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ENHANCING SURVIVAL OF MOTHERS AND THEIR NEWBORNS IN TANZANIA

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This thesis is dedicated to my late wife
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ABSTRACT

General aims: The main purpose of the present studies was to examine the problem of maternal and perinatal mortality in an upcountry region of a low-income country. This was done by estimating the magnitude of maternal and perinatal mortality, both in the hospital and in the community, through elucidating the underlying causes of maternal and perinatal mortality, and by initiating low-cost interventions and monitoring mechanisms in order to enhance the survival of mothers and their newborns, in Kigoma, Tanzania.

Specific aims: To utilise all available evidence to register the causes, contributory factors and real magnitude of maternal mortality in a regional hospital as well as to estimate the magnitude of maternal mortality in the community. To formulate low-cost interventions to address the identified contributing factors to maternal mortality and to follow these interventions over time. To perform regular audits of the causes of maternal mortality in order to elucidate avoidable causes. To monitor and adjust the interventions during the study period, while assessing the impact of these interventions. To investigate the suspected causes of obstetric risk knowledge among community members, health workers, and traditional birth attendants. To assess the utilisation of the simple "three phases of delay model" in the audit of maternal and perinatal mortality.

Methods: A retrospective analysis of mortality in the hospital setting utilising all available evidence was undertaken for three years, 1984-1987. The magnitude, causes and contributory factors to maternal mortality were examined in the hospital setting. This led to the formulation of 22 specific, low-cost interventions, which utilized local resources. These interventions were followed-up for a period of 7 years. Monitoring was conducted through monthly audit-oriented meetings. Maternal mortality in the community being served by the hospital was assessed utilizing the "sisterhood method", followed by an assessment of perceptions of obstetric risk among community members, health workers and peripheral staff in order to evaluate factors contributing to further non-reduction of maternal mortality in the hospital. Finally, an assessment utilising the three phases of delay methodology was conducted focussing on the reduction of maternal and perinatal mortality.

Results: There was gross underreporting of maternal deaths in the official statistics (849 against 350 per 100,000 live births, respectively). Major causes were haemorrhage, obstructed labour, infections and rupture of the uterus. Several other associated factors comprised lack of equipment, drugs/blood and issues concerning staff and community distrust of the obstetric unit. The application of the 22 specific interventions saw a progressive reduction in the maternal mortality ratio (from 849 to 275 per 100,000 live births) after the 7-year period (p<0.001). This was despite an increase in the number of admissions to the unit (3,000 to 4,296 respectively). Also the case fatality rate for the major causes of death was reduced from 9.2 to 3.1%. However, morbidity increased, which indicated that more sick patients were admitted to the unit. The community assessment undertaken in 2001 revealed the actual MMR at that time to be 447 (urban) and 757 (rural) per 100,000. The result of the assessment in perceptions of obstetric risk revealed low knowledge among the community, staff and traditional birth attendants and that there was distrust in the health system. A final audit using the "three phases of delay methodology" revealed that the major causes of perinatal and maternal deaths occurred in the health system.

Conclusions: Maternal and perinatal mortality can be reduced through low-cost interventions available in most low-resource settings. Regular audits of maternal and perinatal deaths can be undertaken in these settings. Low-cost methodologies exist to assess the magnitude and causes of maternal deaths, such as the Sisterhood methodology. To be of value audits must be sustained and used as monitoring mechanisms for service delivery improvements and as managerial tools to reduce maternal and perinatal deaths the "three phases of delay model" is a simple and user-friendly method for the audit of both perinatal and maternal deaths.

Key words: maternal mortality, intervention, audit, Kigoma, Tanzania

LIST OF PUBLICATIONS

This thesis is based on the following papers:

I   Mbaruku G, Bergström S. Reducing maternal mortality in Kigoma, Tanzania.
Health Policy Plann 1995; 10:71-8.

II   Mbaruku G, Vork F, Vyagusa D, Mwakipiti R, van Roosmalen J. Estimates of Maternal Mortality In Western Tanzania by the Sisterhood Method.
Afr J Reprod. Health 2003; 7:84-91.

III   Mbaruku G, van Roosmalen J, Kamugisha C, Nturugelegwa E, Bergström S. Perceptions of obstetric risk among health staff, traditional birth attendants and community members in rural Tanzania.
Int J Gynecol Obstet. (Submitted)

IV   Mbaruku G, van Roosmalen J, Kimondo C, Bilango P, Bergström S. Perinatal audit using the "Three Phases Delay" in Western Tanzania.
In manuscript.

The papers will be referred to by their Roman numerals I–IV.

LIST OF CONTENT

ABBREVIATIONS

AIDS	Acquired Immune Deficiency Syndrome
CI	Confidence Interval
DALYS	Disability-Adjusted Life Years
DHS	Demographic and Health Survey
DSS	Demographic Surveillance System
FIGO	International Federation of Obstetricians and Gynaecologists
HIPC	Highly Indebted Poor Countries
HIV	Human Immunodeficiency Virus
LTR	Life Time Risk
MDG	Millennium Development Goals
MOH	Ministry of Health
MMR	Maternal Mortality Ratio
NGO	Non-Governmental Organisation
NMR	Neonatal Mortality Rate
ICPD	International Conference on Population and Development
IHCAR	Division of International Health, Karolinska Institutet
IMCI	Integrated Management of Childhood Illness
ODA	Overseas Development Aid
OR	Odds Ratio
LBW	Low Birth Weight
PNMR	Perinatal Mortality Rate
RAMOS	Reproductive Age Mortality Survey
SAREC	Department for Research Cooperation (within Sida)
Sida	Swedish International Development Agency
TBA	Traditional Birth Attendant
TFR	Total Fertility Rate
UNAIDS	United Nations AIDS Programme
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Fund
WHO	World Health Organisation

1. INTRODUCTION

1.1 Maternal and perinatal deaths

Each year 600,000 maternal deaths occur worldwide, 99% in low-income and middle-income countries. This is equivalent to one maternal death every minute. The Maternal Mortality Ratio worldwide ranges from 234 and 635 per 100,000 live births. The maternal mortality ratio is the major health indicator that shows the greatest disparity between high- and low-income countries. In high-income countries, maternal deaths have been progressively decreasing and the average is currently 13 per 100,000 live births. In low- and middle-income countries, current estimates are high, 940 per 100,000 live births for the African region, 560 per 100,000 live births in South East Asia and 110 per 100,000 live births in the East Pacific region. Again, even in these regions, there are differences with the current figures for the African region between 1,200 per 100,000 live births in West Africa and 700 per 100,000 live births in East Africa. Africa, accounts for 53% of maternal deaths while the bulk of the rest are from the Asian sub-continent (Pittrof & Stanfield 1995; UNICEF 2004). The lifetime risk of dying a maternal death in East Africa is one of the highest in the world, with as many as one woman in 11 standing the risk of a maternal death as compared with one in 4,000 in Western Europe (Hill et al 2001). While in the 1980s, the lifetime risk of a maternal death in Northern Europe was estimated to be less than one in 9,850, in West Africa it was one in 21, almost a 500-fold discrepancy (Maine et al 1997).

Every year 4 million newborn babies die in the first month of life, the neonatal period, 99% in low-income and middle-income countries (UNICEF 2004). This is equivalent to more than 10,000 babies every day or 450 newborns every hour. An almost similar number are stillborn. Over the years, perinatal mortality in high-income countries has been progressively reduced to a current average of 4 per 1000 births while in low- and middle-income countries progress has been slow and the current estimates are 33 per 1000 births. Great differences, however, exist even within these low-income countries with ranges from highs of 120 to lows of 15 (UNICEF 2004).

In fact, even child mortality, which has been decreasing worldwide, is still high in low-income countries despite optimism from international organisa-

tions. What is more important is that neonatal deaths contribute to almost 40% of overall child mortality. However, the proportion of deaths has been increasing; in 1980 the proportion that died was 23%, while estimates for the year 2000 show that the proportion was 28% (Ahmad et al 2000). Therefore, if the world is to reduce child mortality then more efforts should be directed towards the neonatal period (Lawn et al 2005). We have to appreciate that, globally, neonatal mortality reduction has been slow. While child mortality (mortality after the first month of life) fell by a third between 1980 and 2000, the neonatal mortality rate was reduced by only about a quarter during the same period. On the other hand, maternal deaths have actually been increasing in some countries, in spite of the constant deliberations and efforts since 1987, at which time the Safe Motherhood Conference in Nairobi, Kenya brought awareness of this problem to the world. At that time, the annual estimate was 500,000 maternal deaths and at the subsequent 1990 World Summit for Children and the 1996 International Conference on Women in Beijing China, the aim was to reduce this figure by half at the turn of the century. The same emphasis was reiterated by the Programme of Action approved by the 1999 ICPD + 5 in The Hague, Netherlands (Stanton et al 2001). It was then pointed out that maternal mortality ratios in low-income countries were at least 100 times greater than those found in high-income countries.

Most of these deaths are avoidable, but it seems that efforts to combat this problem have hit a stalemate in the majority of low-income countries, especially in sub-Saharan Africa and in a large part of the Asian continent. Since most deaths are a result of complications that arise during pregnancy and childbirth, efforts to reduce these deaths must be directed to this specific period of a woman's life. The connection to perinatal mortality is clear since, in both cases, it is this perinatal period that is so critical. Indeed, most causes of neonatal and maternal deaths are so interlinked that discussion of both tragedies together is relevant.

1.2 Technology and survival

Advances in technology are always cited as the major reason for differences in maternal and perinatal mortality between high and low-income countries. However, the reduction in neonatal mortality in high-income countries preceded the introduction of expensive neonatal intensive care. In England, the neonatal mortality rate fell from more than 30 in 1940 to 10 in 1975, a reduction that was linked to the introduction of free antenatal care, improved care during labour and the availability of antibiotics (MacFarlane et al 1999). Neonatal intensive care became generally available only after the NMR had fallen below 15. In Sweden, perinatal mortality declined at the end of the

19th century by 15-32% among those who used midwives for home deliveries (Hogberg 2004). In fact, the training of midwives at that time, working largely in community settings, emphasised keeping the baby warm and neonatal resuscitation with tactile stimulation, daily cord care, early breastfeeding and the use of aseptic techniques (Anderson et al 2000). Indeed, even maternal deaths have declined tremendously in Western European countries during the last 200 years. In Sweden, for example, the decline started even earlier, at around 1750, the ratio falling from 1000 to 500 in 1850. The current figure is around 5 per 100,000 and the decline was due to better obstetric practices, improved hygiene and nutrition, and decreasing fertility rates (Hogberg 2004).

High income among the general population is cited as another cause of differences in perinatal mortality between high and low-income countries. There are, however, several low-income countries that have achieved low neonatal mortality rates and maternal mortality ratios despite limited resources such as Sri Lanka, Honduras, Indonesia and Nicaragua. The explanation is mainly due to the result of sustained inputs into and use of primary care facilities, the use of midwives, high coverage of antenatal care, accessibility, high rates of supervised institutional deliveries with access to services, and female literacy (Martines et al 2005). Low-cost interventions have been estimated to be able to reduce neonatal mortality substantially, by up to 70% if provided universally (Paul & Singh 2004; Damstadt et al 2005). There is more evidence now that about 50% of births take place without skilled care, in the poorest quintile of many low-income countries where the first-line providers are usually family members or TBAs and where home confinement is dictated by a combination of poverty, cultural and societal factors (Gwatkin 2004; Okong 2004).

There are simple low-cost interventions, such as tetanus toxoid vaccination, exclusive breastfeeding, and kangaroo mother care for low birth infants, as well as community-supplied antibiotics for neonatal infections, that have been shown to reduce mortality (Bang et al 1999; Martines et al 2005). The cost of providing universal packages for neonatal health in countries with very high neonatal mortality rates is also low as compared to other global programmes. For example, the cost of prevention of mother-to-child transmission of HIV is $ 3.40 per woman screened, while an improved package for newborn child has been estimated to cost only 0.47 cents (Darmstadt et al 2005).

Sometimes, adequate care cannot be provided due to a shortage of essential items and equipment. This may result from issues related to commodity procurement and distribution. This erratic supply of essential commodities could be overcome with innovative mechanisms, such as social marketing,

although market forces might not always ensure that commodities are available and affordable, especially for the poor (Okuonzi 2004). Oftentimes, however, there is pressure to develop and utilise high technology devices for neonatal care. This seems to be due to the large, for-profit industry focused on the 1% of neonatal deaths that happen in high-income countries, yet, little is spent on developing and testing simple, low-cost methods, technologies and devices for the prevention, detection and management of neonatal illnesses and emergencies in the places where most foetal and neonatal deaths occur. There is a need to develop innovative research in this area and this may be feasible through partnerships. For example, postpartum haemorrhage represents a quarter of all pregnancy-related mortality in low-income countries and, in sub-Saharan Africa, accounts for an even higher percentage as shown by figures from Burkina Faso (59%), Ivory Coast (37%), and Guinea (43%) (Goodburn & Campbell 2001). Yet, there is minimal research in this area, although it has been shown that by utilising traditional birth attendants in Gambia and Tanzania and cheap preparations of a prostaglandin, vaginal or rectal misoprostol tablets, that this problem can be prevented in home births (Prata et al 2005). The same inequalities in research funding are seen and are reminiscent of the inverse care law, called the "ten to one" rule, implying that most research funding goes to countries that have ten times less morbidity and mortality.

1.3 Human resources – the most crucial issue

Lack of skilled care has also been cited as a bottleneck whereby the trend is migration of staff to urban hospitals with a neglect of rural and home deliveries. It has also been said that human resources for health care are in crisis (Chen et al 2004), where skilled health professionals are moving to countries with a perceived higher standard of living, creating what has been referred to as a "carousel of movement" (Martineau et al 2004). The issue of skilled attendants is important, although evidence points to possibilities for delegation, training and the use of traditional and community providers who can provide much of the needed care (Haider et al 2000; Pereira et al 1996). This will not solve the problem of internal and external "brain drain" completely, hence, a proper personnel planning and management system that ensures satisfactory terms of employment and career pathways is needed. The quality of clinical care for sick newborns and mothers in labour can be improved. The capacity to use a partograph in childbirth, to resuscitate a newborn baby, and to prevent and manage infection in the neonate, can be taught as competency-based practical skills (Penny & Murray 2000), but several issues such as attitudes and absenteeism should also be addressed. In India, an average of 40% of health facility staff have been found absent at any point in time (World Bank 2004) and similar situations have been

documented in Africa (Okong 2004). Supervision and enforcement of quality control through regulation should also be assured (Haines & Victora 2004). The foreign countries that receive migratory labourers should have the obligation to establish and mitigate the adverse effects in low-income countries by strengthening their health systems, particularly through human resources development (Anon 2005).

Even communities themselves can be empowered to deliver care and have actually been shown to demand skilled care, resulting in better outcomes (Haider et al 2000; Manandhar et al 2004). There is also a need to improve the neonatal care component in the pre-service education of health care providers. Oftentimes this component is included in passing during the paediatric rotations in midwifery and medical training and can be a missed opportunity (Martines et al 2005).

The lack of political will has also been cited as a contributory factor to high neonatal deaths. Ironically, while globally 99% of neonatal and maternal deaths occur in low- and middle-income countries, the concern for the remaining 1% has been significant as they are the subject of confidential inquiries and public outcry if services are judged to be substandard. In fact, most trials of neonatal interventions focus on these few deaths proving the truth, in practice, of the inverse care law as it was first described in the United Kingdom in the 1960s "the availability of good medical care tends to vary inversely with the need for it in the population served" (Hart 1971).

1.4 Skilled and unskilled attendance during pregnancy and childbirth

In the 1990s, interest in community health systems fell and global policy refocused almost exclusively on the promotion of skilled care in childbirth. In fact, governments were advised to stop training traditional birth attendants, since this factor was seen as ineffective and detracting from investment in skilled care. In these policy shifts, the losers are today's poor women and children, who have the highest mortality risk, yet face deteriorating community health systems and weak clinical systems. In essence, therefore, conflict can be transformed into progress since community and clinical care are both included in the definition of health systems (Travis et al 2004). With phased programme planning, outreach and family-community services can be effective in ensuring the poor access to basic services while professional clinical care is being strengthened and made more equitable. There is evidence that strong community services can promote and create demands for skilled care (Manandhar et al 2004). This

has been avidly demonstrated in the integrated management of childhood illness (IMCI) assessment, where clinical system strengthening or community activities alone have little effect; the greatest success coming when both are linked (Bryce et al 2004).

Due to the fact that 50% of labours take place outside of health institutions, all births cannot be monitored as required and community outreach services and the involvement of traditional birth attendants cannot be totally disbanded. Besides, globally, 56% of women deliver with a "skilled" attendant, but the variation between countries is very great (5-99%) (UNICEF 2000). Skilled attendance and institutional delivery rates are lowest in countries with the highest NMRs and MMRs. In sub-Saharan Africa, less than 40% of women deliver with skilled care and in south Asia the figure is less than 30%. In fact, across 40 countries with DHS data between 1995 and 2003, more than 50% of neonatal deaths arose following a home birth with no skilled care. In sub-Saharan African and south Asian countries for which DHS data are available, the NMR is consistently higher and the coverage of skilled care consistently lower in rural areas. The scenario is made worse by the fact that the average number of mothers giving birth with a skilled attendant in Africa has risen by only 0.2% per year for the past decade (Knippenberg et al 2005). Hence, at this rate, by the year 2015 the average skilled attendant coverage in Africa will still be less than 50%. Furthermore, clinical care is even less equitable than antenatal care; within low-income countries well-off women have two- to three-times higher antenatal coverage than the poorest, but 6-times higher skilled attendance at delivery. Hence, coverage is low, progress is slow and inequity high (Knippenberg et al 1997).

Other complications of labour such as eclampsia and haemorrhage are extremely important and also require the presence of skilled staff and facilities to mitigate them. It is estimated that 15% of pregnancies will experience life-threatening complications (Hibbard 1978). These risks affect, not only the mother, but also the neonate whose mother has died due to pregnancy complications, decreasing the neonate's own chances of surviving during the coming year (Urassa et al 2003).

A large proportion of 4 million stillbirths occur as intrapartum stillbirths. Therefore, although neonatal outcomes are affected by health throughout the life cycle, starting with mother's childhood, adolescence and pregnancy (Bacci et al 1993; Machungo 2002; Okong 2004), complications during labour are very important determinants of foetal and neonatal survival (Kulmala et al 2000; Kusiako et al 2000; Chalumeau et al 2000). Many neonatal deaths take place within the first 24 h after birth - at least one million per year (Lawn et al 2005) - and are secondary to birth asphyxia and

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preterm birth. During delivery, obstructed and prolonged labours and malpresentations carry the highest risks and require skilled intervention. Some of these risks cannot be predicted antepartum, hence the need for careful monitoring of all women who go into labour.

Antenatal care has been mentioned as one of the milestones in the reduction of perinatal and maternal mortality since its creation in the United Kingdom in the early 1900s. In low-income countries, expensive screening programmes are not feasible due to the high per capita investments required. However, there are several basic investigations, which are low-cost and, if implemented, will further reduce the high perinatal mortality seen in these settings. Between 4 and 15% of pregnant women in sub-Saharan Africa are believed to be infected with syphilis, which is very easy to treat and will prevent significant perinatal mortality from occurring due to miscarriages, stillbirths and even preterm labour (Gloyd et al 2001; Challis 2002). It has also been found that concurrent syphilis infection is significantly associated with the vertical perinatal transmission of HIV and that treatment is cheap and very cost-effective (Bique Osman 2000). Another well-known cause of preterm birth, low birth weight and foetal death is malaria. Screening and treatment for malaria has also been found to be very cost effective in pregnancy as, recently, malaria has also been implicated in facilitating the vertical transmission of HIV (Steketee et al 2001; Challis 2002). Also important in the antenatal period, basic anthropometric measurements made during antenatal visits can be important predictors of obstetric outcome and do not require expensive equipment. These include height, serial weights, symphysis-fundus measurements, blood pressure, limited routine urine examinations, and haemoglobin estimation to rule out anaemia (Massawe 2002; Bique Osman 2000).

A proper history of previous obstetric outcome such as a prolonged labour, intrapartum foetal death and pre-labour macerated foetal death may point to areas where further investigations can be directed such as glucose tolerance tests and the planning of supervised delivery during the current pregnancy. These procedures can be performed by ordinary clinic staff and do not require very sophisticated equipment or investments. Those found with significant markers could be referred to district hospitals, where doctors are available and more advanced screening procedures can be performed. Otherwise, at-risk mothers could be advised to deliver in these district hospitals where supervised labour monitoring facilities are available. The clinics are also used as counselling points for at-risk behaviours such as smoking and contraception, and for the care of the newborn.

For planning purposes, health workers need to have the most current information on the causes and magnitudes of the major issues, which take

place in their areas. Information is always lacking from Ministries of Health, the DHS is not regular and censuses are rare events. There is a need to utilise the data that is available at the facility and district level through registers and log books. This data can go very far in providing information to managers at the local level, as well as to staff. However, this existing data is underused. It must be considered that only 50% of the estimated births take place at health facilities, so this cannot be regarded as representative of the whole population. Expensive research and extensive verbal autopsy or labour intensive household survey methods are not necessary. Research tends to focus on assessing the effects of biological interventions, with little consideration for the requirements of the health care system for effective service delivery, including the examination of alternative strategies and cadres of workers (Haines & Victora 2004). Learning from implementation in diverse settings is very essential and the existing data in facilities can still be used to audit the performance that exists in these units.

1.5 Millennium development goals for maternal and perinatal mortality

The MDG-4 will depend on child mortality reductions even greater scope than those achieved in the past. In order to meet MDG-4, a substantial reduction in NMRs in high-mortality countries is needed and the reduction of deaths in the first week of life is essential. During the past decade, some regions of the world have made great progress in reducing NMRs but inequity is very evident between the high- and low-income countries. There has been no measurable decline in the regional average NMR for sub-Saharan Africa. In contrast, the Americas achieved a 40% reduction in NMR, largely due to progress in Latin America, where six countries have achieved reductions of 50% or more. In the western Pacific region, the largest percentage reductions have been recorded in Japan, South Korea and Malaysia, all of which have low NMRs (<5 per 1000 live births). In South Asia the picture is mixed. In Southeast Asia, many countries have reduced neonatal mortality; in some, such as Indonesia, Bangladesh and Sri Lanka (which have reduced by 50%, 40%, and 40%, respectively), the reduction has been considerable. In others, more limited advances have been made, such as India, which has recorded only a reduction of 11% (World Bank Group 2005). With the current trends in neonatal mortality and challenges that include AIDS and increasing poverty, particularly in Africa, as well as a lack of global investment in child and maternal survival despite 10.6 million deaths every year, the prospects are gloomy (Claeson et al 2003; UNICEF 2004). For maternal deaths the situation is worse, since, the MDG 5 requires

countries to reduce their maternal mortality ratios by 75% by 2015, a goal very unlikely to be reached.

The risk of neonatal death due to severe infection in high-mortality countries is about 11-fold the risk in low-mortality countries. The risk of dying due to birth asphyxia is about 8 times higher for babies in countries with very high NMRs. The risk of death due to preterm birth in a country with a very high NMR is 3 times that of a country with a low NMR. Deaths due to low birth weight are also important, but it has been estimated that, at most, only 1-2% of neonatal deaths are directly attributed to in-utero growth restriction in full-term neonates and attempts to reduce rates of babies born with low birth weights at the population level, in general, have been met with little success (Kramer 2003). However, most deaths in moderately preterm babies and in those born at term but whose growth had been restricted, can be prevented with extra attention to warmth, feeding and prevention or early treatment of infections (Aleman et al 1998; Duke et al 2000).

In addition to variations between countries in the distribution of causes of NMRs, there is often substantial variation within countries, for example, between– and within-district variations in populations with limited health care. Therefore, there is an international obligation to respond to this issue, but individual countries must decide and invest more resources towards this problem and vulnerable population group.

1.6 Deprivation and poverty

Poverty has been seen to be an important factor in perinatal and maternal mortality, either through increasing the prevalence of risk factors such as maternal infection, or through reducing access to effective care. This factor is not just a problem in low-income countries. A study in Canada suggests a disparity in stillbirths and neonatal deaths between the richest and poorest 20% of the population that has persisted for almost 20 years (Luo et al 2004). Demographic and Health Survey (DHS) data from 20 countries in sub-Saharan Africa and three large countries in South Asia reveals consistently higher NMRs for those in the poorest 20% of households than for those in the top quintile. If the NMRs noted for the richest 20% of the population in every country were seen in the entire population, NMRs would be reduced by 19% (539,000 to 79,000) in Africa (median across 20 countries, IQR 9-28) and 28% (158,000 to 43,000), 41% (1,098,000 to 450,000), and 43% (32,0000 to 14,000) in Bangladesh, India and Nepal, respectively. These reductions would prevent an estimated 0.5 million neonatal deaths in these countries alone, and an additional 219,000 deaths in Africa (Lawn et al 2005).

To achieve major reductions in maternal and neonatal mortality in these settings, coverage of care during childbirth and the early postnatal period should be increased to reach the poorest and most underserved populations. Addressing inequity should be a priority for all strategies for improving the survival of newborn babies (Lawn et al 2004). Poverty, too, is responsible for a lack of access to care. In a Ugandan study, only 21% (15 of 71) of severely ill babies completed referral as advised (Peterson et al 2004). The most common reason for not completing referral (90%) was lack of money. Households are the prime source of health-care financing in most low-income countries and costs for emergency maternal and neonatal care are often unanticipated and catastrophic (Xu et al 2003; Okong 2004). Affordability, especially of clinical care, is a major obstacle in most countries. In fact, formal user fees, as well as under-the-table payments for care, are often great and act as powerful disincentives to care-seeking (Martey et al 1998). Such out-of-pocket expenditures by poor households contribute to increasing poverty and inequity (World Bank 2004).

1.7 Gender issues and reproductive rights

Gender issues are important as they are characterized by inequities related not only to wealth. Reduced care-seeking for girls as compared with boys has been reported, especially in South Asia (Nielsen et al 1997; Victora et al 2003) while in Africa it has been addressed on several occasions. Analysis of DHS data alone does not provide evidence of a reduction in girls' survival advantage at national levels and may be misleading, but female infanticide has been reported in China and South Asia, although the true incidence of this practice is unknown (Xu et al 1997; Wu et al 2003). We know, however, that sex discrimination before birth through sex-selective abortion is well-documented and that the practice has been reported in India and China (Plafker 2002).

Violence during pregnancy has recently been recognised as an important issue in maternal mortality and morbidity and also in neonatal deaths; this is, largely, a hidden tragedy (Rizzi et al 1998; Granja 2002). In fact, violence during pregnancy is a known factor in suicides and has recently been recognised as a significant contributor to maternal deaths even in African settings (Granja 2002); it has also been well-documented in high-income countries (Campbell 1999; Shumway et al 1999).

Abortions constitute another important, but unseen, contributor to maternal deaths. Abortions have been used as a method of controlling human reproduction since ancient times and it is estimated that 36-53 million

unwanted pregnancies are terminated every year throughout the world (Henshaw 1990). It has also been estimated that abortion-related mortality in low-income countries is at least 15 times higher than in high-income countries and, in some regions, as high as 40-50 times higher (Rasch 1999; Machungo 2002). However, in countries with restrictive abortion laws, unsafe abortion remains a major public health problem (Sjostrand et al 1995). Apart from contributing to a significant proportion of gynaecological ward admissions, up to 40% in some centres (Singh & Ratnam 1998), abortion is also a significant cause of maternal deaths (Unuigbe et al 1988; Okunofua et al 1992; Yusuf & Zein 2001). In Tanzania, it was estimated that abortion was a contributory factor in 15% of all maternal deaths (Johnson et al 2002), with estimates for the WHO being similar (Lema et al 1996).

1.8 Donor countries and maternal and perinatal health

Many governments of donor and low-income countries have made commitments and signed declarations with respect to increasing funding for health in low-income countries. These good intentions have not always been translated into increased funding, however, and what is evident is that the money available is often distributed on the basis of political priorities rather than towards the highest disease burden or the most cost-effective interventions.

The overseas development aid (ODA) of three quarters of donor countries fell far short of their commitment of 0.7% of their gross national income (GNI) in 2003 (International Monetary Fund 2004). Of the countries that account for the bulk of the 4 million neonatal and 600,000 maternal deaths per year, 41 fall in the most heavily indebted category and, in fact, debt reduction packages have been approved for only 27 of them. Even a close look at this debt forgiveness leaves one a bit suspicious of the commitment (Organisation of Economic Cooperation and Development 2003).

Donor funding for maternal, neonatal and child health is pitifully low in view of the number of deaths, the human rights imperative, and the fact that cost-effective interventions do exist. While the challenge is to increase donor funding, it must be ensured that, when given, it also supports national priorities. In this, transparency in allocation and the tracking of resources are mandatory prerequisites.

Moreover, many low-income countries have not achieved the degrees of public health expenditure that were promised in the Abuja declaration,

which was adopted at the Organisation of African Unity´s special summit on AIDS in 2001. In that meeting, African countries pledged that 15% of national budgets would be allocated to health spending (WHO 2001; Bhutta & Nundy 2002). Despite poor health status in several countries in South Asia and Africa, there is exorbitant spending on maintaining huge conventional armies and even developing nuclear arsenals (UNAIDS 2002).

Political, ethnic and class rivalry in many of these countries have resulted in large numbers of refugees and even internally displaced persons whose health indices are extremely poor. In most cases, the majority of the affected populations are women and children, while a large number of men end up becoming war wounded. Particularly high NMRs and MMRs are seen in countries with recent civil unrest, such as Liberia and Sierra Leone. The MMR for Sierra Leone was estimated to be 2000 per 100,000 live births in 2002 (UNICEF 2004). There are also issues of accountability and lack of transparency with allocated funds not yet reaching the intended beneficiaries. Therefore, the reallocation of national resources to development, especially to health and education, is an urgent need.

Recently there has been a very systematic effort to analyse the cost effectiveness of various interventions within the maternal and neonatal care programmes. The major conclusions reached are that several strategies, when applied together, yield greater dividends than individual vertical programmes and they are, thus, cost effective. For example, in countries with high NMRs and MMRs, in the absence of strong clinical services, programmes can start with family and community care and outreach services, followed by addressing missed opportunities within the limitations of health systems and integrating the care of newborn children into existing programmes, such as safe motherhood and integrated management of childhood illnesses. Such measures will reduce deaths at a much lower cost. Later, the necessary scaling-up of clinical care, although a challenge, follows, if optimum effect and equity are to be achieved in neonatal health and maternal mortality reduction. This step involves systematic strengthening of the supply of and the demand for services. Such a phased programmatic implementation builds momentum by reaching achievable targets early on, while building stronger health systems over the long term (Knippenberg et al 2005).

2. AIMS

1. To register the real magnitude of maternal mortality in the regional hospital by the utilisation of all available evidence.

2. To investigate the causes and contributory factors in cases of maternal death.

3. To estimate the magnitude of maternal mortality at the community level.

4. To formulate low-cost interventions and follow up of the interventions for a seven-year period.

5. To perform regular audit of the maternal and perinatal deaths aiming at avoidability.

6. To monitor and adjust the interventions accordingly.

7. To continually assess the impact of the interventions.

8. To investigate the degree of knowledge of obstetric risk in the community, among health workers and among traditional birth attendants.

9. To assess the utilisation of the "three phases of delay" model in the audit of perinatal mortality.

10. To establish a joint team of doctors, midwives and nurses for the clinical review of each maternal and perinatal death, which occurs in the setting.

3. STUDY SETTING

Tanzania, situated on the Eastern coast of the African continent, has an area of 940,000 square kilometres and is the largest country in East Africa. Tanzania borders Kenya and Uganda to the North and North West, the Republic of Congo and Burundi (with some portion of Rwanda) to the West, and Zambia, Malawi and Mozambique to the South. The population of Tanzania is 33.8 Million making it the thirty-third largest nation in the world by total population with an average growth rate of 2.9% (The United Republic of Tanzania 2002). Tanzania became independent in 1961 and has remained politically stable, apart from a war with neighbouring Uganda in 1979-80, which greatly destabilised the country's growing economy. The majority (85%) of the population are farmers and reside in rural areas (The United Republic of Tanzania, 2000a).

3.1 Tanzania

During the last three decades, Tanzania has had a very committed primary health care system, with this sector receiving the largest proportion of the health budget, about 52%. This is reflected in the very high coverage of antenatal care (90%) and immunisation rates of under-fives, which exceed 85%. The total fertility rate has declined from 6.2 births per woman in 1991 to 5.6 in 1999. However, in spite of these impressive indicators, the general health and nutritional status of the population has remained low, the life expectancy being 52 years, infant mortality 99 per 1000 and the maternal mortality ratio 529 per 100,000 live births (The United Republic of Tanzania, 1997a). The unmet need for family planning remains high, with one in five (21.8%) currently married women reporting unmet family planning needs. Post-independence health care, education and water were completely free and there was an extensive period of construction of dispensaries, health centres and hospitals in all districts in addition to a well-organised referral system. Today, there are definite signs of deterioration in health status with a reversal of the declines in infant and under-five mortalities that were evident post-independence. About a quarter of all under-five deaths occur within the first month and two-thirds within the first year after birth. Approximately 90% of all child deaths are attributable to

common and preventable illnesses such as malaria, pneumonia, diarrhoea, malnutrition and low birth weight; 8 out of 10 children die at home, 6 of them without any contact with formal health services. There are large disparities between rural and urban areas, and between the various income quartiles, with the rural poor being the most disadvantaged.

The HIV/AIDS pandemic has affected the country with a current estimated prevalence of 11%. Otherwise, Tanzania has a fairly well distributed health care system. About 80% of the population have access to health services and over 80% of the population live within 10 kilometres of a health facility. There are about 4,844 health facilities in Tanzania of which 2,877 are government owned, 848 are voluntary, 283 are parastatal and 836 are private (The United Republic of Tanzania, 1997b). There is notable deterioration of the standards of curative health care in Tanzania, which is evidenced by a significant collapse in public hospital services, particularly the notable loss of skilled medical and nursing capacity shifting to the private sector. This has led to open public complaints and dissatisfaction in the services rendered at public health facilities. The adult Morbidity and Mortality Survey and the Health Management Information System has revealed some important facts, which are relevant to health provision in the country including findings that nearly 19% of the 240,000 reported births in 1996 required an intervention generally available only in hospitals; maternal deaths accounted for 7-9% of all adult deaths; 23-57% of the maternal deaths occurred at home; HIV/AIDS was the leading cause of death among the 15-59 year age group; and accidents, particularly transport-related injuries, were a major cause of death.

There are several constraints that have affected the country, leading to decreased funding in all sectors with severe effects on the health sector. Decreased funding was evident in the deteriorated services, buildings, plants and general infrastructure present in the majority of the government-funded system. In Tanzania, the Non-Governmental (NGO) system (mostly Mission hospitals) have continued to be funded by their respective donors and, since these provide almost 40% of the health care services in the country, they have helped to alleviate some of the shortages, but at the expense of increasing work loads. Due to the Socialism and Self Reliance policy, which was adopted in the country in 1967, private medical practice was banned and people had to depend on the public sector and on the overburdened mission health facilities.

In 1990, the Tanzanian government realised the extent of the deteriorating conditions and formulated the Civil Service Reform Programme (CSRP) which aimed at reducing the size and cost of the civil service and at transforming the role and functions of the government. In line with these

reforms, the Ministry of Health introduced a comprehensive programme of Health Sector Reforms in the areas of management, decentralisation, health financing, a public-private mix of services, and research (Mwisongo et al 2000). In 1999, the sector-wide reform programmes developed by the Ministry and partners was launched. The reforms started with the main national hospital and are intended to spread to the rest of the country. The experiences with the reform have been varied and, with the current decentralisation policy, each district is responsible for planning, budget formulation and utilisation. The sector-wide approach has seen more donors collaborating with the government and a comprehensive basket funding system is now in place, which subsidises the normal budget in district health care (The United Republic of Tanzania 1997b). However, although increasing, per capita expenditure is still low. Private practice has been allowed since 1990, which has given people more choice, but is beyond the reach of most of the population and is mainly available in urban areas. The government is committed to the elimination of corruption, although there are still indications that better health care is available to higher income citizens and that "under-the-table" payments for services are still present (The United Republic of Tanzania 2000b).

In Tanzania, nearly 9,000 women are estimated to die annually due to pregnancy related conditions (MMR=529 per 100,000 live births) and at least another 250,000 women become disabled due to the same complications seriously compromising their reproductive health. About 26% adolescents have their first birth by the age of 19 years. There is a declining trend in deliveries taking place in health facilities: 60%-1984, 44%-1991/92, 38%-1996, and 36%-1999 (The United Republic of Tanzania, 2001).

3.2 Kigoma region

All the studies in this thesis were conducted in the Kigoma region, being one of the most remote and upcountry regions of the 20 regions in the country. Kigoma is situated on the shores of lake Tanganyika bordering the countries the Republic of Congo and Burundi. The population of Kigoma in 2002 was 1,600,000. The health facilities consist of six hospitals (three owned by Non-Government organisations), 10 Health Centres and 155 dispensaries. Due to its geographical location, Kigoma is the home to various influxes of refugees from neighbouring countries with recurrent civil conflicts since the mid-1960s. Since 1993, the number of refugees has ranged from 350,000 to 400,000; these are mainly located in nine camps scattered throughout the region. Basic health care is provided in the camps. Except for in the three camps that have full-fledged hospitals, all major surgeries and diseases occurring in the camps are referred to the nearby district hospitals. Aside

from the large refugee presence, Kigoma is reminiscent of other regions in the country with the same disease and mortality patterns and constraints in human and other resources of varying degrees. On the other hand, due to its remote location from the main cities, there is an acute shortage of qualified staff and difficulties of erratic supplies of essential health commodities as compared to other regions, which are situated near the major towns. In Kigoma, the average family size is the highest in the country (7.5) and great grand multiparity is a common condition, while the contraceptive prevalence rate is 13%.

The regional hospital Maweni, is a 200 bed hospital and has a staff of about 300 workers. Staffing during the study consisted of an obstetrician gynaecologist, a paediatrician, three medical officers, one pharmacist eight assistant medical officers, 24 midwives, eight medical assistants, two laboratory technicians and X-Ray personnel, 80 nursing assistants, two pharmacy assistants and four laboratory assistants. The maternity ward consisted of four delivery beds, 20 antenatal and 20 postnatal ward beds and a small room of four cots for neonatal care. The hospital is meant to be the referral centre for the other five hospitals, but in essence, it mainly serves the main town population of 150,000 and the surrounding district with a population of 460,000 (The United Republic of Tanzania 2002), which does not have a district hospital. Therefore, on average, there are approximately 20 deliveries per day with obvious overcrowding in the postnatal ward.

The average number of deliveries is 5,000-6,000 per year with about 300 caesarean deliveries, 300 general surgical operations and an outpatient department with approximately 400 attendances per day. High-risk patients are referred from the surrounding district but the bulk of work is due to emergency operations mainly caesareans due to labour complications (the commonest being prolonged and obstructed labour followed by foetal distress) and laparotomies for rupture of the gravid uterus and extra uterine pregnancies. The minor operations consist mainly of post-abortion evacuations and minor accidents.

The Maternal Mortality Ratio was around 900 per 100,000 births in 1984-87 but is currently around 340 per 100,000 births with a caesarean section rate of around 6%. The Perinatal Mortality rate is around 48.5 per 1000. All obstetric, gynaecologic and under-five cases are treated free of charge but, due to shortages of drugs and supplies, sometimes relatives have to purchase commodities especially antibiotics, IV infusions, suture materials and blood bags. The laboratory can perform basic investigations and an ultrasound has been available only during the last two years. Anaemia is quite common, especially for children and pregnant women. There is an average of 10 blood

transfusions in children per day, with the major cause of both outpatient and inpatient admissions resulting from malaria.

4. SUBJECTS AND METHODS

4.1 Paper I

The project was carried out at the Regional Hospital in Kigoma, where the total load of deliveries increased by approximately 40% over the 7 year period 1984-1991, corresponding to an increase in number of births from 3,070 to 4,400. The initiative was launched in the beginning of 1987 in Kigoma. A retrospective analysis was carried out for the three years prior to the initiative (1984-86) concurrent to planning for a prospective study to be conducted from 1987-91. Extreme scarcity of human and material resources made it impossible to approach the problem of maternal mortality at the community level

4.1.1 The retrospective study

The starting point was a review of all case notes of maternal deaths, admission records, nurses' shift reports and operation theatre records. From these reports, it was quite clear that maternal deaths were grossly under-reported in the official statistics. The maternal deaths registered were almost exclusively obstetric deaths and there were almost no gynaecological deaths reported. It was also discovered that maternal deaths occurring within 4 hours of arrival had not been included in the maternal mortality statistics. The corrected number of maternal deaths was 28 in 1984 (corresponding to a maternal mortality ratio of 933 per 100,000 live births). It is probable that this figure, and the figures for 1985 and 1986 (Table 1) still represent significant underestimates, since they refer merely to the hospital setting.

From available sources, a review was also undertaken regarding the main causes of admission to the gynaecology emergency ward. These retrospective data for 1984-86 (Table 2) indicate that the three predominant conditions during the review period were malaria, anaemia and pelvic infection. Both sepsis and septic abortion represent significant proportions of the total number of admissions registered. During the retrospective study there were 4 maternal deaths due to "septic abortions" among 9,191 live births.

Table 1. Number of causes of maternal deaths, number of livebirths and stillbirths and maternal mortality ratio in the Regional Hospital, Kigoma, 1984-1991

Causes	1984	1985	1986	1987	1988	1989	1990	1991	Total
Uterine rupture	10	8	7	5	2	2	1	1	36
Sepsis	7	6	8	5	2	1	2	2	33
Anaemia	5	4	6	3	5	1	2	2	28
Obstetric haemorrhage	2	4	1	2	1	1	0	1	12
Septic abortion	1	1	2	0	3	3	2	2	14
Other causes	3	1	2	1	1	1	0	0	9
Total	28	24	26	16	14	9	7	8	132
Live births	3000	3221	2970	3490	3800	3960	4080	4296	28817
Stillbirths	70	84	102	90	45	83	90	104	668
Total births	3070	3305	3072	3580	3845	4043	4170	4400	29485
Stillbirth rate (0%)	2.3	2.5	3.3	2.5	1.2	2.1	2.2	2.4	
Maternal mortality ratio[1]	933	745	875	458	368	227	172	186	

[1] Number of maternal deaths/100,000 livebirths

Table 2. Main causes of admissions to the Department of Obstetrics and Gynaecology, the Regional Hospital, Kigoma 1984-1991

Causes	1984	1985	1986	1987	1988	1989	1990	1991	Total
Uterine rupture	13	10	11	10	14	8	11	9	86
Sepsis	43	52	41	35	29	21	30	17	268
Anaemia	89	82	97	76	102	143	111	104	804
Obstetric haemorrhage	27	19	34	29	16	18	12	7	162
Septic abortion	26	29	31	39	45	56	67	79	372
Ectopics	5	3	10	10	14	17	9	12	80
Pelvic infection	80	92	156	192	214	247	290	284	1555
Malaria	115	228	280	317	411	502	784	914	3551
Other causes	12	9	11	14	19	9	10	4	88
Total	410	524	671	722	864	1021	1324	1430	6966

After the data collection for the retrospective study was complete, an analysis of potentially important contributory causes to maternal death was performed. First, an assessment was made of the equipment in the department and in the operating theatre, its functioning and whether there was a local supply of spare parts as well as a possibility for local repair. A significant shortage of most of the basic equipment was noted. Apart from the non-availability of proper equipment, much of the equipment that was present was old-fashioned or out-of-date. There was, however, a large collection of fairly recent, but non-functioning, equipment such as beds, waterproof covers, non-organized material for assisted deliveries and equipment for resuscitation and anaesthesia. There were, allegedly, constraints on existing funds to order new equipment. In addition, there was an acute shortage of water due to the absence of a reserve water tank for the hospital.

Second, staff attitudes and performance were confidentially and anonymously assessed, the staff being unaware of the study at the time of the assessment. A deplorable indifference among staff was noted and manifold frustrations related to living conditions, traditional administrative bureaucracy, and intercadre problems were registered. Staff attitudes were judged to have direct implications for patient management.

Third, attitudes among patients were recorded, indicating dissatisfaction with services, staff absence from the hospital during office hours, prescriptions of treatment without physically seeing the patients, and unavailability of essential staff during emergencies occurring after office hours. The latter problem was aggravated by the lack of regular transport to fetch people on-call when urgently needed.

Fourth, certain departments fundamental to the planned interventions were particularly closely scrutinized. The pharmacy department was involved due to the pressing problem of unavailability of essential drugs such as antibiotics, anaesthetics and intravenous fluids. All drugs were supplied from either the zonal medical store (600 km away) or the central medical store in the capital (2,400 km away). Maintenance of stocks was difficult due to slow public transport and erratic availability, even in these central stores. The central laboratory of the hospital was involved because there was an acute shortage of blood for transfusion. This was caused by a general reluctance among the population to donate blood, with ensuing difficulties in establishing a blood bank. The operating theatre was involved because of the acute shortage of surgical and anaesthesia equipment. There was no trained anaesthetist and, therefore, two staff nurses gave all forms of anaesthesia. These limitations in anaesthesia service and, more importantly, skills were critical during many obstetrical interventions.

4.1.2 The prospective study

Twenty-two specific interventions were carried out prior to the initiation of the prospective study.

The professional responsibilities were clarified and the senior obstetrician was nominated the leader and responsible person for the intervention programme. This entailed a change in many of the traditional roles of hospital hierarchy such as emergency procurements and a more liberal approach to patient management by non-doctors, implying the delegation of more responsibility to nurses and midwives.

Regular, monthly meetings were arranged to enable as many of the staff as possible to be informed and to receive feedback about the events of the past month. At these meetings, problems were described and solutions discussed and agreed upon.

Efforts were made to utilize available resources and to contact outside donors only when local resources were exhausted. The number and frequency of productive ideas were surprising, particularly those coming from junior workers among the staff, such as ward attendants and nursing assistants. Local resources were utilized, particularly to solve equipment problems through local repairs. Local carpenters and artisans could repair much non-functioning equipment at remarkably low costs. Examples of such equipment were sphygmomanometers, suction equipment, sterilizers and elimination equipment.

Schedules for regular maintenance were started in order to prevent breakdown. Manufacturers' instructions were cautiously adhered to and, for each piece of equipment, simple on-the-job training was arranged. Attention was drawn to the proper usage and care of equipment and the appropriate training for this was given to all workers. Messages regarding the importance of the longevity of such equipment were emphasized. An old cement reservoir metal tank was rehabilitated and installed as a reserve water supply for the theatre and maternity wards.

Maintenance of working skills was guaranteed by a number of training activities for all cadres in the department. The trainers were all the senior staff, including midwives, who taught the nursing assistants, doctors who taught the medical assistants, and the obstetricians who were responsible overall for the training.

Improvements in patient management were aimed at the early diagnoses and treatment of diseases known to be common causes of maternal death.

Follow-up patient management exercises enabled staff to be sensitised as to the value of early diagnosis.

Efforts were made to improve the resuscitation of patients by training the admitting auxiliaries. Prompt execution of life-saving skills was, thereby, delegated to this category of staff.

Attention was paid to the proper sterilization and disinfection of equipment.

The use of broad-spectrum antibiotics pre-operatively was emphasized, particularly for women undergoing caesarean section.

The anaemia problem was tackled by instructing peripheral antenatal clinics to refer all cases of clinical anaemia early to the Regional Hospital for correction.

Better management routines in cases of severe anaemia were introduced.

Regular staff evaluation resulted in the transfer of members not complying with the agreed upon rules.

Public complaints regarding patient management were taken into consideration.

It was decided that all essential staff would be accommodated in housing within the hospital compound.

A detailed plan for the supply of essential drugs was made in order to list such drugs by priority. In order to avoid unforeseen shortages, a small sub-store of drugs was initiated on the maternity ward.

A small infusion production unit was started in order to cater for the acute shortage of infusions often facing the department.

Early provisional blood for transfusion from the blood bank was guaranteed.

A vigorous campaign was initiated to stimulate blood donor recruitment for the improvement of the existing blood bank. Replacement of the blood was performed by relatives of patients, who had received blood during an intervention.

Strict norms were elaborated regarding minimum requirements to receive blood.

The problem of scarcity of blood bottles with citrate was partially resolved by local preparation of citrate for recycled, sterilized bottles. Donor-sets were made from re-sterilized needles of used sets.

Culture facilities were restored by a microbiology technician, who attended a special course and, later, initiated the local production of sensitivity disks and culture media.

Local fund-raising allowed for the operation theatre to be repaired.

The study was approved by the Ethical committee of the National Medical Research Institute, Tanzania and by the Ethical Committee of Karolinska Institutet, Sweden.

4.2 Paper II

The Kigoma, with its 1.2 million inhabitants, has a crude birth rate of 40 per 1,000 and a total fertility rate of 6.3 per thousand (The United Republic of Tanzania. 2002). Therefore, 48,000 births are expected to occur in the region each year. However, only 9,000 are registered annually by the four facilities with comprehensive emergency obstetric care (this means facilities with the availability of basic obstetric care, operative delivery and blood transfusion). Another 7,000 births are registered in Rural Health Centres with basic emergency obstetric care facilities. The remaining 32,000 (66%) women, therefore, deliver at home, largely by themselves or assisted by untrained traditional birth attendants.

Data collection took place during a two-week period in October 2000. Twenty-six students from Kigoma Clinical Officers Training Centre were trained for two days prior to conducting the survey. One afternoon was used for pre-testing the questionnaire. The estimated number of interviews per student per day was between 20 and 25 with an estimated duration of 10 minutes for each interview. Villages in each of the four districts were randomly sampled in proportion to the population. Villages were enumerated and sampling was performed at the district headquarters with the involvement of the district medical personnel and administrators. From the data, which was available at the district headquarters, the number of households per village was obtained. Depending on the population of each district, the average number of households to be interviewed per village was calculated. District leaders were informed and permission was obtained. Supervisors were physically present during the actual interviews and counterchecked the questionnaires in the field. Both men and women who were present in the household at the time of the interview were included.

Respondents had to be 15 years or older and were subdivided into five-year groups i.e. 15-19 years, 20-24 years, etc up to 60 years and older.

The following four questions were asked:
- How many sisters do or did you have whom are 15 years or older and whom were born to your own mother?
- How many of these sisters are still alive?
- How many of these sisters have died?
- How many of these sisters who died, died during pregnancy, childbirth or within 6 weeks after childbirth?

The first question defines the total number of women ever at risk for maternal death, while the fourth question gives the total number of maternal deaths in this group.

Since respondents were asked about sisters born to their own mother, we excluded the so-called extended family. Interviewers were urged to check whether the sum of answers to questions number 2 and 3 were equal to number 1. Data were processed according to the method of Graham et al (Graham et al 1989). Details of the method will be presented together with the results, since the figures will facilitate explanations.

There is a relationship between the number of interviews held and the margin of error of the calculated maternal mortality ratio. Also, the expected level of maternal mortality is inversely related to the number of interviews needed. If maternal mortality is expected to be low, one will need a large number of interviews to achieve a reliable estimate. According to the method of Hanley et al (Hanley et al 1996) in case the expected MMR is between 500 and 750, between 2,100 and 3,200 interviews are needed to achieve a margin of error of +/- 20%. To achieve a margin of error of +/- 10% one would need 8,000 to 13,000 interviews. These large numbers were not feasible in our setting and we, therefore, chose to interview 3,000 people aiming at a margin of error of 20%.

Two adjustments were made:
1. Due to the fact that respondents of 15-19 and 20-24 years old still have other sisters, not yet 15 years of age at the time of the survey, the actual number of reported sisters by those younger respondents will underestimate this number. Therefore the hypothetical number of sisters ever to be at risk in these younger respondents groups should be calculated, based upon the average number of sisters reported by the older respondents (those being above 25 years.)

2. Respondents of 60 years or older would be able to provide information about sisters, who, on average, have been exposed to full time risk. Younger respondents would give information about sisters who have been exposed for only part of their reproductive life to the risks of maternal death. Multiplication of the reported number of sisters (column 3 of Table 1) with an adjustment factor (column 5) gives the so-called sister units of risk exposure (column 6). This adjustment is based upon the age distribution pattern of developing countries. In these countries, where fertility is generally high, the age scale has to be transformed as originally suggested by Brass (Brass & Bamgoye 1981) in-order to be representative. The age distribution of the study population in Kigoma was typical of this pattern and, therefore, this adjustment was mandatory. The transformed model is equivalent to Gompertz's model (Booth 1984), in which a transformed one replaces the natural age scale so that the observed fertility is related to a typical pattern of fertility.

The life time risk (LTR), i.e. the risk for a woman to die from maternal causes during the whole of her reproductive life, was calculated using the formula of Hanley et al (Hanley et al 1996).

The study was approved by the Ethical committee of the National Medical Research Institute, Tanzania and by the Ethical Committee of Karolinska Institutet, Sweden.

4.3 Paper III

The study area was located in two divisions of Kigoma, a rural district in western Tanzania. The district is one of five in the region and had a population of 360,970 inhabitants at the time of the study. Most of the people are peasants engaged in subsistence farming and small-scale fishing. The income per capita is estimated to be one of the lowest in the country at 100 US dollars. More than 85% of the people live in villages scattered throughout the district. There are four health centres that can offer only basic obstetric care without any surgical services, as well as 50 dispensaries that can offer basic antenatal care and treatment of minor conditions. The district does not have a hospital, but depends on the regional hospital, situated in Kigoma town, where comprehensive obstetric care is available. One of the health centres, operated by a non-governmental organization, has facilities for operative delivery and blood transfusion. A large proportion of the population is served by the remaining three health centres, which are scattered throughout the district. Pregnant women with obstetric emergencies from these health centres are disadvantaged and those who can

make it to the regional hospital arrive in various degrees of adverse conditions with frequent negative consequent outcomes.

There is an acute shortage of staff in all health units. The situation in the regional hospital is, comparatively, better. Health centres are staffed by a clinical officer (secondary education and three years training in a medical training centre), assisted by a midwife and two auxiliary midwives. Doctors are situated at the regional hospital, among them there is one obstetrician. Dispensaries are staffed by assistant clinical officers (primary school education with three years in a medical training centre) assisted by auxiliary nurses.

According to the District Medical Office report of 1999 the expected number of deliveries in the district, assuming a crude birth rate of 40 per thousand, would be around 18,000. However 2,192 delivered in health institutions and 2,404 were reported as home births. This left about 13,500 births unaccounted for. This is an indication that the majority of births take place outside of institutions and that most of them are not reported to the existing registration system. Traditional birth attendants (TBAs) are recognized in the area, each village or two adjacent villages having at least one. Less than 5% of the TBAs have received any kind of training. There are also traditional healers in the area who are consulted for various ailments by the community. In the current study, all local leaders at the district level and all village leaders were informed about the study and, in turn, transmitted information to the population concerning the study.

4.3.1 Sampling of health facilities and workers

Two out of the existing four divisions in the district were randomly selected. Two health centres in the two divisions were included. All 24 dispensaries in the two divisions were listed and a total of eight were selected through random sampling. All 40 health workers from the four health centres and the eight dispensaries were included in the study. Health workers and TBAs involved in the focus group discussions were obtained through convenience sampling from the health facilities and rural areas that were visited (Babbie 1992).

4.3.2 Sampling of community members

Two villages adjacent to the dispensaries and the health centres were included. Hence 20 villages were selected. Since some of the dispensaries were remotely situated, then the issue of distance was accomplished as some of the villages selected were situated around these facilities. All households were listed in each village. Ten households were randomly selected in each

village and visited. In each household an adult above 15 years was selected and interviewed; hence every villager came from a different household. A total of 220 community members were interviewed. In case the occupants were not present at the time of interview, the household was visited again on a subsequent day.

The interviewees gave informed consent, were not forced to participate and could refrain from participation even during the exercise itself. Confidentiality was ensured through questioning individual respondents in a place of their choice in the household. In addition to the interviews, four focus group sessions were held including one group of health workers, two groups of eight TBAs, one group of 10 women and another of 10 men from the community. The community members, both men and women of reproductive age, were randomly selected. TBAs were obtained through convenience sampling and health workers were selected randomly from the list of 40.

4.3.3 Survey instruments

The study instruments were structured questionnaires, which were specific for each cadre (community members, health workers, and traditional birth attendants) and included mainly closed- and a few open-ended questions. All questionnaires were prepared in collaboration with the District Medical Office, translated into Swahili and then back into English for consistency, pre-tested and revised. Questionnaires were mainly read to the community member interviewees and were directly filled-in by health worker interviewees, and some other educated members of the community. Focus group discussions were conducted separately for health workers, TBAs and community member groups. Each group was limited to 8 or 10 people and lasted a maximum of one and one-half hours. Each focus group discussion was coordinated by one of the researchers and guided in order to cover areas of interest, using "complications narratives". These are narratives used for in-depth interviews or group discussions that focus on exactly what happens in the case of an obstetric emergency. Focus group discussions, using this narrative technique, were conducted with women of reproductive age and experienced TBAs (however, for men there were no narratives as they were not directly involved in child birth). The narratives aimed to get a detailed account of how obstetric complications are identified, who the important decision makers are, what steps are taken in an obstetric emergency, and what delays are encountered. Care was taken to minimise researcher's bias by taking a very passive role in the discussion, only to come in when the discussion wavered or participants asked questions, which required some medical clarification. All sessions were individually audiotaped and notes

were taken by the researchers. All questionnaires were crosschecked and data entered in a computer as soon as possible.

4.3.4 Data analysis

Data from the questionnaires was entered into the computer. The quantitative data was analysed using the Epi Info version 6.04. The qualitative data processing was a continuous process. After all the data was gathered, it was cleaned to rectify any unintended human error throughout the period of fieldwork. The tapes were transcribed and translated from Kiswahili to English. Data analysis followed standard qualitative and quantitative methods (Graham et al 1989; Granja, 2002) including clustering by themes and on the basis of research questions and objectives. Major issues/topics were highlighted and explanatory issues in field notes.

The study was approved by the Ethical committee of the National Medical Research Institute, Tanzania and by the Ethical Committee of Karolinska Institutet, Sweden.

4.4 Paper IV

The study population included all births that took place in the Department of Obstetrics of the Regional hospital in Maweni, Kigoma, Tanzania between July 2002 and July 2004. This is a referral hospital for a region that has a population of 1,600,000 inhabitants (The United Republic of Tanzania 2002). During the study period there were a total of 10,200 deliveries.

A detailed questionnaire was utilised for all perinatal deaths, which took place in hospital. The questionnaire included details of the mother's demographics (age, marital status, place of residence), complete medical, family, social (including smoking and alcohol habits) and obstetric histories. Basic investigations included blood for malaria parasites and haemoglobin estimation, syphilis and HIV serology, weight, height and mid upper arm circumference (Mbaruku et al., forthcoming data). Specifically, the mothers were asked whether the current pregnancy was planned or not and about their use of and knowledge about family planning.

Careful attention was paid to the details of the current labour before admission in the regional hospital in order to ascertain the duration, foetal viability and care which took place at the onset of labour. The time taken from home to the institution after labour began, type and cost of transport, whether referred from lower levels and diagnosis given there were all ascertained and recorded. The care provided during labour was carefully

noted, including delays in the institution, the observations undertaken, the number of attendants, type of attendant, decisions about management, mode of delivery, complications and resuscitation. Standard partograph utilisation was carefully assessed. All babies were examined immediately after delivery and details were recorded including: weight sex, presence of congenital anomalies, assessment of gestational age, viability and, most importantly, whether the delivery was a fresh stillborn. All neonatal deaths (up to 7 days) were carefully recorded. The neonates who were sick received standard care as per the prevailing protocols of the hospital. No autopsies were performed for any of the stillbirths. The questionnaire was completed immediately after delivery of the baby, at which time specimens for investigations were taken. Mothers were asked to follow-up at the hospital after discharge so that those found to have treatable medical conditions could receive the necessary care. All questionnaires and notes were recorded by one of the researchers (KC) and counterchecked by the first author.

The data were analysed by a local team, which consisted of a consultant obstetrician, a consultant paediatrician, two medical officers and two midwives. A careful audit was performed of all stillbirths and early neonatal deaths with a birth weight of 2000 grams and more by utilising the "Three Phases of Delay" methodology.

The research protocol was approved by the Ethical Committee of the Karolinska Institutet (Sweden) and the National Medical Research Institute (Tanzania). A written consent was obtained from each participant.

5. RESULTS

5.1 Paper I

In the catchment area of the Regional Hospital, the coverage of antenatal care ranged from approximately 70% in 1984 to approximately 80% in 1991. On average, 85% of all antenatal clinic attendees made at least 3 visits with an average gestational age at first antenatal visit of 18-20 weeks. The institutional birth coverage amounted to approximately 65% with a wide variation between rural and urban areas.

In the Regional Hospital, the annual number of deliveries increased steadily over the period 1984-91 (Table 1). During the first 3 years prior to the intervention programme, the maternal mortality ratio remained above 700 as calculated with a denominator of approximately 3,000 livebirths. In spite of a significant rise to almost 4,300 annual livebirths during the period of the intervention, the absolute number of maternal deaths declined markedly, resulting in a still more conspicuous reduction in the maternal mortality ratio (Figure 1). The average maternal mortality ratio for the period 1984-86 was 849/100,000 livebirths. The corresponding average for the period 1987-91, following the launch of the strategy, was 275/100,000 livebirths. The difference is highly significant (p<0.001).

The cause of maternal death could not be established in all cases. Autopsies could be carried out only after the consent of the relatives who, in most cases, refused. The only exception was maternal death in which the woman had not yet delivered. According to prevailing custom, it was regarded improper for the woman to be buried with her baby still in the uterus. Even if autopsy could not confirm a probable cause of death, all evidence indicated that rupture of the uterus was the predominant cause. The annual average number of deaths caused by rupture was 5 during the retrospective study. There was only one death per year caused by rupture in 1990 and 1991. Sepsis and anaemia ranked as the second and third causes of maternal death during the three years of the retrospective study. Postpartum haemorrhage, abortions and ruptured ectopic pregnancies contributed significantly to direct maternal deaths, whilst indirect maternal deaths were mostly associated with malaria and local drug intoxication. Some of the patients, considered intoxicated, arrived in a moribund state presenting with bizarre findings, which

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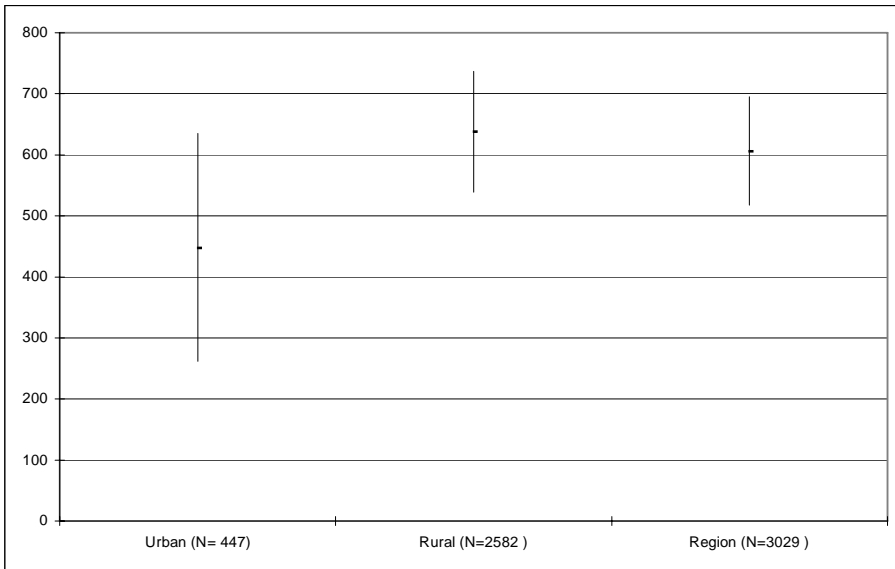
Figure 1. Estimates of maternal mortality ratios, Kigoma, urban and rural areas (mean values with 95% confidence intervals

could not be explained by the duration of labour or by any other objective criteria. Indeed, in some of these there was evidence of fresh tattoos on the abdomen and home use of traditional medicine such as leaves in the vagina or the regurgitation or purging of pieces of leaves during delivery or anaesthesia. Very few patients admitted that they had taken traditional drugs. The practice seemed to be shrouded in secrecy.

The registered causes of maternal deaths must be considered uncertain and unreliable prior to 1987. In addition, the active search for maternal deaths, not only in the obstetric department but also outside, made coverage more complete. Still, the number of maternal deaths declined tangibly.

The morbidity pattern, as reflected in the main causes of admissions, shows a slightly declining trend in the prevalence of uterine rupture, sepsis and postpartum/antepartum haemorrhage, while the opposite trend was evident for anaemia, septic abortion and pelvic infection. It is difficult to define any significant singular impact of the 22 interventions on the maternal mortality decline. Empirically, however, it appears as if some of the steps taken were more essential than others. First, the availability of essential drugs was very tangibly improved, especially due to the buffer effect of the sub-store and to the improved ordering system. Intravenous infusions were readily available

in a local production unit, which, therefore, assuaged the delays from the central medical stores. The second important factor was the availability of improved equipment, which enabled basic functions, such as sterilizations and surgical operations, to continue uninterrupted for long periods. The third factor was the improved availability of essential staff (obstetrician, surgeon, anaesthetist and laboratory workers), who - being stationed and actually living in the hospital compound - were readily available during emergencies. Finally, the fourth factor was a registered improvement in the skills of workers at all levels. Their attitudes improved, resulting in fewer complaints from the community with a subsequently enhanced confidence in the hospital. The obstetric unit enjoyed a tangibly improved respect and the unit, previously regarded as one of poor performance, was often referred to as a reliable place for safe management of complicated pregnancies, safe deliveries and decent care. These improvements in the community opinion were probably reflected in the steeply increased number of deliveries in the regional hospital.

5.2 Paper II

In total 3,029 people were interviewed. The actual number of sisters, reported by the respondents in the age groups 15-19 and 20-24 years, were 578 and 1,811 respectively. However, these respondents could be expected to have sisters about to become 15 years. For correct estimation, it was necessary to use the ultimate number of sisters ever to be at risk (aged more than 25 years). This average was 3.34 in our group. The number of respondents in the first two age groups was, therefore, multiplied by 3.34 in order to get the estimated ultimate number of sisters ever to be at risk. These estimated numbers were 725 and 2,061 respectively (Table 3)

A second adjustment was needed since only respondents aged 60 years or older would provide information about sisters who, on average, have been exposed to a full lifetime of obstetric risk. The reported number of sisters (column 3) gave the so-called sister units of exposure (column 6) by multiplying with the adjustment factor (column 5).

In our survey lifetime risk (LTR) was 181 / 4,815 = 0.0376, or approximately a 3.8% (95% CI: 3.2-4.3) chance to die from maternal causes during reproductive life. This gave an estimated MMR of 606 (95% CI: 518-695) per 100,000 live births for the Kigoma region as a whole.

Table 3. Maternal mortality estimates Kigoma region. Sisterhood survey, 2000

Age group	Number resp.	Sisters reaching 15 years	Maternal deaths	Adjustment factor	Sister units of risk exp.
(1)	(2)	(3)	(4)	(5)	(6)
15-19	217	725	6	0,107	78
20-24	617	2061	25	0,206	425
25-29	626	1982	20	0,343	680
30-34	538	1836	33	0,503	924
35-39	473	1637	41	0,664	1087
40-44	281	1003	29	0,802	804
45-49	138	458	11	0,900	412
50-54	81	245	8	0,958	235
55-59	25	75	2	0,986	74
60+	33	97	6	1,000	97
TOTAL	3029	10119	181		4816

We divided the respondents into an urban group and a rural group, the latter with poor accessibility to hospital facilities (Figure 1). The MMR in the urban group was 447 (95% CI: 262-635), while in the rural group it was 638 (95% CI: 539-737). When we divided the region into districts, it was found that the MMR was the highest in Kigoma rural district, which was the area with poorest accessibility to health care (Figure 2).
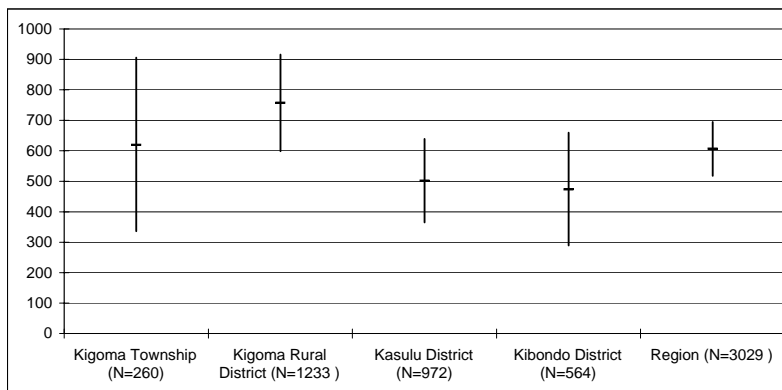
Figure 2. Estimates of maternal mortality ratios, Kigoma, by districts (mean values with 95% confidence intervals)

5.3 Paper III

5.3.1 Knowledge of pregnancy risks and complications

The national antenatal card for Tanzania was utilized to formulate basic questions for the health workers. Antenatally, there are seven high-risk conditions, which are supposed to be referred to a higher level of care. These include a history of a previous caesarean delivery, previous miscarriages, previous postpartum haemorrhage, previous pregnancy more than 10 years ago, previous stillbirth, maternal height below 150 centimetres and parity above 7.

Health workers' knowledge of high-risk conditions requiring referral was poor. Only 10% of health workers were able to mention all five risk conditions that require delivery in a

hospital, 17.5% knew only four, while 7.5% did not know any such condition. However, the risk condition mentioned by the majority of the workers (75%) was a history of previous caesarean section followed by previous stillbirth and parity above 7. The community, on the other hand, knew very few high-risk conditions. The majority, 64%, mentioned only one condition. The traditional birth attendants demonstrated their almost total lack of knowledge of the antenatal high-risk conditions. Only 42% knew at least one cause (Table 4)

Table 4. Knowledge of at risk conditions by the various groups

Risk factor	Health workers N=40 %	TBAs N=16 %	Community members N=240 %
Previous caesarean	75	<1	5
Previous stillbirth	55	2	5
Previous abundant post-partum haemorrhage	30	5	2
Height <150 cm	25	10	1
Parity >7	40	10	10
Recurrent miscarriages	20	15	18
Last pregnancy >10 years	20	1	2

Knowledge of life-threatening emergencies was also sought from each group. These, according to the card, need immediate referral to a hospital. They include prolonged and obstructed labour, antepartum haemorrhage, eclampsia, foetal distress, severe anaemia, malpresentations and hypertension. The results indicate that there were inadequacies in knowledge in all three groups. Only 10% of the health workers knew at least four emergency conditions, while 13% did not know any single condition. The community members mainly mentioned haemorrhage as a risk factor while TBAs mentioned delays in delivery and antepartum haemorrhage as the main risk factors (Table 5).

Table 5. Knowledge of emergency conditions during pregnancy

Conditions	Health workers N=40 %	TBAs N=16 %	Community members N=240 %
Prolonged/obstructed labour	35	40	2
Eclampsia	58	10	15
Antepartum haemorrhage	55	30	40
Preterm rupture of membranes	58	15	10
Severe anaemia	60	10	12
Foetal distress	30	5	1
Malpresentation	45	12	10
Hypertension	60	1	5

The area of knowledge of life threatening obstetric emergencies was also asked for. For the health workers only 10% knew all the eight major obstetric emergencies and they demonstrated significant gaps of knowledge when asked for the way in which they could manage these cases. Only about 25% knew exactly what initial life-saving steps to perform during these emergencies. The aspect of labour management revealed that most labours were not monitored, since only 42% of the workers stated that they used the partograph routinely.

TBAs were asked about their awareness of these emergency conditions and their reaction to them when they occur. They recognised haemorrhage and the failure of the baby to come out as the only emergency conditions. However for these and the other conditions presented to them, such as convulsions due to eclampsia and loss of consciousness, their management consisted of herbs, portions and sorcery since they believed that these were due to supernatural powers. The community, on the other hand, only recognised haemorrhage as a serious condition. Their reaction to this was mainly to send the woman for care; the

choice of TBA or health facility was dependent on the their availability and distance.

Birth spacing was specifically asked about due to the high parities existing in the region. The level of knowledge among health workers was high. However, TBAs showed a lack of knowledge of modern methods of birth spacing and were biased towards traditional methods on the pretext of side effects due to various rumours in the community. The community members were divided on the issue of birth spacing. Almost all agreed on the advantages, but not on the usage. Knowledge was about 60%. The most common methods mentioned were pills and injectables.

After completion of the structured questionnaires, it was obvious that there was much to be learned from further exploration into many areas that had not been fully understood and explained by the three groups. Hence, focus group discussions were performed in order to get more information. The following areas were specifically probed in the focus groups, since they had been identified as the major issues determining maternal mortality and morbidity.

5.3.2 Delays to seek care

The community did not, in general, regard pregnancy as a high-risk condition. There were no specific preparations before, during and even after its completion. It was taken as a natural event that a woman experiences. Pregnant women received ad hoc advice, mostly from peers and older women, which included reduction of heavy manual labour, more rest, consumption of nourishing foods (without overeating, as the baby could become too big for the passage) and avoidance of allegedly risky behaviours such as pit latrine use. Most people were aware that problems could arise during pregnancy, but they were optimistic about their own pregnancies, even if they had had previous complications.

Men revealed a lack of knowledge of pregnancy complications. They noted that pregnancy was a woman's issue and that their role is to respond when asked by the elder women to give help.

In all complication narratives, the women mentioned more danger signs and complications here than in the initial interviews. Prominent among these were excessive bleeding and gushing of water, which were perceived to be real dangers and even to cause death. Others dangers signs mentioned included malpresentations, size of baby, age and parity, prolonged labour, ruptured womb and swollen limbs. The community regarded the complications as natural phenomena and, therefore, to have no physiological or causal explanation. A predominant opinion was the quest for large families, for both prestige and social security.

TBAs, on the other hand, recognised these dangers but trivialised them and claimed to possess remedies. Hence, if consulted first, as is often the case in rural areas, the TBA becomes a major cause of delay. Health workers had the opinion that the delays were due to a great reliance of the community on TBAs who have no skills. Also, they regarded the latter to make decisions that may be detrimental to the patient. This opinon was not universal, however, as most TBAs have the experience to recognise when things are not normal and some do refer these women to health facilities. On the other hand, most of the health workers had the opinion that women prefer to go to TBAs for deliveries since they are cheap and they offer a welcoming atmosphere. This may indicate a lack of trust in the service offered at health units. When an emergency occurs, however, most families tend to take the women to a health facility equipped with emergency obstetric facilities, although they may not go directly there. The indecision can aggravate complications, but study participants did not perceive delays and inappropriate decision-making to be factors in pregnancy outcomes.

5.3.3 Delays in reaching care

One of the major findings here was the delay in decision to seek care. In the community, labour is expected to progress naturally and preparations are made to receive the baby. It is a social event and involves only women. Men are sidelined and are not allowed to be near the labouring woman. The community seems to be unfamiliar with the existing health facilities, especially concerning childbirth.

One man confessed during one of the discussions that*: "up to now, it is not clear when to advise a woman to go to the hospital or clinic, so many of them give childbirth locally"*

Hence, sometimes valuable time is lost in the delayed decision-making of men and the older women who advise the labouring patient. Delays are also incurred when labouring clients start at a TBA who, later, advises them to go to a health facility due to complications or an antenatal card, which is marked with a red cross (implying high risk). Often the community starts by allowing the woman to begin labour at home and resorts to a health facility when they perceive the occurrence of complications. Reasons given here include the harmless nature of pregnancy, odd hours (such as during the night), distance to the facility, proximity to a TBA and lack of affordable and reliable transport. The latter was emphasised by health workers who regarded it as one of the most important contributing factors in adverse pregnancy outcomes.

Health workers also highlighted the effects of indecision by relatives and optimism of the pregnant women themselves, trying first to labour home, sometimes in order to guarantee a short waiting period at the health facility when coming in advanced labour. Health workers also described the influence of TBAs and distance to the facility as factors affecting adverse pregnancy outcomes. TBAs explained that they perform assessments of each and every patient who consults them and decide who will deliver under their care or in a health facility and that, in case of complications, they refer early.

However, they agreed that they usually give some herbs which help the women as exemplified by one of the TBAs: *" Not all women are the same. Some take longer to give birth. Babies cannot come out of their own…. And we have remedies to do exactly that"*

The herbs could not be authenticated and the proportions or amounts remained unknown to the researchers. This aspect of herbs was strongly emphasised by health facility workers to be a factor in delays to access care and to cause serious complications

such as rupture of the uterus. They also pointed out that, since TBAs cannot perform any meaningful examinations, conditions which should have been detected during pregnancy such as hypertension, anaemia and malaria are missed and appear only when the woman is brought to the health facility during labour. Also, TBAs do not offer antenatal care, as such. The major purpose of the TBA antenatal visit to pregnant mothers is to provide assurance, to create rapport and to render them ready for birth when the baby is due. It was unclear from discussions with the TBAs what they exactly did at the antenatal visit. Many sent their clients to the health facilities and instructed them to report back to them. In this way, they got assurance that the women did not have risk factors that they could not handle. The most feared condition was abnormal position of the foetus.

5.3.4 Delays in receiving care

Most community members acknowledged that giving birth at a health facility had many advantages. It was found in the focus group discussions that women and their families in the rural communities did not understand what a skilled attendant was and why those skills are important. They could not distinguish between TBAs and midwives and other health workers. Most births took place at the TBAs' place or at home, with the woman alone, or assisted by relatives. Through the discussion with women in the focus group, it was revealed that there were several reasons why women chose to attend the health facility rather than the TBA and vice versa. Reasons for home births included fear of costs, shortage of tools and medicines in hospitals, sudden occurrence of labour pains, distance to the health facility, uncomplicated pregnancy and the poor and blaming attitudes of some nurses towards patients.

Women also described occasions when nurses had beaten women in labour. Older women found skilled attendants to be too young to attend to them. TBAs were regarded highly by the elderly women and rural mothers. Many women revealed some of the reasons for preference for TBAs as caregivers. TBAs were said to attend to anyone, even those without formal education (including people from the rural areas) using a respectful language. In addition, TBAs reportedly allow the presence of a

relative during the deliver, and were preferred by those who fear delivery by caesarean operations in the hospital.

It was further revealed that they use soothing words and show kindness and, as one of the TBAs explained: *"We give them black tea, prepare hot water for her to take a bath. Labour pains draw near when you take a hot water bath and drink tea"*

Surprisingly, the derogatory behaviour of some of the health workers was confirmed by the discussions with the workers themselves. It was also revealed by community members, both males and females, that women have confidence in TBAs due to good reports they hear from women who have previously been attended to by TBAs. Also, pregnant women want additional assurance over and above what they learn from clinic attendance that they will have a safe delivery, the most expressed fear being caesarean birth and losing the baby. Women do have apprehension after attending these clinics and this takes them to TBAs, who have a way of accommodate these temperaments and performing rituals for those who require them. The community and health workers recognised the fact that health facilities are generally poorly-equipped and poorly-staffed with substandard quality of care.

The low quality of care and the poor reception make health facilities unpopular as explained by one of the participants: *"We were told to go to the big hospital after 2 days in labour. On arrival we were asked why we delayed. Before answering I was handed a paper with a long list of things to go and buy. When I said I didn´t have money, they barked at me and asked whether I want my wife to live or not...".* But such experiences may not be the only reason for women to choose not to seek skilled care. Family pressure and proximity to a TBA may play a role. Skilled attendance in health facilities can also be costly to many families, especially if a woman is referred from remote rural areas, and costs can be higher if a woman suffers complications or is not discharged immediately after birth.

While TBAs are popular, their knowledge is questionable. It was revealed that, apart from the kindness that they demonstrate, a few leave the labouring women to undergo the birth process by

themselves. Almost all insert their bare fingers into the birth canal to check for the passage and descent of the baby, and allow the woman to walk around very soon after delivery. When the woman experiences excessive bleeding, they make her lie on her back and quickly prepare a soft porridge with a lot of sugar to give to the woman. Reports indicate that they sometimes even attempt to turn the baby by manipulating vaginally.

Relationships between peripheral health workers, TBAs, the community and the referral hospital were found to be antagonistic. Examples include health workers blaming the TBAs as the main culprits in delays to seeking care while TBAs and the community depreciate peripheral units as being of low quality. On the other hand, there were general complaints concerning the bad attitudes of many health workers towards women while in labour. It was also clear that the community expressed sympathy with health workers regarding their difficult working environment and the overall poor transport system. They requested the government to respond to its obligations of infrastructure development and to keep to the promise of free health care, especially to vulnerable groups, which include women and children.

5.4 Paper IV

During the study period, 200 perinatal deaths fulfilled the criteria of the total 385 (52%). There were 132 fresh stillbirths (66%) and 68 early neonatal deaths (34%). The leading cause of deaths was asphyxia in 38 cases (19%), followed by prolonged or obstructed labour in 37 cases (18.5%), and antepartum haemorrhage in 23 cases (11.5%). Other complications of labour included 18 cases of uterine rupture (9%), 15 cases of cord prolapse (7.5%), and 10 cases of breech deliveries (5%). Apart from malpresentations and eclampsia, 9 cases each (4.5%), congenital anomalies accounted for only 7 cases (3.5%) of perinatal death, which implied that most cases were viable. Eighteen cases (9%) of perinatal death were of unknown origin (Table 6). A substandard care analysis of the three phases of delay revealed the following findings.

Table 6. Main causes of perinatal deaths

Cause of death	Number of cases	Percent
Birth asphyxia	38	19
Prolonged/obstructed labour	37	18.5
Antepartum haemorrhage	23	11.5
Uterine rupture	18	9.0
Cord prolapse	15	7.5
Breech presentation	14	4.0
Malpresentation	10	5.0
(Pre)eclmapsia	9	4.5
Sepsis	9	4.5
Congenital anomalies	7	7.0
Shoulder dystocia	2	1.0
Unknown causes	18	9.0

5.4.1 First Phase Delays

A substantial number of cases, 74 cases (37%), were categorised into this group. Many of these cases could not have been predicted, as most of the women came for delivery only after labour had already begun and facilities for prenatal screening are still rudimentary. The antenatal care coverage is high in the area, approaching 95%, however. There is also a general feeling among the local population that they will only go to the hospital when labour is well established or when they perceive a complication. However, we found in our audit that 38 cases (20%) of the pregnancies were unplanned.

5.4.2 Second Phase Delays

We found in the audit that 44 cases (22%) had second phase delays. The major issues here were lack of transport after labour had started in 10 cases (5%), distance from the place of residence to the delivery room in 8 cases (4%), inability to pay for transport in 5 cases (2.5%), waiting for labour to be well-established in 11 cases (5.5%), advice from relatives in 4 cases, and 'husband not around' in 2 cases. In 4 cases, the cause for the delay could not be ascertained. In most cases, it was difficult to establish with certainty when the labour had actually started and, therefore, an extrapolation was performed on the partograph depending on the stage of labour in which the patient presented

on admission. A significant number of patients arrived when labour was very advanced or even during the second stage.

5.4.3 Third Phase Delays

Since the majority of the cases fell under institutional care, we further audited the findings aiming at improving the services. It was revealed that 66 cases (33%) were delivered by caesarean section. This intervention was performed mainly for saving the lives of the foetus. However, there were 22 cases (11%) whereby the procedure was undertaken to attempt to save the life of the mother, since there was no foetal heartbeat at the time of the decision to send the mother for this major operation. Noteworthy in 10 cases (5%), is that the procedure was undertaken for so called "obstructed" labour, however, membranes were still intact. Three cases of caesarean delivery were due to hydrocephalus, which went undetected during the first stage of labour. Malpresentations constituted 10 cases (5%) but the malpresentations were mainly persistent occiput posterior positions, face, arm prolapse in a second twin and compound presentation. It was also found that rupture of the gravid uterus occurred in 18 cases. However, eight occurred in the hospital, whereas three more occurred at dispensaries or health centres. This means that 60% of uterine ruptures occurred within the health system.

The cases were further analysed as to determine the details of the delays (Tables 7 and 8). For each case, the partogram was carefully analysed in order to detect delays, frequency of monitoring of vital signs for the foetus and mother, treatments received during labour and immediately after delivery, as well as outcome. The number and level of education (skill) of the staff present during the shift when the perinatal death occurred, together with the total number and type of deliveries on the ward at that time, were also recorded in order to assess the workload per shift. This also included a record as to the time interval when a doctor was called and his arrival, the decision-delivery interval and the record of care ordered. Partograms were further evaluated and graded into absent, unsatisfactory and satisfactory categories. Only three cases (1.5%) had no partograms, 32 (16%) were unsatisfactorily filled in, while in 165 cases (82.5%) the partograms were satisfactorily filled in.

Table 7. Substandard care analysis by Three Phases of Delay

Phase	Number	Percent
First Phase Delays	74	37
Second Phase Delays	44	44
Third Phase Delays	141	70.5

Table 8. Main reasons for delays by three phases

Phase	Reason	Number	Percent
FIRST PHASE DELAYS	Antenatal care factors	28	14
	Patient factors	30	15
	Social factors	9	4.5
	Poverty	4	2.0
	Undetermined	3	1.5
SECOND PHASE DELAYS	Lack transport	6	3.0
	Distance	7	3.5
	Dispensary delays	12	6.0
	Health Centre delays	6	3.0
	Absent staff	4	2.0
	Attitudes (staff)	3	1.5
	Poverty	1	0.5
	Undetermined	2	1.0
THIRD PHASE DELAYS	Late diagnosis	24	12
	Wrong diagnosis	12	6.0
	Wrong procedure	18	9.0
	Delayed intervention	22	11
	Absent equipment	3	1.5
	Low skills	30	15
	Attitudes (staff)	14	7.0
	No doctor	2	1.0
	Undetermined	4	2.0
	TOTALS	289	100

Doctors were called for consultation in 80 cases (40%) and the average time to arrival was 60 minutes (range 30 minutes to 4 hours). There was no doctor at all times after official hours of the

day. Therefore, doctors were called when abnormalities were noted on the partograph or in cases of specific emergencies, such as severe (pre)eclampsia, prolonged labour, history of a previous caesarean section or antepartum haemorrhage. Otherwise, since normal deliveries are performed by midwives, it occurred that in a significant proportion of cases, even high risk patients were managed by this cadre, especially after official hours. However, during the audit, the low cadre staff explained that doctors could not be found. The results, especially in malpresentations, were sometimes disastrous. For example, in eight breech deliveries, which were performed by nurse auxilliaries, there was a failure to deliver the aftercoming head due to underestimation of foetal size.

For each perinatal death a "process audit" was undertaken. This is where actual practice is compared with standard (best) practice, based on the evidence of research or expert consensus. As far as was possible, prevailing up-to-date information to support the provision of evidence-based care was utilised. Due to limitations in some aspects of care (such as the absence of electronic foetal monitoring, foetal scalp blood sampling and neonatal intensive care facilities) local adaptations were considered. Hence, foetal monitoring was mainly by intermittent auscultation and infant resuscitation of low apgar score-born babies was by suction, simple drying and immediate skin-to-skin contact with the mother and ventilation by bag and mask.

Neonatal care consisted of warmth with the "Kangaroo method", frequent feeds of breast milk and close observation of early signs and symptoms of infection. Sick neonates were seen by a consultant paediatrician. Half of the babies died in the neonatal period due to causes attributed to asphyxia, whereas infections accounted for nearly 20% of the deaths. Hypothermia was documented in 10% of the neonatal deaths, while cerebral haemorrhage and hypoglycemia were recorded in 4% each. In the remaining 12% of the neonatal deaths, the cause of death could not be determined.

Most of the perinatal deaths occurred at night both in the labour ward and in the postnatal ward.

6. DISCUSSION

6.1 Facing the reality

Workers in obstetric units in low-income countries much more frequently experience the depressing occurrence of maternal and neonatal deaths and these deaths may even become such common events that they seem to be inevitable and beyond the influence of professional intervention. As a result, this leads to discouragement and even complacency. This is exemplified by the notable less-concern attitude of some governments in such countries. The consequences are detrimental in that maternal and perinatal deaths have not received the due attention they deserve, in spite of various reminders from concerned professional organisations and several international commitments. This was exactly the situation found in the study area in 1987, when the first study (I) was initiated. This insensitivity among the health workers led to the beginning of a serious approach to try and mitigate the problem. The study was undertaken as a service delivery tool in an area, which was suspected to have more maternal deaths than indicated in the official statistics.

This period was a time when a young obstetrician was posted to an upcountry station at the height of the Safe Motherhood Initiative, when the entire world was informed of this forgotten problem. Local, concrete problems were innumerable. The sensitivity regarding maternal deaths was low and the staff was totally demoralised with the situation of multiple problems, which beset them in terms of worn-out and unavailable equipment, acute staff shortages, low pay, and an administrative system which did not appreciate the heavy work they were enduring. Poor relations existed between the nursing staff and medical doctors, who were frustrated and saw the system as unresponsive to their demands. These problems were aggravated by the frequent admission of terminally sick patients who arrived

at the hospital to die within minutes. These patients, who died a few minutes after arrival, were not recorded in the official registers.

The community had distrusted the hospital and attended other hospitals in the region or (those who could afford it) sent their wives to the national capital city, 2000 kilometres away, for delivery. It is possible that, at that time, the patients whom were being seen were those few patients who could make it to the hospital and that the majority of patients were dying at home. However, the morbidity figures and the progressive increase in the number of admitted patients contradict this argument. Indeed, the case fatality rate fell remarkably, from 9.2 to 3.1%, which also indicates that the intervention had effect.

The intervention package in study I resulted in a reduction in the maternal mortality ratio by 70-80%. It was difficult to make this impressive result sustainable for a long period of time, as this required the maintenance of morale and commitment of the workers. Many of them were transferred away from the region, some died and some actually asked for re-allocation to other wards of the hospital, where the workload was perceived to be lighter. The investigator remained in the same place for 18 years and this is one of the strengths of the study, allowing the same person(s) to bring change, which might have been impossible with a shorter assignment. It was difficult to control the influence of the community, who had their own views and trust of particular workers and the way the system functioned. Replication to other areas of the country is urgently needed, as the interventions applied were all local and dependent on the initiative of the workers.

While the magnitude of the problem of maternal deaths is known, progress towards reducing it and its consequent disabilities has been slow, often because interventions are not properly phased-in or focused (Kurjak & Bekavac 2001). As of late, maternal mortality has been regarded as a human rights issue (Donnay 2000). This level of concern has been reached when it was realised that women in low-income countries continue to die simply because they are women (Heise et al 1993). In fact, it is becoming clearer now that they die simply

because they are poor and powerless. The other reason that these deaths are ignored is that they are not dramatic, since with worldwide media coverage, we have become accustomed to spectacle and these deaths are not considered front-page news (Kurjak & Bekavac 2001).

Dr Malcolm Potts, the former president of Family Health International and currently with Berkeley University, drew the following comparison to visualise the extent of the problem of maternal mortality: "If a jumbo jet containing 350 pregnant women crashed, it would make headlines in many newspapers. If two such jumbo jets crashed on one day, with 700 pregnant women dying, this disaster would be reported in every newspaper and be on television in every country of the world. Now, if such jumbo jets, each carrying 350 pregnant women, crashed everyday for a year, the governments of the world would be forced by public opinion to band together to put a stop to such tragedy. And yet, this is the same number of pregnant women 500,000, who are dying every year in childbirth or from complications of pregnancy" (Sciarra 1993).

6.2 The magnitude of the problem: local estimates with limitations

There are few affordable approaches to estimate maternal mortality in any given setting. We made two attempts, one utilising a conventional approach (paper II), the Sisterhood method (Graham et al 1989) and one utilising individuals in health facilities (Mbaruku et al, unpublished observations). We found that almost twice the number of maternal deaths occurred outside the health institution. Actually, the number would have presumably been larger than this if a thorough and more laborious search for maternal deaths in the community had been performed (Urassa et al 1994; Songane & Bergström 2002).

When resources are limited, provisional approaches are justified, in order to show health administrators that more efforts are needed to attain a reduction in maternal deaths. It is, however, difficult to assess progress towards the reduction of the burden of maternal mortality since the information available in many

countries does not permit good baseline data to be established. Better and user-friendlier methods are urgently needed if the international community is to reduce maternal deaths significantly. In many low-income countries, the vital registration of births and deaths does not exist, however, and such registration is crucial for the better planning of health care services. In Sweden, the registration of vital events was a major achievement in the reduction of maternal deaths. This was accomplished in Sweden long before other countries through the parish system, which utilised catechetical examination registers (Hogberg & Broström1985; Alm Stenflo 1994).

In many low-income countries, some form of village registration for purposes such as the collection of government taxes, exists. These registers can easily be modified to include the registration of births and deaths. Of course, without proper elucidation, the estimates will still be crude, as some of the maternal deaths, especially those due to early pregnancies, will still be missed. However, in specified areas, these can be augmented by verbal autopsy methods in order to further refine the cause of deaths (Chandramohan et al 1998; Urassa et al 1994). If one is to wait for censuses and other elaborate population estimate exercises, which are rare, infrequent and often very expensive, it will be impossible to reach the overall goals for monitoring the reduction of maternal deaths set by the international community.

Still, maternal deaths are still rare events even in societies with high mortality levels (WHO 1996). Therefore, in order to identify one maternal death in the community, several thousand individuals must be counted. These exercises are tedious, time-consuming and require a lot of resources. In resource-poor countries other needs, such as immunisation and the control of epidemics, take precedence and it is very difficult to convince governments to perform such surveys for maternal deaths alone. Hence, the Sisterhood method (Brass, Graham et al 1989), which can be performed by the health workers themselves, is one easy solution to this problem. Limitations of the method, however, need to be kept in mind and the figures obtained, often with wide confidence intervals, are to be interpreted with caution. Otherwise, erroneous conclusions can be reached, which do not reflect the real situation that exists in the community, and

information achieved cannot be utilised for within-country comparisons or programme evaluations (WHO 1996).

In fact, this is true to the extent that the assessment of progress towards reducing the burden of maternal mortality is almost impossible, since the information available in many countries does not permit the establishment of good baseline data (Andersson et al 2000). Indeed, even officially reported health statistics in low-income countries are in many, if not, most instances based on outdated figures (Kaufman et al 1997). In many situations, however, in the assessment of intervention programmes, relative changes in maternal mortality over time in a particular area may be more important than absolute values of MMR (Andersson 2000). Therefore, there may be a justification in these circumstances to utilise this methodology with careful consideration of the inherent limitations.

Of late, the use of process indicators has been advocated as a better measure for assessing progress than simply relying on the absolute numbers of MMR (UNICEF/WHO/UNFPA 1997). These are monitoring tools, which are increasingly being promoted as useful indicators to monitor progress. They are based on the concepts of six essential obstetric functions for life threatening conditions and on the provision of surgery and blood transfusion. Apart from aiding evaluation, these process indicators suggest areas towards which interventions can be directed. The most useful aspect of the indicators is that immediate information is provided regarding needed actions and tracking for progress can be appreciated in a short time. This is an improvement over relying on the MMR, which takes time to show changes and may even be discouraging to programme managers who cannot utilise results on a continuous basis for service improvements (UNICEF/WHO/UNFPA 1997). When study I was initiated, attention was not paid to the availability and importance of process indicators, although we did observe that deaths due to major causes were reduced tangibly.

The Sisterhood methods presuppose a number of assumptions. This is indicated by their wide confidence intervals. Secondly, the estimates of maternal mortality that they provide are not current. Therefore, what we obtained were estimates of the

MMR from 7 to 10 years back. The Sisterhood methods also present problems of recall due to the lag period between events and the inaccuracy of respondents' certainty to whether their sisters died due to causes related to pregnancy. In a rural setting, such as the one where the study was performed, deaths are often attributed to other causes such as witchcraft, bad omens or just inevitable natural events and most deaths due to early pregnancies may not be realised. Due to current lifestyles and migration, the people interviewed may not have been born in the villages where they were found and interviewed, having migrated from other towns or even neighbouring countries.

The only justification for the Sisterhood method was that our approach provided estimates and they gave a general impression of the community-situation of maternal mortality, which, from the perspective of the regional hospital, was thought to have been tackled. Furthermore, the age pattern of the interviewees gave much concern as many were young and the information from the older respondents, who were few, must be regarded as less accurate. Given the resources that were available to the hospital at that time, and in the absence of any census data, these approximations were the best compromises possible.

The accuracy of the Sisterhood method is increased by the sample size. Therefore, in order to detect a margin of error of only 10% we would have needed a sample size of between 8,000 to 13,000, which was not feasible with the resources available, and that is why we interviewed 3,900 respondents in order to estimate MMR with margin of error of 20% (Hanley et al 1996) which is further justified by taking lifetime risk into consideration in the calculation. Indeed, even in studies using prospective registration (demographic sites) such as the one undertaken in Tanzania for a period of 6 years among 77,000 women, the confidence interval for MMR was very wide (600 to 1,100) and it indicates that maternal deaths are rare events and efforts to measure them routinely may not be justified by the labour and cost involved (Mswia et al 2003). Therefore, as of late, process indicators have been advocated, and these can be followed up in audits performed routinely in hospital units.

An innovative step was taken by investigators in Northern Tanzania (Olsen et al 2000) when they applied the Sisterhood method to health facility users in 2,043 respondents in households and 4,172 women in antenatal clinics in northern Tanzania. They found the method applicable and much less time-consuming than the conventional Sisterhood method. We made a parallel attempt and found a maternal mortality ratio almost identical to the ratio found using the conventional Sisterhood method (Mbaruku et al unpublished observations). The overall ratio using the conventional method amounted to 606 per 100,000 live births (95% CI: 518-695) with and urban MMR of 447 (95% CI: 262-635) and a rural MMR of 638 (95% CI: 539-737). Using the health facility-based Sisterhood method the overall MMR was 604 per 100,000 live births (95% CI: 516-693). The highest MMR was found in patients who lived more than 20 kilometres from a health facility, amounting to 951 (95% CI: 626-1282).

6.3 The magnitude of the challenge: audit as the key issue

Maternal deaths in big hospitals in low-income countries are so common that even efforts to document all the events at this level are incomplete, leading to gross underreporting and even misclassification. In our first study, there was great underreporting and more maternal deaths were revealed only after a detailed search in other, non-obstetric areas of the hospital. The question of misclassifications does not exist only in low-income countries but also in high-income countries where, for a variety of reasons, including issues of litigation (Schuitemaker et al 1997).

The major causes of deaths found in the first study were no different from the globally well-known causes, including haemorrhage, obstructed labour, sepsis and hypertensive disorders as direct causes and anaemia, malaria and as indirect causes of maternal death (WHO 1996). The management of these disorders has been well documented; their management does not require sophisticated technologies (Donnay 2000). When efforts were made to look closely at places other than the

obstetric unit, many more maternal deaths were revealed. This was due to the fact that pregnant women were not always admitted to obstetric units and that mortuary records were easily overlooked. There was no attempt at close examination of the factors that contributed to these deaths. When the attempt was made, it was revealed that there were several issues that contributed to the deaths. These included the late arrival of critically sick patients, lack of essential equipment and drugs, errors in diagnosis and management, delays in timely institution of life saving procedures, and the non-availability of skilled staff during emergencies. In the interim, it was clear that solutions must be sought for these problems, which were practicable and were within reach of the circumstances. When these solutions were applied and followed-up with regular review meetings, which incorporated all relevant departments, it was observed that there was a gradual fall in the occurrence of maternal deaths.

Audit is not only clinical and death-oriented, but can and should be wider and cover non-clinical circumstances. Instituting this in the hospital setting was not easy, as extra efforts and persuasion were necessary for the idea to be accepted, especially the audit sessions. However, the decrease of maternal deaths and solutions to some chronic shortages, especially working tools, had a very positive effect on the workers who observed that some of the critical patients, who had previously been destined to die, survived. Regular ward rounds, repair of damaged equipment, solutions to a chronic water shortage and availability of simple supplies such as sterile gloves could be seen as very gratifying conditions for the working environment. Also, the workers on the ward, especially the midwives, realised that there was now someone who could solve some of their immediate problems at the workplace, whereas past answers to these questions by administration officials had always been "ready-made" and quoted a lack of essential supplies and money. The latter also supported the new initiatives, as the workers were seen to be more motivated and the public noted the improvements and supported them. This aspect of public appreciation and worker involvement had far-reaching effects as was observed in a recent study in Uganda (Okong 2004). Of course, this led to more admissions and increased workload, but was readily tolerated.

Attempts to further reduce the maternal mortality were not possible mainly due to factors that were out-of the control of the hospital environment, such as the arrival of many more sick patients, the identification of more deaths which occurred in other departments, not keeping pace with increased supply needs and staff attrition. This phenomenon of an increase in maternal deaths has also been observed in a 13-year intervention in Ghana, in which it was attributed to more sick patients being admitted after the improvement of services. This should not be a discouragement for managers, since even in the study from Ghana, it was noted that the fatalities for the major causes of death had decreased (Geelhoed et al 2002). In fact, it was revealed in this study, that the increase was due to more abortion complications, which were initially overlooked.

One cannot single out a single intervention that resulted in the dramatic reduction of maternal deaths, especially after the initial six months of the interventions. However, it is more reasonable to assume that the constant availability of the eight essential obstetric functions, as advocated by WHO, were, in combination, responsible for the reduction in maternal deaths (UNICEF/WHO/UNFPA 1997).

The major convincing evidence was, however, the significant fall in case fatality rates of the main causes of maternal deaths. This fall was evident despite increasing morbidity, which implied that better care was being offered at the hospital. Case fatality rate is one of the major process indicators for the quality of obstetric care (UNICEF/WHO/UNFPA 1997). The question of whether study I can be replicated to other areas with similar circumstances also needs consideration. There is ample evidence that a reduction in deaths, even in high-income countries, preceded the introduction of advanced technologies and was based on the extensive collaboration between physicians and highly professional, competent midwives who were locally available (Hogberg & Broström 1985; De Brouwere et al 1998). Similar findings have been recently described in other low-income countries in sub-Saharan Africa, e.g. Mozambique and Uganda (Bugalho & Bergstrom 1993; Lalonde et al 2002). Therefore, what seems to be the solution, is a focus on audit with an ensuing reorganisation of services and a change in the mindset of health

workers and in the political system of the concerned country. Previous emphasis on antenatal screening for risk factors alone seems to be inadequate and it has been suggested that only essential obstetric care can substantially reduce maternal deaths (Maine & Rosenfield 1999; Weil & Fernandez 1999).

The suspicion that there were more maternal deaths in the community was initially borne out of the arrival of more sick patients. However, it is well known that the majority of births in sub-Saharan Africa still take place outside of health institutions and are attended by relatives or untrained providers (Kwast, Kidane-Mariam et al 1986). Definitely, the spillover effect would mean that those who reach hospitals arrive in critical condition, but it is also true that complications can arise even in women who have had an uneventful pregnancy period. The estimate that 15% of normal pregnancies are destined to develop life-threatening complications implies that institutional deliveries should be universal (UNICEF/WHO/UNFPA 1997). However, not all patients can be accommodated in these institutions and many more cannot reach areas of skilled care when complications arise for various reasons, including poverty and a lack of adequate transport facilities (Moller et al 1989). Therefore, there is a need to have an estimate of the magnitude of maternal deaths that occurs outside institutions in order to develop better plans for the delivery of services.

6.4 Education on danger signs - the most crucial human resource factor

It is now common wisdom that all pregnancies face risk and WHO has estimated that 15% of all pregnancies may develop life-threatening emergencies which will require major interventions if maternal deaths are to be averted (UNICEF/WHO/UNFPA 1997). This has led to the conclusion that screening for risk factors during the antenatal period is insufficient without the availability of emergency obstetric care, since most of these emergencies are unpredictable. Additionally, the majority of maternal deaths occur among low-risk women (Granja 2002). This outlook has even suggested that antenatal care does little to reduce maternal deaths since, for example, in

Tanzania more than 90% of pregnant women do attend antenatal care.

While there is some truth to these conclusions, we do not feel that they are wholly correct. This is due to the fact that while all pregnancies face risk, we have to appreciate that some pregnancies face more risk than others. This is a safer caveat, as it emphasises the need for the continuum of pregnancy monitoring. There is ample evidence now that antenatal care is a highly cost effective exercise, as two of the six most cost effective sets of health interventions in low-income countries include components of antenatal care (Jowett 2000; World Bank 1993). In a World Development Report it was estimated that in a typical low-income country, family planning costs $ 100 per DALY averted, whilst antenatal/delivery care costs $ 60. The report also estimated that family planning services would avert 1% of the total disease burden, whilst antenatal and delivery care would avert 3% (World Bank 1997). In fact, it has been estimated that 26% of maternal deaths are avoidable through antenatal/community-based interventions, costing around 30% of the WHO Mother Baby Package. It has also been estimated that access to quality essential obstetric care can prevent a further 48% of maternal deaths, consuming 24% of the total Mother Baby Package costs (UNICEF/WHO/UNFPA 1997). A more recent analysis has revealed that the distribution in total annual programme expenditures for expanded coverage are 16% for antenatal care, 53% for intrapartum care and 31% for postpartum care (Darmstadt et al 2005).

Antenatal care programmes were designed in the 1920s, not only to screen for pregnancy complications, but also to detect conditions that might affect outcome of labour. The aim for antenatal care also included the ascertainment of taking the pregnancy to term, the correction of conditions such as anaemia, which arise during the antenatal period, and improving foetal outcome (Lindmark 1992). In our study sample, antenatal coverage was above 85% and the maternal mortality was high; this needs closer consideration. Similarly, high coverage has been demonstrated in other low-income countries, which also have high maternal mortality. Of course these have to be compared to the quality of care instituted in high-income

countries where, apart from the utilisation of more resources, there has been a direct correlation between pregnancy outcomes and the number of antenatal visits (Dranzacic 2001). One important randomised trial in Zimbabwe was the first to show that antenatal care can be provided with fewer resources and still give satisfactory pregnancy outcomes (Munjanja et al 1996).

The knowledge and attitudes towards obstetric risk must be continually monitored; otherwise late care-seeking or complete neglect of the pregnant woman may result. Health workers are expected to have the knowledge and the necessary skills in order to anticipate and mitigate life-threatening situations when the need arises. Since many births take place outside health institutions, it important for families and traditional birth attendants to be aware of these risks early so that they can seek appropriate care. Issues such as transport, distance and place of confinement must be defined well in advance.

When we made an assessment of the levels of knowledge and attitudes towards obstetric care, risk factors and danger signs (study III), we found that there was an overall lack of adequate knowledge in all three sections of the population including among peripheral health workers. This is an indication that the proper management of life-threatening emergencies was in jeopardy and may have explained the late arrivals, delays and even the occurrence of preventable complications in women who were in labour in the study community.

The issue of high antenatal coverage but a low proportion of institutional deliveries was explored. It seemed that the population knew where to seek care during emergencies but still refrained from using the facilities. Similar findings were obtained in a study in South Africa (Myer & Harrison 2003). It revealed the reluctance to frequent health facilities due to perceived attitudes of the health workers. These bottlenecks resulted in a preference for home deliveries and, secondly, for delivery with traditional birth attendants. Recently, there have been numerous reports of abuse of women during labour from various areas of the continent (Jewkes et al 1998; Grossman-Kendall et al 2001; Kyomuhendo 2003). This is a serious issue as it negates the whole aim of institutional deliveries and

attendance by a skilled attendant, which has been strongly advocated by WHO as the major intervention towards the reduction of maternal mortality. Indeed, it is one form of violence against women that seems to be rooted in culture, even at the family level. Unless these issues are discussed and solutions found, women will resist institutional deliveries and a general lack of trust in the existing health system may have far-reaching effects, as was revealed in a study in Cape Verde (Wessel et al 1998).

The magnitude of the issue of abuse is not universal, however, as there are encouraging reports of improvements when these issues are followed-up. It has also been found that the level of satisfaction can be enhanced, as shown in a study from Zambia (Mackeith et al 2003) and in Trinidad and Tobago (Singh et al 1999).

6.5 Delay is a also a "danger sign"

In low-income countries the fact that the majority of births occur outside health institutions with an ensuing lack of vital registration implies that even perinatal mortality rates are underestimated. Delays in care have been found to be the major cause of maternal mortality and Thaddeus and Maine (1994) alerted the world by launching the "three phases of delay" model. It provides a tool for analysing the circumstances surrounding the interval from the appearance of a danger sign to the death of a mother. To our knowledge, this method has never-before been applied to perinatal mortality, which we did in study IV. We revisited the issue of maternal and perinatal mortality reduction using the experiences from the preceding studies, particularly study I.

The need for more complete maternity care to reduce maternal and perinatal mortality has been suggested in studies from low-income countries (Fauveau et al 1991) and the prevention of maternal and perinatal mortality have been major issues in global public health in recent decades. Despite these priorities, the burden of both of these problems remains high in many low-income countries (Dawodu 1998; Maine & Rosenfield 1999).

Due to difficulties in the measurement of maternal mortality, it has been suggested that perinatal mortality be used as a proxy for maternal mortality, since the most common threats to the mother's survival during pregnancy or childbirth are in most cases, the cause of death of the newborn (MotherCare 1991). Indeed, perinatal deaths occur much more often than maternal deaths, and are easy to measure as compared to maternal deaths, which are relatively rare events.

 In the audit, which utilised birth weight-specific fresh stillbirths, useful results were obtained, which pointed out the deficiencies in the study-area health system. Ironically, delays in the health system constituted the major cause of perinatal and maternal mortality. This finding was unexpected, since the prevailing attitude was always to blame the victim. Therefore this aspect of the health system needs to be given more emphasis without forgetting the roles of the other aspects of care, that is the antenatal, transport and even community influences. Hence, in our study IV we utilised perinatal audit as an assessment tool. This approach is supported by others who state that the process audit complies with the principles of the audit method when utilized, as we did, to compare actual practice and standard (best) practice (Mancey-Jones & Brugha 1997).

Confidential enquiries into maternal deaths have become a cornerstone in the reduction of maternal mortality since its inception in the United Kingdom in the early 1950s (Wildsmith 2003). In many institutions in low-income countries, the exercise is mainly a "hot seat" for doctors and midwives in-training and has lost meaning as a useful tool for the improvement of services. It is not surprising that, after graduation, these workers tend to abandon the practice in their areas of work, making it unsustainable.

The audits we conducted in study I did not have the same character and this may explain why they have been sustained for long periods of time. In our regular monthly reviews, which originally started with maternal deaths (paper I), everybody in the department was involved. There was an open discussion and care was always taken not to apportion blame to any individual. This process of audit was applied even in study IV and the value

has been documented in other areas of the continent (Bugalho & Bergström 1993; El Amin et al 2002). Indeed, the involvement of other workers from relevant departments, such as the pharmacy, laboratory and operating room, gave an opportunity to learn from each other and to appreciate each other's efforts in solving the prevailing problem. In many cases, the exchange of ideas was very fruitful and suggestions, which were placed on the table for consideration, were regarded as combined efforts from each participant.

There is ample evidence that such mortality review meetings are important tools for the improvement of essential obstetric services, even at district hospital levels in low-income countries (Pattinson et al 1995; Stekelenburg et al 2004). Recently, there have been suggestions to focus on audits on "near miss" cases in addition to audits of maternal deaths, in order to also include cases that were saved despite almost dying (Okong et al 2005. This is a welcome step, although there have been some difficulties in defining what really constitutes a "near miss" event. Guidelines have been developed and can be adapted to individual circumstances.

Also, it has been suggested that criteria for the clinical audit of the quality of hospital-based obstetric care in low-income countries be established so that evaluations can be standardised (Graham et al 2000). The major problem here seems to be the involvement of multinational teams with different backgrounds and interpretations of the degree of complications, with possible resulting disagreements. As a compromise, criterion-based audits have been suggested, which set local standards. The major part of record review is then performed by low-cadre staff. The latter may be more applicable to low-income settings, where, in many cases, doctors and, particularly, specialists are few. This is especially the case in rural areas where it may be difficulty to establish local review boards.

7. CONCLUSIONS

The following conclusions arise from the various studies undertaken in this thesis:

- The real magnitude of institutional maternal mortality can only be obtained by proper record keeping and searching for these deaths from other areas of the hospital where female patients are admitted; these include the medical and surgical departments, operation theatres and mortuary.

- Maternal and perinatal mortality can be reduced by low-cost interventions which are available in most low-resource settings such as the one where these studies were performed

- The interventions must be simple, local and not needing a lot of external support in expertise and funds

- Regular audits of maternal and perinatal mortality are possible in health institutions in these settings, but they require that some conditions are ensured in order to make them sustainable. These include the involvement of all staff in the units, stewardship, a non-accusing atmosphere and feedback to the staff so that they see the value of the audits in their daily practice

- In order to involve everybody in the audit process local standards must be set, according to which conclusions will be based. The use of "criterion-based audit" methodology should be introduced, whereby data is collected by auxiliaries.

- Health managers and administrators should not concentrate on mortality as impact indicator but utilise and appreciate the value of process indicators to guide programmes in their areas.

- Low cost methodologies exist for the assessment of the magnitude of maternal mortality in the community but their limitations must be borne in mind so that they are interpreted with caution, especially when they are for planning purposes to improve services.

- Stakeholders' knowledge and views, including those of community members and traditional birth attendants must be taken into consideration so that any improvement plans are incorporated in each area.

- Utilisation of the simple "Three Phases of Delay Methodology" should be adapted as a standard audit procedure for maternal and perinatal deaths.

- The findings of these studies should be a stimulus to national obstetrics and midwifery societies to plan for a national Confidential Enquiry establishment as a body which will monitor obstetrics and perinatal outcomes in order to reduce the unacceptably high maternal and perinatal mortality indices, which exist in the country.

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