Ethiopia			Yemen
Kenya			
Mozambique			
Nigeria			
South Africa			
Sudan			
Tanzania			
Uganda			

The participants were self-selected following multiple promotional activities. In the first instance, this consisted of sending email invitations (see Appendix 6) to members of relevant mailing lists (see below). The major methodological challenge was to obtain a large sample of respondents whilst avoiding response-bias associated with approaching selected groups only. Obtaining a representative sample of maternal health care providers in the developing world was an impossible task due to the huge size of this population, the lack of data to determine the correct sample, lack of contact details required to approach this group, and the limited budget available for this research. A self-selected sample was therefore the only viable option. However, in an attempt to overcome some of the problems of self-selection, a multi-pronged strategy

was adopted to reach as large a sample and as wide a variety of eligible participants across the developing world as possible given the resource constraints. The following dissemination strategies were used:

1. **Collaboration with well-motivated institutions to distribute the invitation to participate amongst their constituencies and encourage participation.** The following organisations were identified and approached, via email/letter in the first instance. Face-to-face meetings were set up where possible to forge formal links with key organisations, including FIGO and ICM. All the organisations listed below agreed to send invitations to participate to their members, either in dedicated email messages or within their regular communication with members (e.g. e-newsletters):

- a. FIGO: 124 member associations worldwide
- b. ICM: 101 member associations worldwide
- c. International Council of Nurses (ICN): 130 member associations worldwide
- d. The Maternal Health Task Force (MHTF): Advisory Group (42) and members (>700)
- e. EngenderHealth: offices in 26 countries
- f. WHO Partnership for Maternal, Newborn and Child Health: International
- g. RCOG International Office: >5000 International Members and Fellows
- h. Population Council Reproductive Health Program: Active in 45 countries
- i. Health care Professionals Global Network: >3000 members
- j. Global Alliance for Nursing and Midwifery: >2500 members
- k. Nursing and Midwifery for Making Pregnancy Safer: 450 members
- l. London School of Hygiene and Tropical Medicine: 12,000 alumni in 80 countries
- m. Geneva Foundation for Medical Education and Research: 200 students contacted
- n. The White Ribbon Alliance: 15 national alliances
- o. REPRONET Africa: 100 members
- p. Health care Information for All by 2015: >3000 members

q. African Medical and Research Foundation: Active in 13 African countries

2. **Identification of country or regional ‘champions’ to promote the survey in their area.** Motivated individuals willing to help in promoting the study were identified through contacts within the University of Oxford and MHTF. Once ‘champions’ were identified, dissemination strategies were discussed in detail over the telephone, drawing on local and cultural expertise to develop a successful strategy. A small budget (up to \$1,000) was provided if necessary for the champions to attend local obstetric or midwifery congresses, hire computers with Internet connectivity, and/or print promotional materials. This approach was employed in several of the target countries: Brazil, China, Guatemala, India, Indonesia, Kenya, Mexico, Nigeria, Peru, South Africa and Yemen.

3. **Use of the social networking site *Facebook* to identify and contact online groups of health professionals in target countries.** A key word search was performed to identify relevant groups using the strings doctor*, nurse*, midwi* in combination with Africa*, Asia*, Latin America*, Middle East*, world* as well as the names of each of the target countries. The following active groups were identified and contacted. The number of group members is given in parentheses:

- a. Doctors and Future Doctors All Over The World (39,337)
- b. Doctors Worldwide (395)
- c. Doctors of the World Unite (611)
- d. Young Midwives of South Africa (211)
- e. Midwives AIDS alliance (20)
- f. Nigeria Medical Students Association (502)
- g. Nigeria Nurses (midwives and health visitors) (189)
- h. MIWA Young Doctors and Medical Students (198)
- i. Indian Doctors (1,578)
- j. Young Doctors South Africa (27)

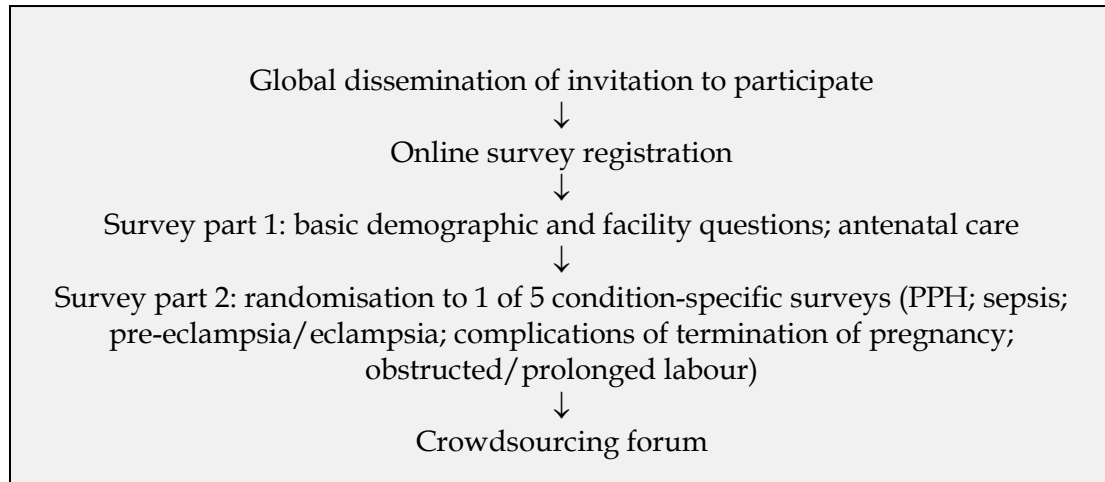
- k. Tanzania Doctors (55)
- l. Kenya Nurses (60)
- m. Afghan Doctors (52)
- n. Doctors of Bangladesh (476)
- o. Doctors of Pakistan (95)
- p. Sudan Doctors (707)

4. **International media coverage was secured to coincide with the launch of the website.** A short press release was drafted and disseminated via the University of Oxford's Press Office (Knight 2010, 8th June). An ongoing campaign to raise awareness resulted in a notable mention by the UK Secretary of State for International Development at his keynote speech in Washington D.C. (June 2010) (Mitchell 2010, 26th June) as well as several other features in blogs and newspapers (Mitchell 2010; Boseley 2010, 14th September).
5. **Participants were equipped and encouraged to recruit additional participants in their own contact networks (snowball sampling).** Biweekly emails were sent to all participants reminding them to promote the initiative amongst health care providers in their facility. 'Easyshare' links were enabled from the website which allowed users to alert other potential participants by email and post links to social networking sites.
6. **Leaflets and study promotional materials were printed and distributed at three major international maternal health conferences** which were attended by large numbers of health professionals from target countries: Women Deliver (7-9th June 2010, Washington D.C., USA); The Global Maternal Health Conference (30th August - 2nd September 2010, New Delhi, India) and the Africa Regional Meeting on Interventions for Impact in Essential Obstetric and Newborn Care (21st -23rd

February 2011, Addis Ababa, Ethiopia).

4.1.2 Survey design

Box 1. Project Structure



In designing the survey questions, a balance was sought between capturing enough detail from participants and keeping the surveys as short as possible (i.e. a maximum of 10 minutes) so as to minimize dropout (MacElroy 2000; Hoerger 2010).

The survey consisted of two parts (Box 1). The first part contained basic demographic questions about the respondent (age, gender, profession and years since qualification) and the characteristics of the facility in which he/she primarily works (type, location, administration, availability of personnel and basic services (e.g. water, electricity), and number of deliveries and maternal deaths in 2009). For each facility a 'facility complexity score' was calculated, following the same method as used in the WHO Global Survey on maternal and perinatal health (Villar, Valladares et al. 2006). Participants were also asked to rate the availability of all 29 components of antenatal care recommended in the new WHO antenatal care model (Villar, Ba'aqeel et al. 2001). Part 2 of the survey involved randomising participants to one of five condition-specific surveys on PPH; sepsis; pre-eclampsia/eclampsia; complications of unsafe TOP, or

obstructed/prolonged labour. From a review of current practice guidelines produced by the RCOG, WHO and other groups, seven key interventions were selected per condition (both prophylactic and therapeutic) for which agreement exists about effectiveness (Table 1-2).

The survey consisted mostly of close-ended questions. Participants were presented with a rating scale and asked to estimate how many women (out of 10) attending their facility would receive the recommended interventions when clinically indicated. If the response was less than 10/10, meaning that the intervention was not always used for the management of that condition, the participant was asked to identify the three most important barriers to the routine use of the intervention in their setting, and to rank them in order of importance.

A typical example of the way these questions were structured is shown below:

1. Out of 10, how many women in labour at your facility are monitored using a partograph?

[If Q1 <10]:

2. In your facility, what are the 3 most important factors preventing partographs being used for all women in labour?

A list of 32 pre-defined barriers, divided into six categories, was provided. The categories of barrier were: human resources; drugs and equipment; guidelines/policy; facility infrastructure; patient-side factors, and referral-related factors. These barriers were identified as responsible for the poor implementation of recommended obstetric practices in a systematic review of the literature on the third delay (see Section 2.2).

Participants were also given the option to enter free text if they wished to enter a barrier that did not appear in the list.

At the end of the survey, participants were given the opportunity to suggest ways to overcome the barriers they had identified using free text, and to identify the level at which these solutions should be implemented (community, facility, national, international). Participants were then given the option to take further condition-specific surveys if they wished.

An electronic certificate of participation was designed, which could be downloaded by participants once they completed the survey. Finally, participants were also able to view a list of useful online resources (relevant journal articles and e-learning opportunities), as well as a summary of the survey results for the section(s) they completed.

External Review and Piloting

The draft questionnaires were evaluated by an external review panel, the members of which were invited on the basis of their particular expertise in one or more common obstetric complication: Chris Redman (Professor of Obstetric Medicine, University of Oxford), Michael Gravett (Director of Maternal-Fetal Medicine, University of Washington), Gwyneth Lewis (National Clinical Leader for Maternal Health and Maternity Services, UK Department of Health), José Villar (Senior Fellow in Perinatal Medicine, University of Oxford), Jennifer Blum (Senior Program Associate, Gynuity Health Projects), Ana Langer (Professor of Public Health, Women and Health Initiative, Harvard School of Public Health), and Ann Blanc (Director, Maternal Health Task Force). Their feedback was incorporated into an advanced draft of the questionnaire.

Over a 3-week pilot phase, paper versions of the questionnaire were given to eight medical students going on electives in developing countries. They distributed the surveys in their hospitals and asked participants to complete a feedback questionnaire, which was subsequently used to make appropriate revisions, e.g. the use of less technical language where possible. An online version of the survey was then developed and a test-link shared with six personal contacts in developing countries who agreed to provide feedback on technical factors such as page loading times and survey skip logic.

Translation

The survey was made available in nine languages: Arabic, Bahasa Indonesia, English, French, Hindi, Mandarin, Portuguese, Spanish and Urdu. Translators were identified through contacts in the Nuffield Department of Obstetrics and Gynaecology and the John Radcliffe Hospital. Most had a medical background and all were native speakers of one of the above languages, as well as being fluent in English. Where possible the translated surveys were back-translated by an independent person to check that no errors were introduced during the translation process.

4.1.3 Data analysis

The individual facility was taken as the unit of analysis. In cases of more than one response from the same facility, mean values were calculated. If there was substantial disagreement between respondents from the same facility, participants were re-contacted for clarification.

For each intervention that was reported as non-routine (i.e. performed in less than

10/10 indications) in more than 70 per cent of the total facilities surveyed, a cumulative score was calculated for each barrier based on its frequency of selection by participants. The score was weighted by ranking position: 5 points were allocated each time a barrier was ranked 1st; 3 points for 2nd, and 1 point for 3rd. In cases of more than one response from the same facility, participants' scores were summed to determine the three most commonly perceived barriers in the facility.

All data analysis was conducted using SPSS v 19.

4.2 The crowdsourcing forum

"Crowdsourcing taps into the global world of ideas." (Evans 2008)

After completing the survey, all participants were invited to take part in an online crowdsourcing forum where they had the opportunity to submit ideas for how to overcome barriers to the provision of safe and effective obstetric care, as well as being able to discuss and rank other participants' ideas.

4.2.1 What is crowdsourcing?

Crowdsourcing, which simply refers to the act of outsourcing a task to 'the crowd' via the Internet, is a well-established method to explore problems and identify solutions, from a large online community (the crowd), rapidly and at minimal cost. It is "one of the most important trends revolutionizing the way in which the Internet is being

viewed by corporations, governments and humanitarian organisations” (Sharma 2010).

Crowdsourcing began during the 1990s but gained prominence in 2006 after an influential article was published in Wired Magazine (Howe 2006). Howe describes crowdsourcing as:

“the act of taking a job traditionally performed by a designated agent (usually an employee) and outsourcing it to an undefined, generally large group of people in the form of an open call.” (p.99)

(Howe 2008)

In its basic form, crowdsourcing invites crowds to submit, discuss, refine and rank ideas or other contributions via the Web to arrive at the ‘best’ or most-likely-to-succeed solutions (Figure 1). This is an ideal way to seek the views of large numbers of interested parties, whilst ensuring they feel that their voice has been heard and they have a sense of ownership over the finished product. Tapscott & Williams have suggested that such collaboration and peer production on a global scale:

“will harness human skill, ingenuity, and intelligence more efficiently and effectively than anything we have witnessed previously”

(Tapscott 2006).

Figure 6 Crowdsourcing – the process



Source: Chaordix™

There are an increasingly large number of examples of successful applications of the crowdsourcing framework in both business and social contexts. The concept can be applied in multiple ways for multiple purposes, enabling firms to deal with challenges of cognition, cooperation and coordination (Surowiecki 2004; Gowdy 2009). Jeff Howe describes four types of crowdsourcing strategy (Howe 2008):

1. 'crowdcreation' – the crowd takes part in a creative activity, for example the design of a new advertisement, the solving of a scientific problem, or the translation of text.
2. 'crowdvoting' – the online community makes judgments that filter and rank content submitted by others, such as music or videos, to gauge end-consumer demand.
3. 'crowdwisdom' – an attempt to harness the combined wisdom of a group of individuals rather than a single expert to solve problems or predict future outcomes.
4. 'crowdfunding' – a network of people who pool their money (or other resources) to support efforts initiated by other people or organisations.

Crowdsourcing initiatives often use competition as a motivator for participation or performance. Many prominent companies, including PricewaterhouseCoopers, Heinz, Dell and Google, have made use of crowdsourcing technology to drive profits by applying the approach to identify market trends and out-source technical tasks. Several companies that have emerged in recent years structure their whole business plan on a crowdsourcing model, for example crowdSPRING, a company outsourcing graphic design tasks to an online crowd of 80,000 graphic designers.

Crowdsourcing has also been applied in the political and public interest sectors. In the wake of the MPs' expenses scandal in 2009, the Guardian newspaper ran a

crowdsourcing exercise that employed the help of readers in sifting through nearly 240,000 pages of expense claim documents. Another successful application of crowdsourcing has been the Ushahidi mapping tool for crisis information, whereby the public send information via SMS, e-mail or web-entry, which is subsequently geo-tagged and time-stamped to create a crisis map. Aid agencies are then able to use this information to improve crisis response and manage relief efforts, for example during the 2010 Haiti earthquake. Websites such as Wikipedia and Wikileaks are also excellent illustrations of the enterprising use of crowdsourcing for information-sharing goals. The European Union has recently announced that it may use crowdsourcing to boost fight against e-crime by establishing a centre for users to report online crimes and scams (Wheeler 2010).

Crowdsourcing has proven its worth in the corporate and social sectors in terms of driving profits and improving efficiency. However, it has not yet been significantly utilised in an academic research context, although grant-making institutions, such as Ashoka and the Bill and Melinda Gates Foundation, are beginning to use decentralised and networked decision making to allocate funds.

4.2.2 What makes a crowdsourcing initiative successful?

Every crowdsourcing initiative functions in a specific macro-environment within a well-defined set of goals to achieve specific objectives. Participation in crowdsourcing initiatives is voluntary and the contribution of a diverse group of people is required for it to reach a substantial scale (Lohr 2009). Sharma has recently concluded that the key element for success is the motive alignment of the crowd with the objectives of the initiative:

"The motive of the crowd must ... be aligned with the long-term objective of the crowdsourcing initiative in order for them to contribute information (Kleemann 2008) or complete micro-tasks (Kittur 2008)... in other words they must care (Eagle 2009)."

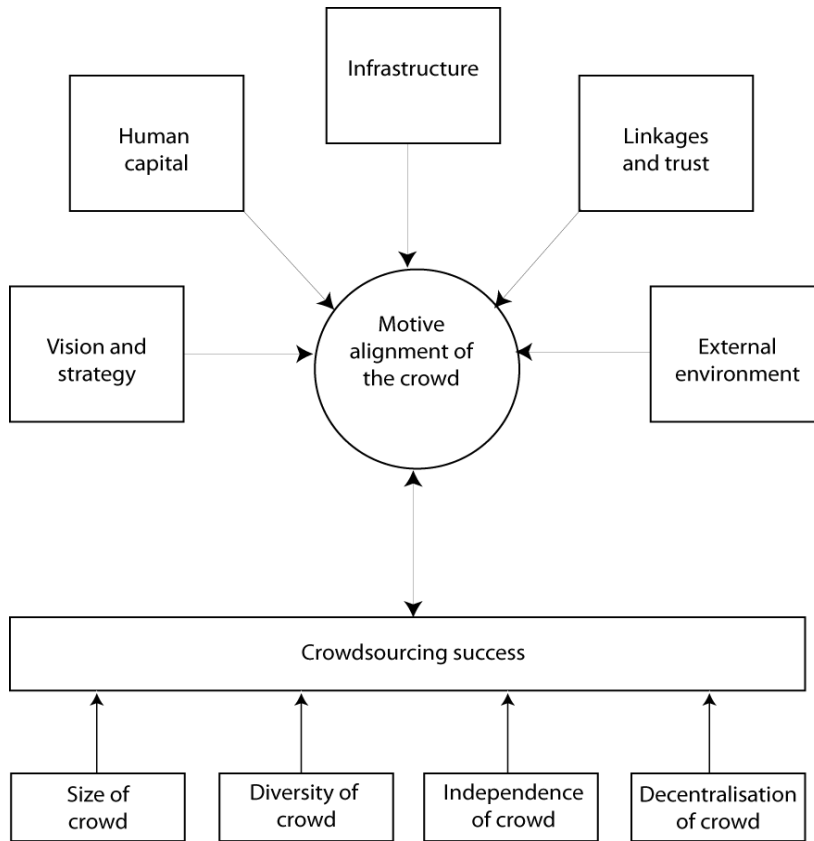
(Sharma 2010)

Motive alignment is in turn influenced by many factors, which Sharma's 'critical success factor model' takes into account. He uses the following five peripheral categories (Figure 7):

1. **'vision and strategy'** – the ideals, goals and objectives of the initiative, as perceived by the crowd.
2. **'human capital'** – the skills and abilities of the crowd processor/s or community moderator/s.
3. **'infrastructure'** – the availability of reliable and cheap Internet access.
4. **'linkages and trust'** – the development of good rapport between the crowd and the community moderators, that can be influenced by factors such as the support of external, reputable organisations, which the crowd perceives as minimizing the cost of participation.
5. **'external environment'** – the macro-environmental factors (political, economic, business and social) responsible for determining the success of the initiative.

In addition, the size, diversity, independence and decentralisation of the crowd are crucial aspects to consider when designing a scheme (Surowiecki 2004).

Figure 7 Critical success factor model



Source: Sharma 2010

4.2.3 Adapting these lessons to solve challenges in maternal health

Between June and December 2010, all survey respondents were invited to participate in a crowdsourcing consultation via an interactive web-platform. The forum was hosted at www.forum.globalvoices.org.uk. The aims of the initiative were to source new and innovative solutions to overcome barriers in the provision of maternal health services and to enable ideas to be shared across geographical boundaries. The critical success factor approach was used to develop a strategy that had the maximum likelihood of success (Table 3-2).

Table 3-2 Application of the critical success factor model

Vision and strategy	Choice of project name, logo and tag-line:  High level, compelling home page with open invitation to participate; Calls for submissions of ideas relating to nine hot-topics in maternal health. Vision statement: “To bring maternal health care providers centre-stage in international efforts to reduce maternal mortality”
Human resources	Website development outsourced to crowdsourcing experts Chaordix™ who provided training for community moderator; Expert panellists identified and approached
Infrastructure	Rapid growth of Internet accessibility across the Global South, particularly amongst educated professionals - but still poor in many rural areas.
Linkages and trust	Reputation of the University of Oxford; Linkages with (and support from) national and international organisations such as the MHTF, FIGO and ICM.
External environment	Maternal mortality high on the global health agenda; Increasing levels of funding and awareness.

During ‘calls’ (invitations to participants to submit ideas), which lasted 2-4 weeks, all participants were asked to contribute, discuss, refine and rank ideas or other contributions to arrive at the ‘best’, or most-likely-to-succeed, solutions. Nine ‘calls’ were launched in total: five on the leading causes of maternal death, and the remainder on challenges relating to: 1) human resources for maternal health; 2) transport and referral of women with obstetric complications; 3) supply of essential drugs and equipment, and 4) care of women in marginalised communities. At the end of the initiative, all participants were invited to take part in a final forum discussion to determine the usefulness of the exercise and how it might be improved.

A range of 'intrinsic' and 'extrinsic' motivating factors were employed to increase participation in the crowdsourcing forum. Participants were rewarded through a points-based system, whereby points were linked to different user statuses (e.g. new user > regular user > power user) and profile badges (e.g. the 'innovator' badge was awarded to participants who have submitted ideas and received 5 votes for their submission; the 'conversationalist' badge was awarded to participants who foster conversation and consistently add value to submission through comments). Prizes of \$50 were awarded to the winners of each 'call'. Winners were selected by members of the forum via a simple voting system.

Development of the website

The website development was outsourced to a US-based company (Chaordix™ of Cambrian House) that specialises in online crowdsourcing initiatives. Chaordix™ hosted the website and provided technical support and training through weekly teleconferences.

The major challenge was to adapt the crowdsourcing approach for a diverse group of maternal health care providers in the developing world. It was to be expected that participants in the target countries would be less computer-literate and/or familiar with similar Web-based initiatives than is typical in the Western corporate sector. With these factors in mind, a simple, lightweight, user-friendly interface was adopted to facilitate easiest-possible use by participants.

Another important consideration related to site design was the speed of Internet connection in many of the target countries, which could not be expected to compare

with UK or US broadband speeds. To overcome this challenge, the website was optimised for low-bandwidth environments by using low-resolution images and keeping page content to a minimum.

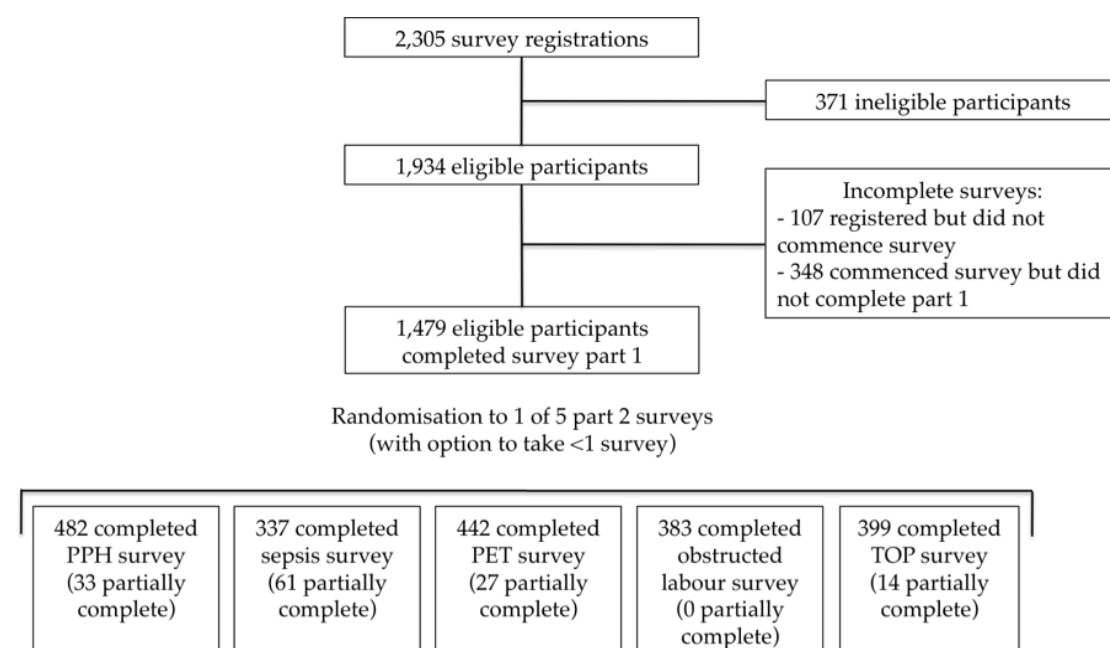
5 Results

5.1 Characteristics of survey participants and their health facilities

5.1.1 Survey participants

A total of 2,305 people registered online to take the survey. Of those who registered, 1,479 (64 per cent) completed Part 1. 371 (16.1 per cent) were not eligible to take the survey because they worked in developed countries or were not direct care providers, and 348 (15.1 per cent) did not complete the basic introductory component. 107 participants (4.6 per cent) registered and were eligible but did not commence the survey. No further information is available about these participants. All incomplete responses were excluded from subsequent analyses (Figure 8).

Figure 8 Survey participation flow chart



All 1,479 participants who completed Part 1 were randomised in Part 2 to one of the five condition-specific surveys. At the end of Part 2, they were given the option to complete additional condition-specific surveys. In total, there were 2,178 responses to

the condition-specific surveys. The breakdown of total Part 2 responses by condition was: PPH (515); sepsis (398); pre-eclampsia/eclampsia (469); TOP complications (413), and obstructed/prolonged labour (383). Forty-one per cent of the participants elected to take more than one survey.

Table 4-1 Characteristics of survey respondents, by region

Respondent Characteristic	Africa n=453	Asia- Pacific n=374	Latin America n=515	Middle East n=128	Eastern Europe n=9	TOTAL n=1479
	n (per cent within region)					n (per cent within category)
Type of provider						
Doctors: all categories	265 (59)	236 (63)	321 (63)	56 (44)	9 (100)	887 (60)
Nurses, midwives, clinical officers	188 (42)	138 (37)	194 (38)	72 (56)	0 (0)	592 (40)
Years since qualification						
≤10 years	259 (57)	183 (49)	248 (48)	80 (62)	5 (56)	775 (52)
Age						
≥30 years	351 (77)	284 (76)	401 (78)	80 (62)	9 (100)	1125 (76)
Gender						
Female	196 (43)	253 (68)	274 (53)	84 (65)	6 (67)	813 (55)
Training/practice in a developed country						
Yes	160 (35)	80 (21)	123 (24)	49 (39)	5 (56)	417 (28)

Table 4-1 shows the characteristics of 1,479 eligible participants who completed Part 1 by geographical region. Sixty per cent of respondents were medical doctors (ranging from 44 per cent in the Middle East to 63 per cent in Latin America); 76 per cent were >30 years old (ranging from 62 per cent in the Middle East to 78 per cent in Latin America); 48 per cent qualified >10 years previously (ranging from 38 per cent in the Middle East to 52 per cent in Latin America); 55 per cent were female (ranging from 43 per cent in Africa to 68 per cent in Asia), and 28 per cent had practised or trained in a developed country (ranging from 21 per cent in Asia to 39 per cent in the Middle East).

5.1.2 Facilities

The 1,479 participants were drawn from 963 birthing facilities in 99 developing

countries. The global geographical distribution of these facilities is presented in Figure 9. There were 332 facilities in Africa; 220 in Asia; 358 in Latin America; 46 in the Middle East, and 7 in Eastern Europe (Figure 10). Due to the small number of facilities from Eastern Europe, I chose not to explore this region further in the analyses.

Figure 9 Global distribution of birthing facilities included in the survey



Footnote: 963 facilities covered by the Global Voices for Maternal Health survey. Each dot on the map represents one facility (overlap occurs in some regions).

The participants reported a total of 3,146,933 deliveries in their facilities for the year 2009. The median facility-based MMRs were 400 in Africa, 178 in Asia (excluding China), 63 in Latin America, and 112 in the Middle East. The median MMR of the 35 Chinese facilities in the survey was considerably lower than the other Asian countries at 10/100,000 and Chinese MMR was therefore calculated separately.

Figure 10 Survey coverage: breakdown by geographical region

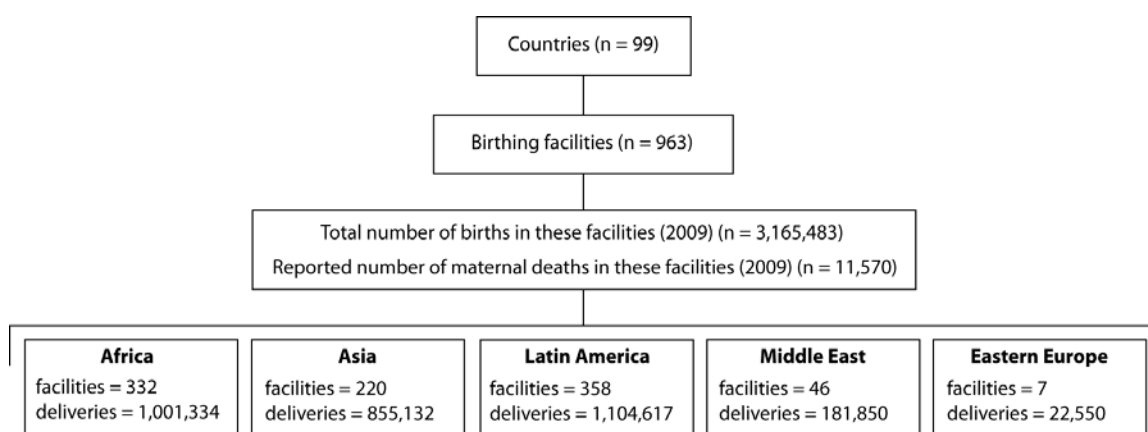


Table 4-2 presents the characteristics of the facilities surveyed according to geographical region. Across all regions, over two thirds of facilities were secondary or tertiary public hospitals reporting some teaching activity. Almost half the institutions at which participants worked conducted over 2,000 deliveries per year; this percentage was slightly higher in Asia than in the other regions.

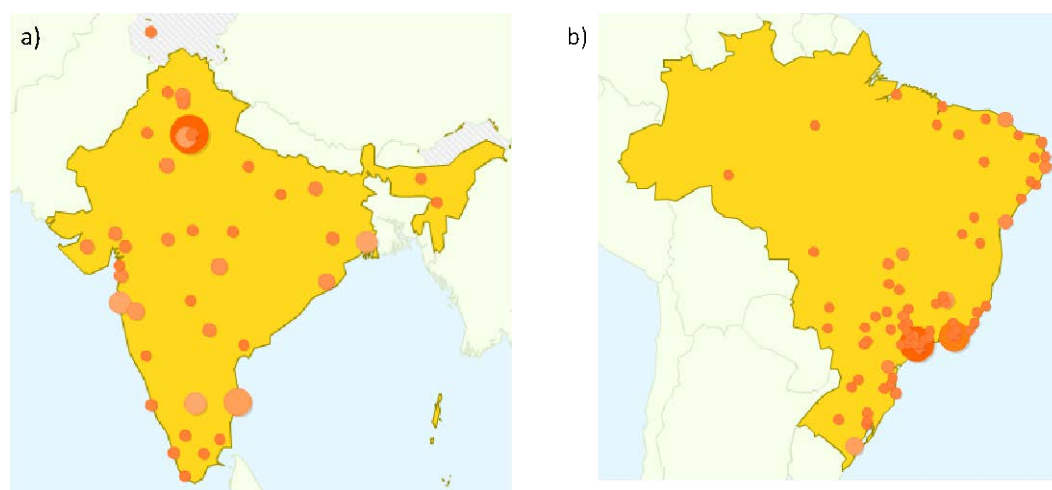
Table 4-2 Characteristics of surveyed birthing facilities, by geographical region

Facility Characteristic	Africa n=332	Asia-Pacific n=220	Latin America n=358	Middle East n=46	TOTAL n=963
	n (% within region)				
Urban	180 (54)	139 (63)	292 (81)	38 (82)	656 (68)
Public	233 (70)	159 (72)	266 (74)	38 (83)	703 (73)
Secondary/Tertiary	227 (68)	170 (77)	254 (70)	31 (67)	688 (71)
Teaching	209 (63)	135 (61)	250 (70)	33 (72)	634 (66)
Deliveries/year					
<2000	195 (59)	98 (45)	200 (56)	26 (57)	521 (54)
2000-5000	82 (25)	63 (29)	91 (25)	8 (17)	247 (26)
>5000	55 (17)	59 (27)	67 (19)	12 (26)	195 (20)
Maternal mortality ratio					
Low (<150/100,000)	103 (31)	134 (61)	244 (68)	25 (54)	511 (53)
Medium (150-500/100,000)	81 (24)	34 (16)	63 (18)	9 (20)	189 (20)
High (>500/100,000)	146 (44)	42 (19)	44 (12)	12 (26)	244 (25)
Adequate availability of:					
Personnel	48 (15)	109 (50)	45 (13)	16 (35)	220 (23)
Basic services	86 (26)	98 (45)	157 (44)	18 (39)	362 (38)
General medical services	156 (47)	147 (67)	242 (68)	28 (61)	579 (60)
Emergency obstetric care	183 (55)	172 (78)	236 (66)	31 (67)	629 (65)

As figure 11 illustrates for Brazil and India, the two countries with the largest number of participants, responses were not limited to a small number of provinces within

each country but were well-distributed over many regions. The picture was similar for the other countries with responses from more than 50 facilities: Nigeria, Kenya, South Africa, Mexico, Guatemala, and Peru. Overall, just over two thirds of facilities were located in urban areas, with some regional variation: half the institutions in Africa were rural, compared with 37 per cent in Asia, 19 per cent in Latin America and 18 per cent in the Middle East (Table 4-2).

Figure 11 Within-country distribution of survey responses in a) India, b) Brazil



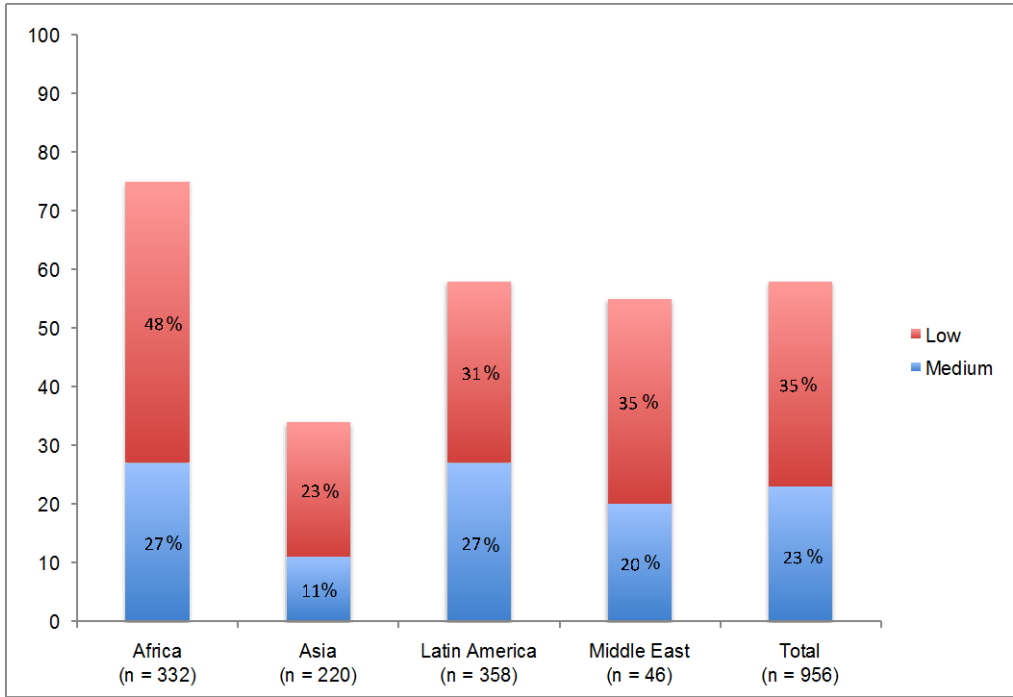
Footnote: The size of dots represents the number of participants from the region (generated using Google Analytics). Countries are not shown to scale.

Both African and Latin American facilities reported inadequate availability of personnel, at 15 per cent and 13 per cent respectively, although in Africa there was a lack of highly qualified personnel whereas in Latin America there was a shortage of lower cadres of health professional. Overall, 38 per cent of facilities were reported as having adequate availability of all the following basic services: clean water supply, sanitation facilities, electricity, refrigerator, telephone or radio transmitter, Internet, incinerator, and ambulance. Sixty per cent of facilities were reported as being able to provide basic supplies for clean delivery, equipment sterilization and a biomedical/clinical laboratory, and 65 per cent were able to provide the components of basic EmOC (Table 2-2). African hospitals had the lowest reported availability of

both basic and general medical services and EmOC. Overall, 75 per cent of the African hospitals were in the low or medium complexity category, compared with 34 per cent in Asia and 58 per cent in Latin America (Figure 12).

Across all regions, the median number of antenatal care visits attended by low-risk women ranged from 4.4 in Africa to 6.5 in the Middle East. However, the providers reported that 40 per cent of women delivering in their facilities did not start antenatal care in the 1st trimester of pregnancy. Of the facilities that provided antenatal care, the median number of recommended activities available to pregnant women attending antenatal care across all regions was 24 out of the 29, ranging from 23 in the Middle East to 25 in Asia. The activities with the lowest reported rates of implementation were: tetanus vaccination, one gynaecological examination during pregnancy, recommendations for breast-feeding and recommendations for postnatal contraception.

Figure 12 Percentage of birthing facilities by ‘facility complexity score’ category and geographical region



5.2 Implementation of key interventions

Table 4-3 shows the number and percentage of facilities in each geographical region reporting routine implementation of key obstetric interventions.

Amongst the interventions for the prevention and management of PPH, the mean percentage of facilities reporting routine implementation of an intervention ranged from 50 per cent for conservative surgical procedures such as compression sutures and arterial ligation, to 91 per cent for IV fluids to treat shock. The mean rate of routine implementation across all PPH interventions was 71.3 per cent of facilities. Close to 70 per cent of health facilities surveyed reported that they were able routinely to provide all three components of the AMTSL to prevent PPH, although 41 per cent could not provide a blood transfusion if necessary. For PPH interventions, the highest rates of implementation were reported by the Asian facilities, with the exception of blood transfusion. For three PPH interventions, the African facilities reported the lowest implementation rates; the Latin American and Middle Eastern facilities each reported the lowest rates for two interventions (Table 4-3).

Amongst the interventions for the prevention and management of puerperal sepsis, the mean percentage of facilities reporting routine implementation of an intervention ranged from 42 per cent for caring for women with sepsis in a separate room, to 77 per cent for the administration of an appropriate antibiotic regime. The mean rate of routine implementation across all sepsis interventions was 63.9 per cent of facilities. There are clear differences in the prevention and management of puerperal sepsis by region, with African and Middle Eastern facilities having the lowest rates of best practice implementation. Half the institutions in these regions reported not following

simple policies for clean delivery. In the words of one participant from Chad, “the practices of hand washing and waste management are simple gestures, but are not integrated into everyday behaviour.” Seventy-eight per cent of women with sepsis are not cared for in a separate room in Africa, and almost half the institutions in the Middle East cannot routinely provide antibiotics and IV fluids if needed (Table 4-3).

Table 4-3 Coverage of key obstetric interventions, by condition and geographical region

Recommended Intervention, by condition	Facilities reporting that intervention is routinely provided when indicated (% within region)				
	Africa	Asia-Pacific	Latin America	Middle East	TOTAL
PPH					
Injectable oxytocin after placental delivery	117/184 (64)	108/129 (84)	109/153 (71)	30/40 (75)	365/515 (71)
Controlled cord traction	121/180 (67)	101/128 (79)	95/147 (65)	31/40 (78)	351/502 (70)
Uterine massage	129/178 (73)	105/127 (83)	102/146 (70)	27/40 (68)	367/498 (74)
Injectable oxytocin to treat uterine atony	144/177 (81)	110/126 (87)	126/144 (88)	32/39 (82)	415/493 (84)
Conservative surgical procedures	77/175 (44)	83/126 (66)	58/140 (41)	22/39 (56)	415/493 (50)
IV fluids	154/173 (89)	119/126 (94)	127/139 (91)	33/38 (87)	437/483 (91)
Blood transfusion	91/174 (52)	78/126 (62)	85/139 (61)	28/38 (74)	285/482 (59)
Sepsis					
Clean delivery practices	67/144 (47)	60/81 (74)	82/115 (71)	27/55 (49)	239/398 (60)
Women with sepsis in separate room	31/144 (22)	41/81 (51)	73/113 (65)	18/54 (33)	166/398 (42)
Antibiotic regime	102/141 (72)	66/78 (85)	98/112 (88)	29/53 (55)	299/389 (77)
IV fluids	93/141 (66)	66/78 (85)	105/111 (95)	28/53 (53)	295/388 (76)
Digital exploration of the uterus	79/141 (56)	52/78 (67)	83/111 (75)	20/53 (38)	237/387 (61)
Laparotomy	82/140 (59)	44/77 (57)	86/110 (78)	20/53 (38)	234/385 (61)
Hysterectomy	87/135 (64)	54/76 (71)	99/108 (92)	19/53 (36)	263/377 (70)
Pre-eclampsia/eclampsia					
BP monitoring in 3 rd trimester	137/166 (83)	98/106 (93)	149/156 (96)	25/31 (81)	416/469 (89)
Proteinuria monitoring in 3 rd trimester	97/164 (59)	79/103 (77)	59/154 (38)	19/31 (61)	261/462 (57)
Magnesium sulphate for severe pre-eclampsia	82/156 (53)	82/102 (80)	112/151 (74)	18/28 (64)	301/447 (67)
Magnesium sulphate for eclampsia	105/156 (67)	92/102 (90)	114/151 (76)	18/28 (64)	337/447 (75)
Antihypertensive treatment for BP >110mmHg	118/156 (76)	89/100 (89)	130/150 (87)	21/28 (75)	365/445 (82)
Delivery of women with severe pre-eclampsia within 24 hours	85/156 (55)	77/99 (78)	118/150 (79)	13/27 (48)	301/442 (68)
Delivery of women with eclampsia within 12 hours	93/156 (60)	81/99 (82)	120/149 (81)	12/27 (44)	315/442 (71)
Complications of abortion					
Antibiotic regime to treat sepsis	107/150 (71)	87/100 (87)	109/129 (85)	19/28 (68)	326/413 (79)
IV fluids to treat shock	117/149 (79)	86/100 (86)	114/127 (90)	19/27 (70)	340/409 (83)
Vacuum aspiration to remove retained products	55/147 (37)	53/100 (53)	46/127 (36)	8/27 (30)	165/407 (41)
Surgical repair of intra-abdominal injuries	87/146 (60)	71/100 (71)	82/125 (66)	10/27 (37)	253/404 (63)
Family planning advice	87/145 (60)	77/100 (77)	92/125 (74)	16/27 (59)	275/403 (68)
Contraceptive provision	52/143 (36)	66/99 (67)	64/125 (51)	14/27 (52)	198/400 (50)
STI screening (including HIV/AIDS)	65/143 (46)	67/99 (68)	87/125 (70)	6/27 (22)	228/399 (57)
Obstructed/prolonged labour					
Partogram/partograph	89/149 (60)	66/77 (86)	79/127 (62)	17/24 (71)	257/383 (67)
Amniotomy for failure to progress	63/149 (42)	46/77 (60)	79/127 (62)	13/24 (54)	203/383 (53)
Oxytocin for failure to progress	79/149 (53)	40/77 (52)	95/127 (75)	12/24 (50)	229/383 (60)
Vacuum extraction	38/149 (26)	29/77 (38)	11/127 (9)	11/24 (46)	92/383 (24)
Forceps delivery	22/149 (15)	24/77 (31)	35/127 (68)	8/24 (33)	93/383 (24)
Caesarean section	89/149 (59)	43/77 (56)	98/127 (77)	13/24 (54)	247/383 (64)
Simple fistula repair	59/149 (40)	42/77 (55)	87/127 (69)	14/24 (58)	206/383 (54)

For the interventions for the prevention and management of pre-eclampsia, the mean percentage of facilities reporting routine implementation of an intervention ranged from 57 per cent for proteinuria monitoring in the third trimester, to 89 per cent for blood pressure monitoring in the third trimester. The mean rate of routine implementation across all pre-eclampsia/eclampsia interventions was 72.7 per cent of facilities. Overall, 33 per cent of facilities reported that they do not routinely offer MgSO_4 for severe preeclampsia, ranging from 47 per cent in Africa to 20 per cent in Asia. However, the same drug was reported as routinely used to treat eclampsia in 75 per cent of facilities. In Africa, only 55 per cent of the institutions surveyed were able to deliver women with pre-eclampsia within 24 hours, and only 60 per cent can deliver women with eclampsia within 12 hours (Table 4-3).

Amongst the interventions for the prevention and management of TOP complications, the mean percentage of facilities reporting routine implementation of an intervention ranged from 41 per cent for vacuum aspiration to remove RPOC, to 83 per cent for IV fluids to prevent and treat shock. The mean rate of routine implementation across all interventions for TOP complications was 63.0 per cent of facilities. The coverage of recommended interventions for the prevention and treatment of TOP complications followed a similar regional pattern as described above for the other conditions, with the African hospitals offering the lowest proportion of services routinely. Across all continents, the provision of post-TOP contraceptive methods were reported as routine practice in 57 per cent of facilities, despite the routine availability of family planning advice in 68 per cent of facilities. Post-TOP screening for STIs, including HIV/AIDS, was routinely offered in only 46 per cent and 22 per cent of institutions in Africa and the Middle East respectively (Table 4-3).

Finally, for the interventions for the prevention and management prolonged or obstructed labour, the mean percentage of facilities reporting routine implementation of an intervention ranged from 24 per cent for assisted vaginal delivery, to 67 per cent for partograph use. The mean rate of routine implementation across all obstructed or prolonged labour interventions was 49.4 per cent of facilities. The implementation rates follow the same regional pattern as above but rates were very low for several interventions, including vacuum extraction (24 per cent of facilities), forceps delivery (24 per cent of facilities) and simple fistula repair (54 per cent of facilities). Across all regions, 36 per cent of facilities surveyed reported not being able to routinely offer emergency Caesarean sections when indicated; this percentage ranged from 23 in Latin America to 46 in the Middle East (Table 4-3).

5.3 Implementation barriers

The three most common barriers identified by participants as being responsible for the 'low coverage' of key interventions are presented in Table 4-4. 'Low coverage' interventions were defined as those which were routinely implemented in less than 70 per cent of facilities surveyed (Fenn, Kirkwood et al. 2007). Barriers are presented here in the order of importance assigned by participants, with barrier 1 being the most important.

5.3.1 Barriers identified by providers

Barrier 1

Amongst the low-coverage interventions, the most commonly chosen barrier was 'the inadequate content, dissemination or enforcement of clinical guidelines' (column 4,

Table 4-4). This pattern was consistent across all regions and types of care provider. Overall, 31 per cent of participants stated that they had never seen clinical guidelines for the use of antibiotics to treat puerperal sepsis, and 24 per cent had never seen guidelines for the use of MgSO₄ to treat pre-eclampsia. In the answers to the open-ended questions at the end of each survey, issues related to all three sub-components of this barrier (content, dissemination and enforcement of guidelines) were highlighted by participants, for example: *"our guidelines are not based on the latest available evidence"* (content); *"no guidelines are available on the labour ward"* (dissemination), and *"hospitals need to set up committees to monitor the enforcement of clinical guidelines"* (enforcement).

For blood transfusion, the most common barrier was the lack of a safe blood supply or blood bank. In the answers to the free-text questions, this was largely attributed to the lack of availability of blood donors, which in turn was attributed to socio-cultural beliefs and taboos. A midwife from Nigeria commented that *"most potential donors feel it [blood donation] will reduce their strength to farm ... and so they refuse."* Moreover, some participants commented that even if blood supplies are available, the cost of buying blood is often prohibitive to women and their families. A Nigerian obstetrician stated that, *"although blood for transfusion is said to be free, the 'hidden cost' in order to access the blood is beyond the reach of poor/rural women."*

There were two surgical interventions (Caesarean section and simple fistula repair) for which the low availability was mostly attributed to 'patient-side factors', which included payment for surgery or the surgical materials. There were also two low-coverage surgical procedures (laparotomy and arterial ligation) for which the leading barrier identified was a 'lack of staff trained or authorised to carry out these procedures' (Table 4-4).

Barrier 2

The second most commonly identified barrier across all low-coverage interventions was 'lack of training or authorisation to administer the treatment or carry out this procedure' (column 5, table 4-4). Overall, 38 per cent and 14 per cent of participants had not received satisfactory training in the use of vacuum aspiration and the partograph, respectively. In explaining the poor uptake of MGgSO₄ for managing pre-eclampsia, one participant commented that, *"although agencies donate MGgSO₄, many doctors outside teaching hospitals don't know how to use it."* In the context of post-TOP care, one senior midwife complained of having *"responsibility without authority."* Several participants made specific comments about the need for high quality in-service training in their facilities. For example, one participant noted that *"on-the-job training is crucial for the majority of staff in my facility who did not have enough pre-entry practical training"* and that *"on-the-job training should be carried out for long enough to really make a difference."*

Most participants who reported that women with sepsis are not routinely cared for in a separate room identified inadequate clinical guidelines as the leading barrier but said that a lack of ward space was the second most important reason for their lack of implementation of this recommendation. Similarly, whilst most participants reported that inadequate clinical guidelines were the primary reason for the low implementation rates of proteinuria testing in the third trimester and clean delivery practices, they said that the cost of urine dipsticks and staff shortages respectively were also issues which prohibited them routinely implementing these interventions.

Barrier 3

For the third most important barrier, a new factor also emerged: 'personal preference

for another treatment considered safer or more effective' (column 6, Table 4-4). The use of out-of-date practices was identified as a problem by several participants in the open-ended questions at the end of the surveys. One said that *"older colleagues should be encouraged to embrace newer practices so that the younger providers training under them will grow up with them rather than proliferating older methods."*

Other barriers that emerged as important when participants' third selections were analysed was the shortage of equipment for vacuum aspiration and vacuum extraction and of magnesium sulphate for severe pre-eclampsia.

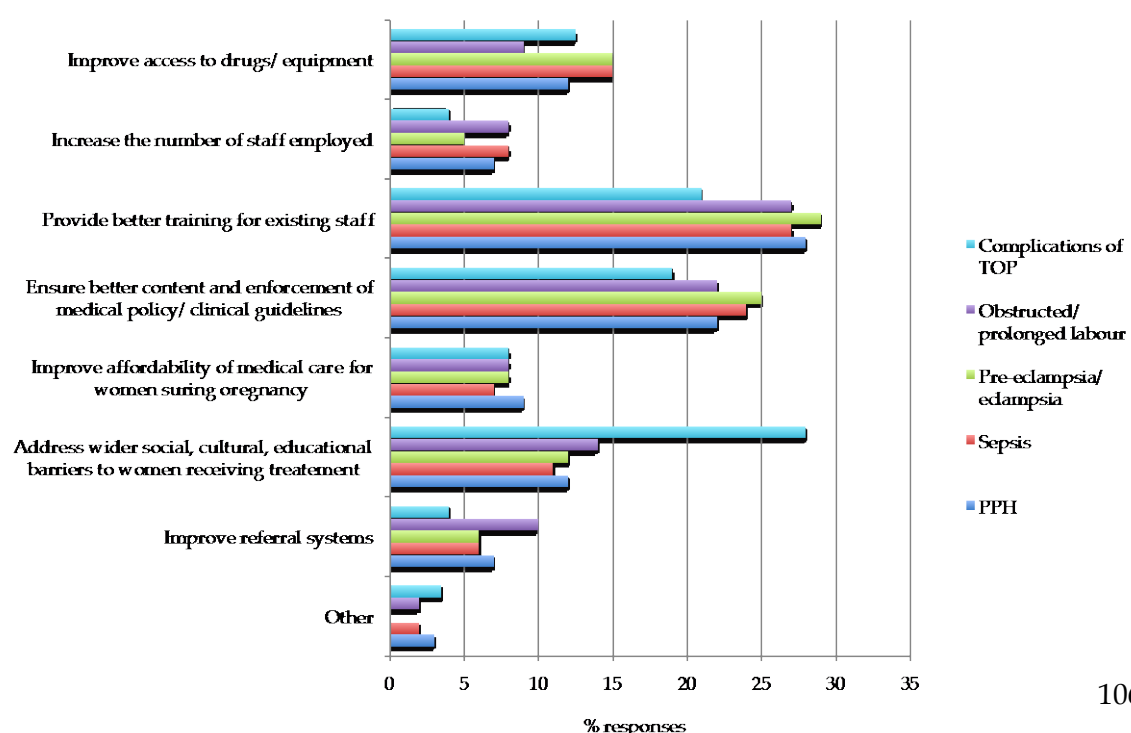
Table 4-4 Perceived barriers to the implementation of low coverage obstetric interventions

Condition	Recommended Intervention	Coverage rate (all regions)	1 st barrier	2 nd barrier	3 rd barrier
PPH	Conservative surgical procedures	50	Training/authorisation	Clinical guidelines	Personal preference
	Blood transfusion	59	Supply of blood	Patient-side factors	Clinical guidelines
Sepsis	Clean delivery practices	60	Clinical guidelines	Staff shortages	Training/authorisation
	Women with sepsis in separate room	42	Clinical guidelines	Lack of ward space	Staff shortages
	Digital exploration of the uterus	61	Clinical guidelines	Training/authorisation	Personal preference
	Laparotomy	61	Training/authorisation	Clinical guidelines	Patient-side factors
Pre-eclampsia/ eclampsia	Proteinuria monitoring in 3 rd trimester	57	Clinical guidelines	Cost of dipsticks	Training/authorisation
	Magnesium sulphate for severe pre-eclampsia	67	Clinical guidelines	Training/authorisation	Supply of magnesium sulphate
	Delivery of women with severe pre-eclampsia within 24 hours	68	Clinical guidelines	Training/authorisation	Staff shortages
Complications of abortion	Vacuum aspiration to remove retained products	41	Clinical guidelines	Training/authorisation	Broken equipment
	Surgical repair of intra-abdominal injuries	63	Clinical guidelines	Patient-side factors	Training/authorisation
	Family planning advice	68	Clinical guidelines	Patient-side factors	Training/authorisation
	Contraceptive provision	50	Clinical guidelines	Patient-side factors	Staff shortages
	STI screening (including HIV/AIDS)	57	Clinical guidelines	Patient-side factors	Training/authorisation
Obstructed/ prolonged labour	Partogram/partograph	67	Clinical guidelines	Training/authorisation	Staff shortages
	Amniotomy for failure to progress	53	Clinical guidelines	Training/authorisation	Personal preference
	Oxytocin for failure to progress	60	Clinical guidelines	Training/authorisation	Patient-side factors
	Vacuum extraction	24	Clinical guidelines	Training/authorisation	Broken equipment
	Forceps delivery	24	Clinical guidelines	Training/authorisation	Personal preference
	Caesarean section	64	Patient-side factors	Clinical guidelines	Training/authorisation

5.3.2 Providers' overall priorities

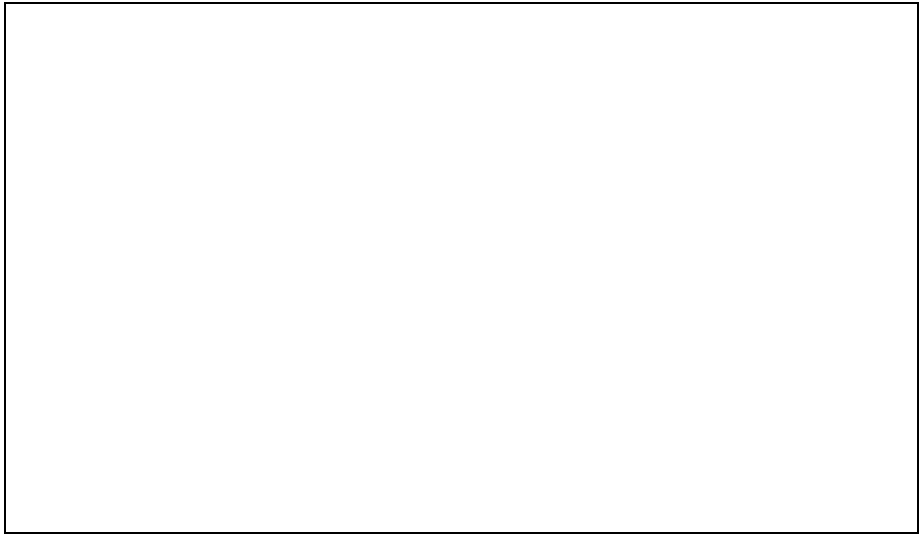
To understand providers' priorities for improving the current situation in their facilities, participants were asked to "choose one area which you think should be the top priority in order to improve the overall management of [PPH; sepsis; pre-eclampsia/eclampsia; obstructed/prolonged labour, TOP complications] in your facility." The pattern of responses was very consistent across regions for four of the conditions (PPH; sepsis; pre-eclampsia/eclampsia and obstructed/prolonged labour) (Figure 13). The most commonly identified priorities were to "provide better training for existing staff" and "ensure better content, dissemination and enforcement of clinical guidelines". Conversely for TOP complications (Figure 13), the main priorities identified across regions were socio-cultural (28 per cent of responses) in addition to training-related (21 per cent) and the need for improved clinical guidelines (19 per cent). Interestingly, for all five conditions, ≤ 15 per cent and ≤ 8 per cent chose "improve access to drug/equipment" and "increase in the number of staff employed," respectively.

Figure 13 Participants' priorities for improving the overall management obstetric complications in their facilities



the individual facility (Figure 15). However, there were important regional differences that should be considered in designing future strategies; for example, 32 per cent of respondents identified the individual facility level in Asia versus only 12 per cent in Latin America and 9 per cent in the Middle East. In Latin America, 46 per cent selected the national level as the primary target for interventions. The community level is an important sector for interventions in Africa and the Middle East (>30 per cent responses) compared to only 17 per cent in Latin America. Finally, the role of the international community was important for 23 per cent of the respondents in the Middle East, whilst this level was considered marginal in the other regions (<7 per cent).

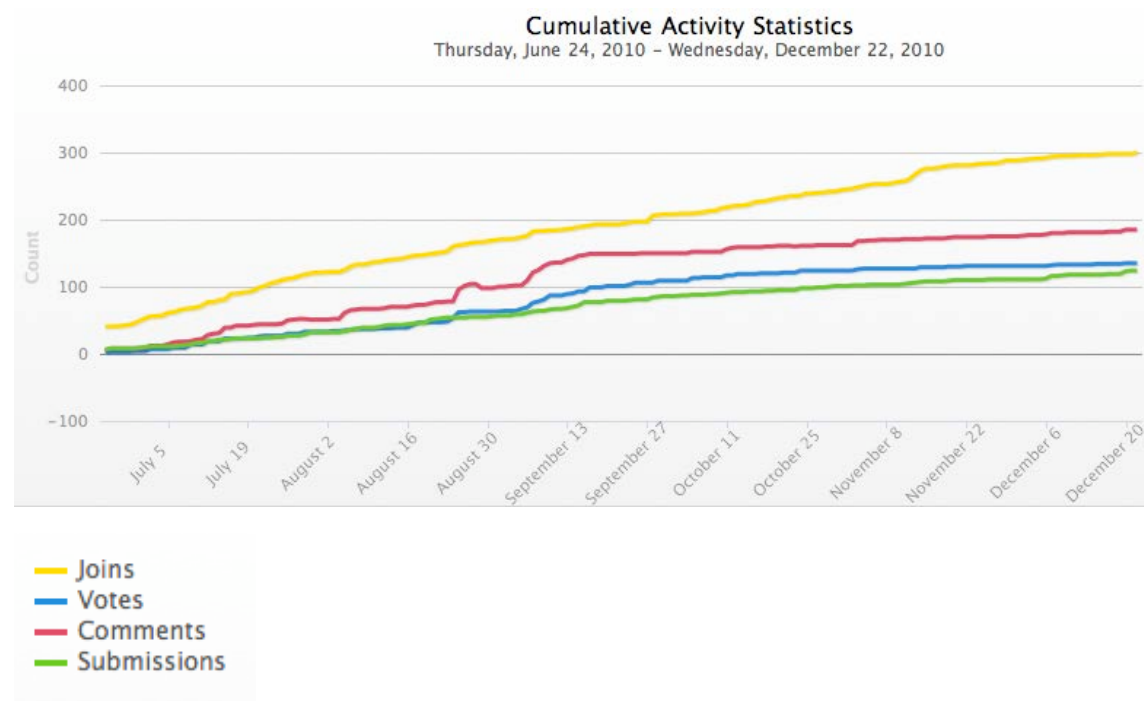
Figure 15 Participants’ priorities on levels at which action must to be taken to address implementation barriers, by condition



5.4 Crowdsourcing forum

The crowdsourcing forum was active between 24th June and 22nd December 2010. Three hundred survey respondents (20.3 per cent) joined the forum during this period. Cumulative forum activity statistics are presented in Figure 16.

Figure 16 Crowdsourcing forum activity: joins, votes, comments and submissions



Forum participants came from Africa (51 per cent), Asia (31 per cent), the Middle East (9 per cent) and Latin America (9 per cent). The professional profile of the participants was similar to the overall survey population; 66% were doctors and 34% were nurses, midwives or clinical officers.

Of those who joined, 74 (24.6 per cent) made at least one submission, 87 (29 per cent) voted at least once and 111 (37) made at least one comment. In total, 132 solutions were proposed, with a mean of 14.7 submissions per call, ranging from 5 to 24. The submissions generated a total of 141 votes (ranging from 0 to 10 per submission) and

190 comments (ranging from 0 to 7 per submission).

Twelve proposals were voted by the 'crowd' as the winning ideas as three calls had joint winners. Table 4.5 presents the titles of the winning ideas, by call topic. Of the winning submissions, ten were submitted by doctors and nine by Africans.

Whilst the majority of the winners outlined schemes designed to overcome a single issue, two of the winners proposed multi-pronged strategies: the winner in the 'Human resources' category proposed a 6 step program to improve the profile of nursing and midwifery, and similarly, the 'Pre-eclampsia/eclampsia' category winner suggested a 6-step approach to improve the early detection of pre-eclampsia in the community.

The two winning solutions in the 'Transport' category both addressed a specific regional problem, namely overcoming particular geographical barriers to transporting women by using non-traditional emergency vehicles. The remainder of the winning ideas were schemes that could theoretically be applied to a variety of settings.

Three of the winners, (the 2nd 'Transport', 1st 'Marginalised communities', and 2nd 'PPH' solutions in Table 4-5), explicitly addressed the limitations of their proposals in their original submission and suggested ways in which these could be overcome. Two of the winners (in the 'Prolonged/obstructed labour' and the 'Sepsis' category) amended their original proposals based on comments made by other forum participants.

One winning solution ('Marginalised Communities' category) outlined steps by which their program could be financed, by drawing on an example of public-private partnerships in other industries.

Table 4-5 Summary of winning crowdsourcing submissions, by topic

Topic	Winning submission	Votes	Winner's country	Winner's job title
Transport (joint winner)	Poor transport systems remain major contributors to inequitable healthcare access in general and maternal health in particular. Poor transport systems often define marginalization and remoteness. Remoteness creates further inaccessibility by scaring health providers. For example, the majority of northern Kenya is arid with poor road network connection to the rest of Kenya. Though an attempt has been made to infiltrate these regions with health centres and dispensaries, the poor road network makes referral to higher-level facilities a hazard in itself. The remoteness also scares health care workers from these regions. In Turkana, for example, there is only a single district hospital in the vastness of aridity and catchment of as wide as 400km radius. Though one or two health centres have ambulances, they are prone to breakdowns and cannot reach to more interior regions. At the same time, motorcycles have increased in this region though they have equally contributed to fatal accidents. The natives also rear camels and donkeys. My suggestion would be to create an improved interconnected cart-car transport system with a long-term solution in mind. The most remote of regions inaccessible to motorcycles would have carts that can be pulled by the camels and donkeys rather than a saddle, to offer the women comfort especially those in labour. These would transport women to areas accessible by motorcycles. Since motorcycles have caused accidents in the past and the difficulty to transport women in labour on the saddle, they would pick up the cart from the camel/donkey and transport them to areas accessible by cars, the health centre ambulance for example. Motorcycles would therefore need a little modification to enable pulling a simple cart. The ambulances would need to be improved to the status of 4WDs to minimize breakages. At the health centre, assessment would be made by the midwives and referral expedited to the district hospital. This flow would be aided by the mobile network, to avoid delays and create anticipation and readiness by the next transport level. The long-term solution would include improving the road network through bridges and tarmac/marrum, building more health facilities in more remote locations and improving the working conditions of workers in the marginalized parts of Kenya.	7	Kenya	Primary Care Doctor
Transport (joint winner)	Bangladesh is a land of rivers, canals, haor etc. In an obstetric emergency, one of the major delays is due to the non-availability of appropriate river transport to carry women from home to higher centres. The introduction of a motor launch vehicle that could rapidly reach women needing	7	Bangladesh	Medical Doctor

	emergency transport would reduce delays in reaching the necessary care. Just one boat may be sufficient to cover a large area in some sparsely populated areas.			
Marginalised communities (joint winner)	For the most severely marginalized regions, in addition to incentives being provided to health workers such as further training, hardship allowances and housing facilities, the government can partner with companies and non-governmental organizations in 'adopt-a-facility' arrangements. The government can give subsidies such as tax-relief to corporate bodies which are willing improve health access in such regions in certain health facilities or regions. Such public-private partnerships would include, for example, transport/motor vehicle assembling companies supporting provision of ambulance services; media companies carrying out public awareness on the consequences of home delivery and teenage pregnancy in the target communities. This partnership would be ideal because the companies already have corporate social responsibility, which can be channelled for such a good cause like improving maternal health in marginalized regions. It will be a win-win situation in which the companies improve their public outlook and widen their coverage, mobile providers for example. The government doesn't however abandon its obligations as the primary player. Such a model would need appropriate monitoring and evaluation. An example of a successful application of the model from another industry is the 'adopt-a-light' model which greatly improved lighting within Nairobi.	6	Kenya	Primary Care Doctor
Marginalised communities (joint winner)	Community-based health workers can be a better solution for marginalized community to access many maternal health interventions. In Rwanda we have 17,500 maternal health workers across the country, which is planned to rise to 50,000. They encourage mothers at their community to complete antenatal clinics visits, and give certain supplements like folic acid and iron to prevent anemia. Currently the MoH has started an interesting program through which maternal health workers send free SMS messages when there is an emergency. An ambulance is then sent to the pregnant woman for a quick save. With further technological innovations and investment in training, community-based health workers will be able to do even more in marginalized communities to save the lives of pregnant women.	6	Rwanda	Medical Doctor

Obstructed/ prolonged labour	My suggestion is to have an education programme to teach communities that conditions such as fistula can be avoided by not letting women labour for days before seeking medical attention. Case studies (one with a negative and one with a positive outcome) could be offered to teach about the importance of early referral. Danger signs should be taught to anyone assisting women during delivery (relatives, TBAs etc.). In addition, communities should be encouraged to introduce an emergency transport fund which all members contribute towards. At the government level, micro-loans could be made available to communities who wish to introduce such a scheme.	5	Suriname	Midwife
Human resources	Having enough motivated, skilled and friendly staff to equip the healthcare system is a real problem - especially in the rural clinics. Unfortunately, at the moment nurses and midwives (of all levels of training) in Nigeria have a bad reputation. They are seen as frequently absent, or not willingly providing the 'care' that is needed. I think that a few strategies might help in rectifying this problem. 1. Encourage the staff to spend at least one day a week in the community with the women holding antenatal education sessions. Here they can observe the mothers and babies, listen to their fears and answer questions as well as sharing health information. This will build the rapport with the community and help prevent complications, thus reduce workload on clinic. 2. Provide incentives for staff who have improved their work ethic and continued building on their knowledge and practice. Start with a basic wage and increase it with proof of the above - e.g. community commendation, workshops attended. Maybe another incentive (apart from monetary) is that they can choose their next placement or have awards for being 'mother friendly' clinic. This will also attract women to attend the clinic. 3. Every region should employ an overseer/trainer who observes clinical practice and offers workshops and continual training according to the clinics needs. They would also visit the clinics to ensure that the staff are using their newly acquired training well. And they would update them on latest research and practices.	10	Nigeria	Midwife
Drugs	One effective way of improving access to essential drugs is the establishment of community-based health network which comprises health clinics located in rural areas and volunteer community health workers (CHWs) trained to diagnose/treat priority health problems working in health post. Two CHWs (one male and one female) can work in one health post, and 10-20 health posts could be located around each clinic. To supervise CHWs activities, and provide them with technical support, one community health supervisor (CHS) can be hired in each clinic. In Afghanistan, we have currently over 22,000 CHWs supervised by CHSs (deployed in rural clinics) all over the country.	7	Afghanistan	Medical Doctor

Abortion	A priority for improving the management of post-abortion complications should be better training of healthcare providers in the use of misoprostol and vacuum aspiration for evacuating the uterus. A task-shifting approach should be applied so that senior midwives and clinical officers can perform these interventions as well as doctors. Building health worker capacity for these interventions greatly improves the management of post-abortion complications and reduces post-abortion morbidity & mortality. The training should also incorporate post-abortion family planning advice. Uptake of family planning by these clients subsequently reduces the incidence of unwanted pregnancy and thus the need for future abortions.	6	Nigeria	O&G
PPH (joint winner)	Non-pneumatic anti-shock garments (NASG) have been in use in Nigeria for about 6 years. In fact, it has helped so much that some local women think it is a form of magic the way it brings back to life women who would have died from PPH. It is non-pneumatic as opposed to the old Military anti-shock garment that use to cause gangrene as a result if it is not removed on time. The NASG can be used for as long as necessary, can be applied by anybody, requires minimal training. The only impediment is the cost, which is about \$200. Some hospitals cannot afford to buy many, however, it can be re-used after washing which is what we have been doing in my hospital. It helps to pool blood back to vital organs from the limbs & also reduce blood supply to the pelvis thereby reducing the amount of bleeding from the vagina. For many years, developing countries have decided not to put together a proper functioning blood banks but rather blood stores to cater for the numerous cases of PPH that they have. It is pertinent to note that PPH has remained the commonest cause of maternal mortality for decades in most developing countries and yet very little has been done to curb it. I think that delivery rooms should have their own blood banks separate from the entire hospital with motivated staff dedicated to respond promptly to the need of the delivery room. Antenatal patients should be made to liaise with their relatives to arrange for at least a unit of blood each before delivery to stock the bank. So that once you have donated, you are guaranteed at least one unit of blood if you need it (and since most patients do not need blood, there will be enough for those who will need more than one unit). There must be a strict rule for replacement by unbooked patients who tend to consume a greater amount of the blood. Blood bank workers must also have other schemes to get voluntary donors to donate blood for the bank through outreach programs.	9	Nigeria	O&G

PPH (joint winner)	Although, there is a great debate about safety of Tradition Birth Attendances (TBAs), due to their cultural and social acceptability to many families, they can play important roles if they are trained to provide folic acid and iron supplementation to pregnant women at the community level. This reduces the risk of anaemia which subsequently plays a role in reducing the maternal death due to PPH.	9	Sudan	O&G
Sepsis	The availability of sterile delivery essentials and a clean delivery environment reduces puerperal sepsis. The provision of disposable delivery kits containing basic sterile supplies would be very useful in many facilities. These packs are often given out to women planning home delivery, but in too many facilities the availability of sterile equipment is still a challenge. Ensuring that clean delivery practices are always followed in the facility is also related to the provider's attitude to work. Regular refresher courses and continuous auditing would help in this regard.	7	Nigeria	O&G
Pre-eclampsia	One of the major issues in preeclampsia and eclampsia management is lack of early diagnosis/ detection, especially to women living in rural communities where adequate maternal health care is scarce. My approach to tackle the problem would be to: 1. Increase community awareness of pre-eclampsia disease, specifically emphasizing on the importance of early disease detection by the recognition of danger signs and risk factors. 2. Training of Village Health workers and health care providers at all levels on the early detection of preeclampsia and how to facilitate referrals. 3. Provision and auditing of guidelines on the detection and management of pre-eclampsia at all levels of health care. 4. Enabling diagnostic services by provision and ensuring constant availability of diagnostic tools such as urine dip stick (Multistick) and blood pressure machines in all health care facilities. 5. Improve referral system and record keeping between different levels of health care and have a feedback mechanism back to the primary health care provider to ensure that patients management plans are well followed at all levels of care. 6. Make anti-hypertensive and anti-seizures drugs constantly available at all levels of health, specifically magnesium sulphate. The policy should categorically require pregnant women with hypertensive disorders to be referred to the hospital for further care after initial evaluation at the health centre and dispensaries.	6	Tanzania	Doctor

Several common themes emerged from the twelve winning ideas:

1. **CHWs.** Four of the winning ideas were projects that involved the use CHWs or TBAs: one suggested that TBAs could be trained to provide folic acid and iron supplementation in the community ('PPH' category); a second proposed a scheme in which CHWs would have access to mobile phones with a free SMS messaging service to enable them to call for back-up in an emergency ('Marginalised communities' category); a third proposed the development of a community health network staffed by CHWs ('Supply of essential drugs' category), and a forth suggested training CHWs to detect pre-eclampsia in the community using urine dipsticks and portable blood pressure monitors ('Pre-eclampsia/eclampsia' category).
2. **Novel applications of existing technology.** Three winning ideas involved the use of existing technology for novel purposes in order to overcome challenges in maternal health. One winner ('PPH category') proposed rolling out the use of non-pneumatic anti-shock garments (NASG) in more developing countries following a successful pilot scheme in their region. The NASG is an inflatable pressure suit originally used to maintain blood pressure during surgery, and later used by the American military to stabilise patients with shock. In the context of PPH it can be used to stabilise women who have lost a significant amount of blood and prevent further blood loss. A second winner proposed a scheme in which CHWs would use SMS messages to alert facilities of obstetric emergencies in the community ('Marginalised communities' category). A third proposed the use of specially adapted motor launch boats to as emergency transport for women living near rivers, as an alternative to land-based

ambulance vehicles ('Transport' category).

3. **Community engagement/education.** Two of the winning ideas involved engaging women and their families through implementing community education programmes. One winner proposed that midwives spend at least one day a week in the community conducting antenatal education classes ('Human Resources' category). It was suggested that this would help women in rural areas to establish a rapport with the medical community, and encourage them deliver at a health facility. Another proposed scheme involved teaching women to recognise obstetric danger signs through interactive classes held in the community ('Pre-eclampsia/eclampsia' category).
4. **Capacity building.** Two of the winning solutions involved the use of task-shifting concepts, i.e. expanding the human resources pool by training less-specialised health workers to perform tasks traditionally done by more highly qualified health professionals ('PPH' and 'Pre-eclampsia/eclampsia categories'). A further two winners proposed training programmes to allow health care providers to update their skills and learn new evidence-based techniques ('Sepsis' and 'Termination of Pregnancy' categories).

6 Discussion and Conclusion

6.1 Interpretation of findings

Health workers often have had limited, if any, involvement in planning national and international strategies to improve maternal health in developing countries. Meanwhile, important decisions concerning health service delivery are instead being made by those with limited, if any, experience providing frontline maternal care. This could be a major obstacle to improving the implementation of recommended interventions. In an attempt to fill this gap, the direct views of health professionals working in 99 developing countries were sought via an online survey, which was designed based on the results of a systematic literature review of facility-level implementation barriers. Participants were asked to rate the coverage of effective interventions in their institutions, and to identify the barriers that can prevent them from implementing them. The 963 institutions from which participants were drawn deliver more than 3 million women annually, approximately 3 per cent of the total number of births worldwide.

The survey results confirm the poor implementation rates of many interventions recommended for severe obstetric complications, even in large teaching hospitals. Only 42 per cent of key interventions were classified as having 'medium' or 'high' coverage, employing the same cut-offs used in a study of neonatal care interventions (Fenn, Kirkwood et al. 2007). According to the healthcare providers who responded to the survey, 41 per cent of these birthing facilities were not able to routinely offer emergency blood transfusions, and 43 per cent did not routinely screen for proteinuria in women in the third trimester. Other underutilised emergency procedures include

assisted vaginal delivery, (which was routinely available in just 24 per cent of facilities surveyed); Caesarean section for obstructed labour (64 per cent of facilities), and magnesium sulphate for severe preeclampsia (67 per cent of facilities). There was an alarming pattern of poor coverage of many low-tech interventions, such as simple clean delivery practices (routinely performed in just 60 per cent of facilities), which are theoretically feasible even in the context of very low-resource settings.

These findings further support the need for indicators that assess the *content* and the *quality* of maternal care, rather than just rates of skilled attendance at birth (Hodgins 2011). The opinions of the care providers surveyed reinforce the idea that without expanding the coverage of these interventions it is unlikely that there will be much further reduction in maternal mortality and severe morbidity.

A clear message from participants was that the inadequate ‘content, dissemination and enforcement of clinical guidelines’ was a major obstacle to the provision of effective obstetric practices. This finding is encouraging as introducing existing guidelines could be achieved in a relatively short time period; however, enforcing some aspects of recommended practice may require new resources and even structural reforms.

The other barriers most commonly identified were related to human resources, a finding which was also highlighted in the literature review. The participants also confirmed that when payment is required for services, particularly emergency or surgical procedures, many women in developing countries do not receive the life-saving treatments they need. As the literature review also highlighted, such financial barriers should not be underestimated, and those proposing market-oriented strategies for health care must be aware of these risks (Lagarde and Palmer 2008).

The appearance of ‘personal preference for another practice’ as a common barrier was a somewhat surprising response given that most of the interventions evaluated represent basic care, for which there is general agreement about effectiveness. Poor availability and quality of in-service training, lack of exposure to medical literature and the need for more clinical role models are most likely responsible for these findings (Godlee, Pakenham-Walsh et al. 2004; Conde-Agudelo 2008).

The providers had a clear message about the level at which these problems need to be addressed. Across all regions, half the respondents felt that action should be taken at a national level, rather than waiting for internationally-led solutions.

6.2 Strengths and limitations of the research

This project was unique for several reasons. First, innovative online technologies were used to provide detailed information on a large scale about the state of maternal health services in developing countries, as perceived by those who provide these services on a daily basis. The survey and forum gave a direct voice to the most crucial (yet often most neglected) set of players in efforts to improve maternal health in developing countries: those working in frontline care. It is clear that “top-down” strategies to reduce maternal mortality will not work without the involvement and commitment of such individuals.

A second advantage was that it addressed a gap in current knowledge about which barriers impede the use of particular interventions, and which areas providers think should be most urgently addressed. The opinions and perspectives of the providers

working in these facilities could usefully inform local, national and international policy designed to overcome barriers to the provision of effective and timely maternal healthcare. The survey responses also act as a form of validation of the barrier framework that was developed during the literature review: very few participants entered their own barriers using the free-text option, suggesting that the pre-defined list was comprehensive. Participants were given an opportunity to expand upon their answers in the free-text option at the end of each survey; however, no new barriers emerged during a review of these answers, even though most participants chose to answer these free-text questions.

Another major advantage of this approach was that the consultation was completed within 9 months and with a budget that can be favourably compared with the cost of any medium sized “experts” meeting in Europe or North America. This experience complements that of the 2005 WHO Global Survey (Villar, Valladares et al. 2006), and could be seen as a proof-of-concept that global online consultations can be conducted in a short period of time, at a moderate cost, allowing for active participation of those directly involved in providing health care.

A final advantage of the online consultation was its wide coverage. Participants were drawn from a very large number of health care facilities, covering approximately 3 per cent of all deliveries worldwide. In part, this was aided by the translation of the survey into several languages. Another factor responsible for the large number of participants was the use of in-country champions to help disseminate the survey invitation. In the majority of countries in which this strategy was employed, the individuals identified were highly motivated and enthusiastic. Several champions organised for computers to be available at local obstetric or midwifery congresses so that responses could be

collected. Using a monitoring tool that was available as part of the online survey, it was clear that these congresses were responsible for the large spikes in participation on the days that they were held.

There were several limitations to the survey component of the consultation. First, this was a facility-based survey, concentrating on barriers to care at the institutional level (Phase III delays), and therefore did not address important community-level or patient-side barriers such as delayed decisions to seek care or problems identifying and reaching a medical facility (Thaddeus 1994). It is true that in many of the regions in which participants worked, the majority of maternal deaths occur in the community, however, this project was designed to focus on barriers to timely and effective maternal care once a woman reaches a medical facility, which is a research area that has often been neglected.

Second, as respondents were a self-selected sample, the results are subject to selection bias and are not intended to be representative of the opinions of other health professionals in these areas. Moreover, the rates of intervention implementation were self-reported by the participants and independent verification of the data was not possible. In an attempt to compensate for this limitation, mean reported rates were used in facilities in which there was more than one response. However, it is possible that the providers who chose to participate in the survey had stronger views regarding the quality of care in their facilities (either too critical or too optimistic). Nonetheless, it seems reasonable to expect that these biases will compensate for each other to some extent and will be reduced by the fact that data were collected anonymously. Participants were also randomly allocated to condition-specific surveys to avoid any “pet” condition bias.

Obtaining a truly representative sample of maternal healthcare providers in the developing world using online methodologies would have been a near impossible task, even if unlimited resources had been available for the research. Accepting that the survey sample, was not representative, the opinions of the individuals who participated should not be extrapolated to represent either the true care provided in their facilities, or the care provided by other institutions in the geographical region. Nevertheless, as respondents were staff in these institutions and independent of each other, it is unlikely that there was a systematic bias in the figures other than some underreporting of maternal deaths and over-estimation of intervention coverage. The respondents also reported MMRs for the institutions surveyed that ranged from a median of 400 in the African countries to 63 in Latin American countries. These values are consistent with the median MMR values recently estimated for the same countries in these regions (560 in Africa and 55 in Latin America) (Hogan, Foreman et al. 2010) suggesting that in fact a fairly representative set of facilities was studied.

Although almost 1,500 providers completed the survey, more responses were originally anticipated. One of the reasons for this outcome was the limited number of direct maternal health care providers on the mailing lists of many of the organisations contacted. Although some organisations showed considerable enthusiasm for the initiative, disseminating the invitation to participate via their mailing lists was not always followed by an increase in participation. A number of the national professional associations for obstetrician/gynaecologists and midwives that were contacted acknowledged that they did not hold up-to-date contact details of their members, or even a record of how many members they had, suggesting that they may in fact be 'membership organisations' in name alone.

The feedback from participants also revealed that the length and complexity of the survey discouraged some people from completing it. A certificate of participation was offered to all participants but this may not have been sufficient motivation. This risk was recognised during the design phase but it was felt that a shorter survey would not provide the detailed information required to answer the research questions in a meaningful way. The fact that 41 per cent of participants chose to take more than one condition-specific survey suggests that the length of the survey was not a problem for those that did not experience technical difficulties. Another important consideration was the speed of Internet connection in many of the target countries. During the survey development phase, I investigated whether it would be possible to enable participants to download the survey and complete it offline, uploading it again once complete; however, unfortunately this option was not available at the time. To overcome the challenge of poor Internet connectivity, the website was optimised for low-bandwidth connections; nonetheless, in many developing countries access to the Internet is still intermittent at best.

There were some additional strengths and limitations that were specific to the crowdsourcing forum. The main limitation of the forum was that although it generated numerous potential solutions, ranked in order of popularity, it could not demonstrate whether the winning solutions would be effective if implemented. The exercise did, however, act as a proof of concept that online technologies can be used to reach this audience and are a potential source of innovative ideas, some of which could be developed into successful pilot projects. Drawing on the success of this project, the Women and Health Initiative at Harvard University, in collaboration with the University of Oxford, has recently begun developing *BetterCareTogether* - an innovative

system that uses social media and crowdsourcing technology to match providers looking for ways to strengthen certain maternal healthcare practices to providers able to suggest practical solutions, therefore creating a global virtual network of connected providers.

A second limitation was the relatively small number of forum participants compared with survey participants; just 20.3 per cent of the survey participants joined the forum. To be successful, crowdsourcing must attract a critical mass of participants (Alonso, Rose, & Stewart, 2008). In this case it could be argued that a critical mass was not reached. One explanation for this may be that the crowdsourcing forum was only conducted in English, thereby effectively excluding participants who did not speak the language. This may also explain why there was better participation from Africa than the other regions where English is less commonly spoken, particularly Latin America. Despite this obvious limitation, conducting forums in multiple languages would not have been possible with the resources and human capital available for this research. Furthermore, even if having multiple forums was feasible, this would not have enabled participants speaking different languages to communicate directly with one another. Another explanation for the low participation rate might have been that, although the website was optimised for low bandwidth environments, a significant portion of the community lacked the appropriate computer skills to interact with the service. Although, in an ideal scenario, the crowd should be able to use the forum without having prior experience, in this case it may have been beneficial to provide further training for participants in the form of an interactive manual.

Further possible explanations for the limited success of the forum include the lack of engagement of the expert panellists and insufficient incentives. Perhaps more

fundamentally, however, there was a lack of process for taking forward the winning solutions once they were selected. This was a proof of concept study and as such it demonstrated that the use of crowdsourcing is feasible in developing country settings; however, successful crowdsourcing should be about more than just getting people to suggest ideas to a common online area. The following advice may be useful for those wishing to undertake crowdsourcing initiatives in future:

“Crowdsourcing is a well thought-out process (ahead-of-time) where there are specific stages of idea submission, enhancement, and selection by the crowd, a panel, or combinations of both. It requires having specific goals for the crowd to accomplish. It involves communication mechanisms that provide just the right amount of information to keep people in the loop and participating, without overwhelming them. It incorporates incentives that make participating rewarding and fun. And its also about making the goal, process and incentives transparent, so everyone knows how it’s going to work, how long it’s going to take and what the outcome is going to be. It’s about getting the crowd to collaborate with a specific purpose in a specific period of time, with a technology platform and moderation that provide the essential ingredients.”

(Corke 2011)

Of those who joined the forum, active engagement (i.e. submitting ideas, commenting and voting) was limited to approximately one third of members. Although this may seem low, the ‘1-9-90’ rule of thumb, states that most online communities can expect approximately 1 per cent of members to become highly active, 9 per cent to become moderately active and the remaining 90 per cent of members to be infrequent participants (Corke 2010).

Despite the limitations associated with this methodology, it has strong advantages over traditional approaches that do not attempt to involve providers ‘on the ground’. The ideas submitted by participants via the crowdsourcing forum were wide-ranging and triggered considerable discussion between members. Overall, there was strong

support for the process. At the end of the exercise, one participant commented:

“This is the first time I have been able to participate in this type of forum ... It has been good to read about other peoples’ ideas and experience and the discussions have given me many things to think about.”

Another participant left the following feedback:

“It was a great idea and I think it would be great to continue having a forum like this for health professionals to be able to bounce ideas off one another.”

As far as I am aware, this is the first time that crowdsourcing technology has been applied to health services research in the developing world. Although the methodology has been widely used in the commercial and political sectors, and to some extent in academic research (Raddick 2010), its potential in clinical medicine and public health has yet to be tapped. It is certainly possible that crowdsourcing could be usefully applied to other areas of medical and public health research to find innovative and locally-appropriate solutions to longstanding challenges. Initiatives such as this could play an important role in encouraging south-to-south sharing and promotion of ideas, expanding the use of strategies that have been effective in some settings, or reducing the use of ineffective or harmful interventions.

One of the most interesting aspects of crowdsourcing is its ability to transcend geographical and socio-economic barriers using online technologies. A key factor to consider when designing a crowdsourcing initiative is the need to develop a strong relationship between the ‘crowd’ and the moderators. It is critical that the crowd is seen as a partner in the crowdsourcing initiative. As Sharma states, “the needs, aspirations, motivations and incentives of the crowd to participate in the initiative must remain the most important consideration while developing the crowdsourcing

initiative.”

It is important that future research in this area addresses issues such as the incentives and motivation for the crowdsourcing participant, the reliability of the user content generated, and, importantly, the impact of these initiatives, looking beyond just the number of participants or ideas submitted. At present there is a shortage of publications on failed crowdsourcing projects, and this would be an extremely useful source of information for those wishing to design new initiatives.

Why did the three different studies produce such different results?

Interestingly, the three components of this research (the literature review, online survey and crowdsourcing forum) produced considerably different results regarding the relative importance of barriers to maternal health care in developing countries.

Whilst barriers related to the inadequate content and dissemination of clinical guidelines did not feature as a principal barrier in the literature review findings, the survey participants highlighted this as an overall priority area. On the other hand, whilst human resource factors such as lack of motivation and inadequate supervision were cited in a number of articles, survey participants rarely identified these barriers as being responsible for the lack of implementation of specific interventions, nor as overall priority areas.

This disparity reflects the lack of generalisability of each research component. For instance, articles included in the literature review were often biased towards particular issues. Many of the papers had an explicit focus on human resource issues, whereas

few papers concentrated on clinical guidelines to the same extent. Geographical differences may also explain some of these differences: whilst the majority of papers included in the review were from Africa, a large portion of survey respondents came from Latin America and Asia. Alternatively, the different findings may suggest a tendency for health care providers, when surveyed, to blame factors that they perceive to be beyond their control, as opposed to factors related to their own lack of training, skill, motivation, or failure to keep abreast of scientific developments.

Interestingly, many of the winning crowdsourcing ideas were not related to overcoming phase III delays but rather to community-level barriers. This suggests that providers believe that a significant portion of the deaths taking place in facilities could be prevented if earlier action was taken at the community level. It is indeed true that in many developing countries the majority of maternal deaths occur at home or on route to a health facility. However, the articles included in the literature review also found that 57-87% of maternal deaths in facilities were attributable to the third delay. One potential explanation for the lack of proposed solutions to tackle the third delay may be that providers underestimate the extent to which it feeds back to influence delays I and II.

Although the three components produced differing results, by bringing these results together it is possible to build up a more holistic view of how maternity care in developing country settings might be improved. Future research in this area will need to examine the extent to which other relevant groups, for example hospital managers, pharmacists, policy makers and patients, agree with the assessment of the frontline maternal health care workers regarding the barriers to appropriate and timely care.

6.3 Final thoughts

I believe that in future, the views of direct health care providers should be routinely included in the development of national and international strategies to implement best practices in maternal health care and in decision-making at all levels of the health service. The technology is already available for such direct participation: we must listen to, and learn from, those at the clinical and public health frontline. Without addressing the current 'disconnect' between decision makers and frontline health care staff, it seems unlikely that further progress towards reducing maternal mortality and severe morbidity will be made.

As a final point, during the preparatory phase of this project, one member of the expert review panel advised the inclusion of women and their families in the consultation - after all, these are both the most important and the most neglected voices. On this occasion, neither the resources nor the expertise for such a complex field approach were available. However, researchers working in this branch of health service research should focus on designing studies that examine women's own perceptions of the barriers they encounter and their ideas for overcoming them, as well as patient-reported outcome measures for maternal health care. Such an approach would compliment the findings of this research and would be a logical next step towards the democratisation of global efforts to improve maternal health.

6.4 Key Recommendations

1. The development of indicators to measure the content and quality of maternal health care, rather than simply rates of skilled attendance at birth, should be a priority research area. Governments should be encouraged to play a greater role in monitoring the coverage of key maternal health interventions in their countries. One recommended strategy is the mapping of BEmOC and CEmOC facilities, which allows governments to evaluate the unmet need for these services and assess whether appropriate referral systems are in place to get women to these locations in a timely way.
2. Participants reported low implementation rates of many internationally-recommended obstetric practices, including low-tech interventions. Implementation research is a field that requires more attention and investment. There may be much that the maternal health field can learn from related fields, such as newborn and child health, which have been more successful in reducing morbidity and mortality. An important step for maternal health care is the development of packages of interventions that address the multiple, and often overlapping, needs of pregnant women.
3. The inadequate content, dissemination and enforcement of clinical guidelines were identified as major barriers by participants. Developing locally-appropriate, nationally endorsed clinical guidelines for emergency obstetric care is a priority. Where they exist, national societies could play a much greater role in the production and dissemination of these guidelines. Furthermore, efforts should be made to strengthen the capacity of national professional

associations to provide continuous professional education and to influence national policy makers regarding maternal health issues.

4. Several themes related to human resources for maternal health care emerged from this research, including the inadequate numbers being trained, the quality of training and continuous learning, and skill-mix and distribution. Key strategies to address these issues include increasing the volume of health care professionals, providing incentives for maternal health care workers to remain in the country after training, particularly in rural areas, and a greater emphasis on task shifting and expanding the clinical officer training programme.
5. Crowdsourcing technology has the potential to become a valuable tool for global health projects. The views of direct health care providers must be routinely included in the development of strategies to implement best practices in maternal health care. Grant-awarding bodies could benefit from using this methodology to invite submissions from innovative individuals 'on the ground' in developing countries. Winning ideas could be developed into pilot projects with input from funders and research methodologists.
6. More developing countries should be encouraged to undertake regular audits, and where possible full confidential enquiries into maternal deaths. Adapted versions of the traditional confidential enquiry methodology, which include near-miss events, may also be appropriate in some settings. These audits would provide a valuable source of data for monitoring the major causes of maternal death, and the relative contribution of the three delays. For maximum impact, countries should be given assistance during both the design and

implementation phase by researchers with experience of conducting these audits in similar settings.

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Appendices

Appendix 1. Systematic Literature Review: Search Strategy Example (Pubmed)

1. Delivery of Health Care [MH]
2. Health Services Research [MH]
3. Health Care Surveys [MH]
4. Health Policy [MH]
5. Manpower [MH]
6. Equipment and Supplies [MH]
7. #1 OR #2 OR #3 OR #4 OR #5 OR #6
8. barrier* [tiab]
9. delay* [tiab]
10. hurdle* [tiab]
11. prevent* [tiab]
12. shortage* [tiab]
13. lack [tiab]
14. quality[tiab]
15. #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14
16. #7 OR #15
17. Maternal Health Services [MH]
18. Postnatal Care [MH]
19. Prenatal Care [MH]
20. Perinatal Care [MH]
21. Maternal Welfare [MH]
22. Maternal Mortality [MH]
23. Delivery, Obstetric [MH]
24. Pregnancy Complications [MH]
25. #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24
26. maternal health [tiab]
27. matern* care [tiab]
28. intrapartum [tiab]
29. EmOC [tiab]
30. obstetric [tiab]
31. #26 OR #27 OR #28 OR #29 OR #30
32. #25 OR #31
33. Maternal-child Health Centers [MH]

34. Obstetrics and Gynaecology Department [MH]
35. Hospital [MH]
36. Hospitals [MH]
37. Birthing Centers [MH]
38. Rural Health Services [MH]
39. Urban Health Services [MH]
40. Hospitals, rural [MH]
41. Hospitals, urban [MH]
42. Midwifery [MH]
43. Maternal-child Nursing [MH]
44. Obstetrical Nursing [MH]
45. #33 OR #34 OR #35 OR #36 OR #37 OR #38 OR #39 OR #40 OR #41 OR #42 OR #43 OR
#44
46. Developing Countries [MH]
47. Africa [MH]
48. Asia [MH]
49. Central America [MH]
50. Latin America [MH]
51. South America [MH]
52. Caribbean Region [MH]
53. #46 OR #47 OR #48 OR #49 OR #50 OR #51 OR #52
54. less-developed countries [tiab]
55. third world [tiab]
56. low-income countries [tiab]
57. developing world [tiab]
58. low-resource [tiab]
59. #54 OR #55 OR #56 OR #57 OR #58
60. #53 OR #59
61. #16 AND #32 AND #45 AND #60

Appendix 2. Systematic Literature Review: Barrier Data Extraction Spreadsheet

[illegible]

	Barnes Hospital (1998)	Cham Hospital (2005)	Cham Hospital (2009)	Chon Hospital (2010)	Arande Hospital (2008)	Comde Hospital (2008)	Tikree Hospital (2006)	Kawu Hospital (2006)	Kongu Hospital (2008)	Mfina Hospital (2009)	Nyam Hospital (2008)	Nyang Hospital (2010)	Orji Hospital (2007)	Pearse Hospital (2004)	Pichu Hospital (2006)	Pichu Hospital (2010)	Ridge Hospital (2010)	Seven Hospital (2009)	Tita Hospital (2005)	Umasa Hospital (1997)	Ziraba Hospital (2009)	Sub-total (1)	Sub-total (0.5)	Grand Total
Drugs and Equipment	0.5	1	1	0.5	1	1	1	1	0.5	1	1	1	1	1	1	1	1	1	1	1	1	33	5	38
Cost issues			0.5												1	1		1	1	1		7	1	8
Inadequate drug supply/ logistics problems		1	1	0.5		1	1			1	1			1	1	1	1	1	1	1	1	26	2	28
Inadequate storage (e.g. fridge/secure cabinet)			1							1												2	3	
Not registered for indication/not registered for this indication																	1	1						
Lack of equipment	0.5			0.5		1	1				1			1	1	1	1	1	1	1	1	18	4	22
Equipment available but not used/faulty/poorly maintained				0.5																	1	5	1	6
Lack of blood		1	1										1	1		1					1	13	0	13
Guidelines/Policy					1	0.5			0.5	1	1			1		1	1	1	1	1	1	24	4	28
Clinical guidelines do not exist/ are out of date/ ambiguous										1	1						1	1				7	1	8
Clinical guidelines are poorly disseminated/not enforced											0.5			1			1	1			1	6	3	9
Poor hospital policy					1											1	1				1	13	0	13
Preference of staff for other (non-evidence-based) treatment/s				1					0.5	1						1	0.5	1	1			8	2	10
Human Resources	1	1	1	0.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	39	1	40
Staff shortages		1	1	0.5		1	1	1			1			0.5		1		0.5	0.5	1	1	18	7	25
Issues related to quality of training/skills/mix	1	1	0.5	0.5	1	1	1	1	1	1	1			1		1	1	1	1	1	1	32	4	36
Staff motivation issues																								
Inadequate supervision	1	0.5			1			1			1			1	1	1				1		16	3	19
High workload					1											0.5			1		0.5	5	5	10
Authorisation to perform certain tasks																								
Absenteeism																						2	2	4
24-hour availability of staff	1							1						1		0.5				0.5	0.5	8	3	11
Management issues		1														1						3	0	3
Facility Infrastructure	1	0.5		0.5	1	0.5	1	0.5			1	1	1	1		1			1	1		17	8	25
Lack of beds/ward space				0.5	1	0.5										1						2	2	4
Power/water shortages	1							1			1	1	1	1		1						8	1	9
Surgical facilities	0.5			0.5			0.5	0.5			1	1	1			0.5			1	1		6	10	16
Transfusion facilities				0.5			1				1					1				1		6	2	8
Laboratory facilities																						1	1	2
Patient-side	1		1		1				1						1				1			12	0	12
Cost-related	1		1												1				1			8	0	8
Social/cultural/religious					1			0.5														4	1	5
Referral	1	1					1	1		1	0.5		1						1	1	1	13	2	15
Distance-related	1	1						0.5			0.5			1								3	3	6
Road infrastructure	0.5	0.5																				0	2	2
Inadequate emergency transport	1	1					1	1			1			1						1	1	11	0	11
Fuel availability	1	1									1											3	0	3
Poor communication								1			1			0.5								4	7	11

Footnote: A figure '1' in a cell indicates that a factor was explicitly cited as a barrier; '0.5' indicates that the reviewers inferred from the article that a factor was a barrier

Appendix 3. Sign-up page (including informed consent)

Are you eligible?

Anyone **directly providing medical care** for women during pregnancy and childbirth in **developing countries** can take part.

If you are not eligible to take the survey, but are interested in getting involved, please [join the forum](#).

Username:

(Username: This is the name that others will see you as in the Forum)

Email:

Password:

Confirm Password:

Preferred Language:

☐ **I agree to these terms:**

- I have read the 'How It Works' page and understand the purpose of the project and how I will be involved.
- I understand that all information collected in the survey will be held in confidence and that, if it is presented or published, all my personal details will be removed.
- I confirm that I will be taking part in this project of my own free will and that I can discontinue the survey at any time.
- I give permission for responsible members of the University of Oxford to access data for the purpose of monitoring and audit.

We will send a confirmation link to the email address you provide.

Signup and take the survey now

Appendix 4. Participant information page

How It Works

How do I join?

To register on our website you just need to [create an account](#) and complete a 2-part survey.

What will the survey ask me?

After registering, you will be taken to the survey section of the website where we will ask for some general information about you and your place of work. There is the option to complete the survey in a range of languages.

You will be asked whether a number of interventions are used at your health facility. If some are not available, we will ask you the three most important reasons why not. You can then suggest ways to overcome these problems.

Once you have completed the survey, you will instantly be able to see a summary of the most up-to-date global results and receive a Certificate of Participation.

When can I participate in the Forum?

After you have finished the survey, you will be invited to visit the Global Voices for Maternal Health Forum. Here you can share ideas about improving maternal healthcare with hundreds of other professionals all over the world. A panel of experts will then search the Forum for the best ideas, and every 2-4 weeks new discussion topics will be posted for you to vote upon. Unfortunately, it is only possible for these discussions to take place in English.

Will my privacy be protected?

We take our duty of confidentiality to you very seriously. Your answers to the survey will be kept anonymously in a database that only the research team has access to. You do not have to provide your name, but if you choose to, it will not appear in any report or publication unless you agree to be on the list of contributors. In the Forum you will be able to comment anonymously if you wish.

What will happen to the results?

A summary of the survey results will be shared with all participants via the website, and distributed widely amongst the international health community. The results will be published in scientific journals and presented at international meetings. Some of the data from the study may be included in the MSc thesis of one of the researchers.

Appendix 5. Formulae for selection of target countries

Africa

The following formula was applied to all countries in Africa:

Formula:

20 with highest MMR (>880)

OR 20 with highest total maternal deaths (>4100)

AND Population >16 million

The following countries met the requirements:

Country	No. of maternal deaths	Maternal deaths rank in Africa	MMR	MMR rank in Africa	Population (thousands)
Angola	11000	6	1400	4	17,555
Cameroon	5700	12	1000	13	18,660
Cote d'Ivoire	5400	13	810	24	20,123
DRC	32000	2	1100	9	62,523
Ethiopia	22000	3	720	26	78,646
Kenya	7700	8	560	32	37,755
Nigeria	59000	1	1100	12	147,722
South Africa	4300	19	400	41	49,173
Sudan	5300	15	450	39	40,432
Tanzania	13000	5	950	18	41,276
Uganda	8100	7	550	33	30,638

Asia

The following formula was applied to all countries in Asia:

Formula:

20 countries with highest MMR (>130)

OR 20 countries with highest total maternal deaths (>340)

AND Population > 100 million

The following countries met the requirements:

Country	No. of maternal deaths	Maternal deaths rank in Asia	MMR	MMR rank in Asia	Population (thousands)
Bangladesh	21000	3	570	4	157 753
China	7800	6	45	34	1 329 090
India	117000	1	450	6	1 164 670
Indonesia	19000	4	420	9	224 670
Pakistan	15000	5	320	13	173 178

Middle East

The following formula was applied to all countries in the Middle East:

Formula:

5 countries with highest MMR (>64)

OR 5 countries with highest total maternal deaths (>99)

AND Population > 20 million

The following countries met the requirements:

Country	No. of maternal deaths	Maternal deaths rank in the Middle East	MMR	MMR rank in Middle East	Population (thousands)
Afghanistan	26000	1	1800	1	29 803
Iran	1900	4	140	5	72 437
Iraq	2900	3	300	3	29 486
Saudi Arabia	120	6	18	11	24 680
Syria	700	5	130	6	20 504
Yemen	3600	2	430	2	22 269

Latin America

The following formula was applied to all countries in Latin America:

Formula:

5 countries with highest MMR (>280)

OR 5 countries with highest total maternal deaths (>1300)

AND Population > 12 million

The following countries met the requirements:

Country	No. of maternal deaths	Maternal deaths rank in Latin America	MMR	MMR rank in Latin Am.	Population (thousands)
Brazil	4100	1	110	15	190,120
Guatemala	1300	4	290	3	13,354
Mexico	1300	5	60	18	107,487
Peru	1500	3	240	6	28,508

Appendix 6. Invitation email

Announcement: New Study from the University of Oxford seeks the Views of Maternal Health care Providers

Calling all Maternal Health care Providers working in Africa, Asia, Latin America or the Middle East...

"What are the problems you face?" "How can these be solved?"

This is your opportunity to make your voice heard!

For the first time ever on this scale, 'Global Voices for Maternal Health' www.globalvoices.org.uk will give thousands of midwives, nurses and doctors around the world a direct voice about the barriers they face in delivering lifesaving maternal health care via an online survey and discussion forum. There will be a strong focus on identifying solutions to longstanding barriers in the delivery of maternal care.

In so doing, we hope to increase the participation and involvement of those working on the ground and give them a direct voice. Although - as we all know - health care providers are the key to any successful maternal health programme, too rarely have their views been sought in a structured, dedicated way so as to provide a useful body of evidence about their perspectives on the problems and solutions.

We know how precious your time is so as a reward for taking part all participants will get:

- A Certificate of Participation from the University of Oxford and the opportunity to have your name included in the list of contributors accompanying future publications.
- An instant summary of the most up-to-date results of the surveys you've taken.
- Access to an online resources page.
- The opportunity to take part in the search for solutions, and discuss the problems you face with other health care providers and leading international experts in the Forum.

And winning ideas in the discussion forum will receive cash prizes of between \$50 and \$100!

Visit www.globalvoices.org.uk now to have your say and become part of Global Voices for Maternal Health.

Please also share this email with any friends and colleagues who might be interested in taking part.

If you are not a maternal health care provider but would like access to the discussion forum, you can do so by visiting www.forum.globalvoices.ox.ac.uk

If you have any other questions, please email us at global.voices@obs-gyn.ox.ac.uk

Appendix 7. Personal contributions to the research

Literature Review

- Conceived the idea
- Developed the search strategy
- Screened the titles and abstracts
- Extracted the data
- Conducted the analysis
- Wrote up the findings

Survey

- Designed and piloted the survey
- Designed promotional strategies
- Implemented promotional strategies e.g. contacting organisations / potential participants
- Conducted the analysis

Crowdsourcing Forum

- Selected the call topics
- Moderated the forum
- Implemented strategies to increase user engagement
- Conducted the analysis