

**MATERNAL MORTALITY AT KENYATTA
NATIONAL HOSPITAL (NAIROBI, KENYA)
2000-2008**

**A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT
FOR THE DEGREE OF MASTER OF MEDICINE IN
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2009

DECLARATION

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ABSTRACT

Background

Developing countries account for majority(99%) of maternal deaths globally. These countries have committed themselves to reducing maternal mortality by three quarters by the year 2015, in line with the millennium development goals. This study intended to establish whether interventions towards achieving this goal in Kenya have influenced the pattern of maternal mortality at Kenyatta national hospital, the biggest referral hospital in Kenya.

Objectives

To describe the magnitude, causes, contributing factors and trends of maternal mortality at KNH for the 9 year period starting 1st January 2000 to 31st December 2008

Design

Analysis of maternal deaths

Setting

Kenyatta National Hospital (KNH)

Study population

All maternal deaths that occurred over the 9 year period starting 1st January 2000 to 31st December 2008

Methodology

The inpatient numbers and dates of deaths for all past cases of maternal deaths were obtained from the coding and indexing section of the records department; files were then retrieved from the secondary filing section. Patient files for maternal deaths that occurred during the study were obtained from respective departments. A questionnaire comprising both open and close-ended questions was then used to extract required information. Data was analyzed using statistical computer programmers - excel and SPSS.

Results

There were 1024 maternal deaths and 56,866 deliveries; MMR was therefore 1800/100,000 live births. Direct and indirect obstetric causes accounted for 54% and 29% of the deaths respectively. Overall, HIV (18.8%), abortion complications (14.9%), eclampsia (13.9%), puerperal sepsis (12.7%) and postpartum hemorrhage (5.1%) were the leading causes of maternal deaths. Over three-quarters of direct obstetric deaths were due to eclampsia, abortion, and puerperal sepsis in almost equal proportions. HIV accounted for most indirect obstetric deaths (64.4%), followed by anemia (16.1%), malaria (11.1%), and cardiac disease (6.4%). Mean age and mean parity at death were 26.61 years and 1.79 respectively. Decision to intervention intervals for emergency surgeries, blood transfusions and ICU admissions were within 2 hours for only 52%, 38%

and 61% cases respectively

Conclusion

HIV has emerged as the leading cause of maternal mortality at KNH, surpassing all the traditional major causes of maternal deaths i.e. hemorrhage, abortion, puerperal sepsis and hypertensive disorders in pregnancy.

Sub optimal care was also a contributing factor to the maternal deaths

Majority of women who died were between 20-34 years, which is the peak of child bearing age in Kenyan women

.

Recommendations

Periodic maternal mortality studies should be done to monitor emerging trends in maternal mortality causes, as well as evaluate effectiveness of interventions aimed at reducing maternal mortality.

Regular CMEs should be organized and SOPs on management of the major causes of maternal mortality formulated to ensure optimal patient care.

ABBREVIATIONS/ACRONYMS

MDGS	Millennium Development Goals
KNH	Kenyatta National Hospital
MMR	Maternal Mortality Ratio
ICD 10	International statistical classification of diseases and related health, Problems, 10th revision
ANC	Antenatal care
HIV	Human immunodeficiency virus
AIDS	Acquired immunodeficiency syndrome
SES	Socioeconomic status
GDP	Gross Domestic Product
FGM	Female Genital Mutilation
TFR	Total Fertility Rate
RAMOS	Reproductive Age Mortality Studies
ICU	Intensive Care Unit
KDHS	Kenya Demographic and Health Survey
UNICEF	United Nations Children's Fund
MVA	Manual Vacuum Aspiration
C/S	Caesarian Section
SOP	Standard Operating Procedure
CME	Continuous Medical Education

Operational definitions: ICD 10

Maternal death: death of a woman while pregnant or within 42 days of termination of pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes.

Maternal deaths are divided into two groups:

- *Direct obstetric deaths:* those resulting from obstetric complications of the pregnant state (pregnancy, labor, puerperium), from interventions, omissions, incorrect treatment, or from a chain of events resulting from any of the above.
- *Indirect obstetric deaths:* those resulting from previous existing disease or disease that developed during pregnancy and which was not due to direct obstetric causes, but which was aggravated by physiologic effects of pregnancy.

Pregnancy related death: death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of cause of death

Late maternal death: death of a woman from direct or indirect causes more than 42 days but less than one year after termination of pregnancy.

Live birth: complete expulsion or extraction from its mother of a product of conception, irrespective of duration of pregnancy, which after such separation, breathes or shows any other evidence of life such as beating of the heart, pulsation of umbilical cord or definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached.

1. INTRODUCTION AND LITERATURE REVIEW

Magnitude of maternal mortality globally

Complications of pregnancy and childbirth are the leading cause of deaths and disability in women of reproductive age in developing countries (1). In 2005, the estimated global maternal mortality was 536,000, developing countries accounting for 99% of these deaths (2).

Estimates of MMR and number of maternal deaths by United Nations MDG regions, 2005(2)

Regions	MMR(maternal deaths per 100,000 live births)	Number of maternal deaths
World total	400	536,000
Developed regions	9	960
Countries of the commonwealth independent states	51	1800
Developing regions	450	533,000
Africa	820	276000
• Northern Africa	160	5700
• Sub-Saharan Africa	900	270,000
Asia	330	241,000
• Eastern Asia	50	9200
• South Asia	490	188,000
• South eastern Asia	300	35,000
• Western Asia	160	8300
Latin America & Caribbean	130	15,000
Oceania	430	890

The large regional differences in maternal deaths demonstrate that most of these deaths are preventable; one of the 8 priority millennium development goals (MDGs) concerns maternal health and aims to reduce by three quarters the maternal mortality between 1990 and 2015(3).

The leading causes of maternal mortality globally include hemorrhage (24%), infections(15%), complications of abortion(13%), eclampsia(12%) and obstructed labor(8%). (1) The largest threat of maternal death occurs during labor, birth and the 24 hours after birth. (5)

Information on maternal mortality levels worldwide prior to 1900 is scanty. However, historical studies show that maternal mortality in developed countries before the 20th century was similar to that of many developing countries today. Among members of the ruling houses of Europe, about 2000 women died per 100,000 live births during the 16th, 17th and 18th centuries and 1470 per 100,000 during the first half of the 19th century. Maternal mortality in England and Wales was 549/100,000 births and 349/100,000 births for the periods 1891-1895 and 1911-1913 respectively (12)

In the early 20th century, industrialized countries halved their maternal mortality by providing professional midwifery care at childbirth; they further reduced it to current historical lows by improving access to hospitals after the second world war(1). Between 1951-1953, the lowest MMRs were 67.7, 69.0 and 73.1 for USA, Sweden, and Israel respectively. In 1961-1963, Sweden had the lowest MMR at 21/100,000 live births (12). Currently, the average MMR in developed countries is 9/100,000 live births (2).

A number of developing countries have gone the same way over the last few decades (1):

In Sri Lanka, maternal mortality levels were above 1500/100,000 live births in the first half of the 20th century. From around 1947, mortality levels started to drop following improved access and development of healthcare facilities in the country. By 1975, maternal mortality ratio was 80-100 per 100,000 live births. Improved management and quality further lowered them to below 30 in the 1990s.

Until the 1960s, Thailand had maternal mortality levels well above 400 per 100,000 live births. During the 1960s, traditional birth attendants were gradually substituted by certified village midwives; mortality came down to between 200 and 250 per 100,000 births. Registration of more midwives and improvement of health facilities led to a steady drop in maternal mortality. By 1990, MMR was below 50 per 100,000 live births.

More recently, Egypt reduced its maternal mortality by more than 50% in eight years, from 174 in 1993 to 84 per 100,000 live births in 2000. Major efforts to promote safer motherhood doubled the proportion of births attended by a doctor

or nurse and improved access to emergency obstetric care.

These examples illustrate that long term initiatives and efforts to provide skilled professional care at birth produces favorable results. On the other hand, however, breakdown in access to skilled care results in unfavorable outcomes.

Malawi experienced a significant reversal in maternal mortality from 752 maternal deaths per 100,000 live births in 1992 to 1120 in 2000. This was due to increase in deaths due to AIDS, fewer mothers delivering in health facilities and deterioration of quality of care within health facilities. In Iraq, sanctions during the 1990s severely disrupted previously well functioning health care services and MMR increased from 50 per 100,000 live births in 1989 to 117 per 100,000 live births in 1997.

Maternal mortality in Kenya

Maternal mortality is a serious public health problem in Kenya(13). Approximately 14,700 women die each year due to pregnancy related complications while between 294,000 and 441,000 suffer disabilities caused by complications during pregnancy and childbirth (14). Maternal deaths represent 15% of all deaths to women aged 15-49 years (15).

The most recent national estimates of MMR are 414 maternal deaths per 100,000 live births, and the lifetime risk of maternal death is 1 in 40. (15) There are huge differences in maternal mortality levels between provinces and districts. For example, in three rural districts studied by Makokha et al (1989-1990), the MMRs for Kakamega, Kirinyaga and Kilifi districts were 219, 283 and 340 per 100,000 live births respectively. In the Kenya maternal mortality baseline survey (1994) that covered 10 districts, Kwale district had the highest MMR at 2220 maternal deaths per 100,000 live births while that for Nyeri district was the lowest at 19 per 100,000 births (16)

Subnational estimates for maternal mortality are, however, lacking. As a result, some indicators associated with maternal mortality have been used to gain some idea of regional maternal mortality patterns

Provincial indicators of 2 proxy indicators of the level of maternal mortality– 1993(17)

Province	TFR	Professionally trained attendant at delivery (%)
Nairobi	3.4	80.0
Central	3.9	73.8
Coast	5.3	32.4
Eastern	5.9	46.3
Nyanza	5.8	39.3
Rift Valley	5.7	40.0
Western	6.4	35.1
Average	5.4	45.4

These data give some indication that the level of maternal mortality as measured by maternal deaths of women aged between 15-49 can be expected to be highest in western and Nyanza provinces (high TFR and low professionally attended deliveries) and lowest in Nairobi and central provinces (lower TFR and higher professionally attended deliveries).

As regards maternal mortality trends, there's been no significant change in the levels of maternal mortality since the first national estimate in 1994. Maternal mortality in Kenya was estimated at 365, 590 and 414 per 100,000 live births in 1994, 1998 and 2003 respectively. However, sampling errors around each of these estimates are large and, consequently, these estimates are not significantly different. Indeed, trends in related indicators such as antenatal care coverage, delivery in health facilities and medical assistance at delivery have remained more or less stable over these periods (15,16,17).

Most of the information on medical causes of maternal mortality is derived from hospital based studies. Hemorrhage, sepsis, hypertension disorders of pregnancy, ruptured uterus and abortion account for the vast majority of direct obstetric deaths. The leading causes of indirect obstetric deaths include malaria, anemia, and HIV/AIDS. (16).

Selected hospital based maternal mortality studies

Researcher(s)	title	period	Live births, maternal deaths and MMR	Leading causes of maternal deaths
Makokha A E (18)	Maternal mortality at KNH	1972-1977	20,510 deliveries 99 maternal deaths MMR: 196/100,000	Sepsis 43.4% Hemorrhage 15.2% Ruptured uterus 6.1%
Ngoka WM, Bansal YP (19)	Maternal mortality at Pumwani Maternity Hospital	1975-1984	223,111 births 150 maternal deaths MMR: 67.2/100,000	Hypertension 20% Sepsis 19% Ruptured uterus 14% PPH 13%
Makokha AE (20)	Medicosocial and sociodemographic factors associated with maternal mortality at KNH	1978-1987	49,335 deliveries 156 maternal deaths MMR: 320/100,000	Abortion 24% Hypertension 12% Sepsis 12% Anemia 9%
Ruminjo SK (21)	Sociodemographic and gynaecological variables of maternal mortality in a Kenyan Subdistrict	1981-1988	86,248 live births 164 maternal deaths MMR: 190/100,000	Sepsis 28.1% Hemorrhage 23.8% Ruptured uterus 11.6% Eclampsia 6.7%
Jaldesa GW, Qureshi ZP, Kigonde CS, Wanjala SM (22)	Maternal morbidity and mortality at Garissa Provincial Hospital	1993-1995	2588 deliveries 44 maternal deaths MMR: 1700/100,000	Hemorrhage 40.9% Hypertension 18.2% Anemia 15.9% Sepsis 11.4%
Oyieke JB, Obore S, Kigonde CS (23)	Maternal mortality at KNH	1995-1999	27,455 deliveries 253 maternal deaths MMR: 921.5/100,000	Sepsis 42.8% Hemorrhage 10% Hypertension 9.4%
Maranga I (24)	Maternal mortality at Aga Khan hospital, Nairobi.	1992-2003	23,507 deliveries 32 maternal deaths MMR: 136/100,000	Hypertension 30% HIV 23.3% Hemorrhage 13.3% Postabortal sepsis 10%

Reducing maternal morbidity and mortality in Kenya remains a big challenge. For example, in the safe motherhood demonstration project in Western Province involving 4 districts (i.e. Kakamega, Vihiga, Lugari and Bungoma) between 2000 to 2003, interventions included educating women on danger signs in pregnancy and childbirth, involving TBAs in referral practices, a domiciliary birth model, outreach MCH clinics, improving referral systems, encouraging dispensaries to conduct deliveries and capacity building at institutional level. The overall case fatality rate for obstetric complications (facility based data) reduced from 3% to 2.4%, use of partograph to monitor labor increased from below 25% to over 75%, and MVA for abortion increased from 16% to 46%. However, there was only a small increase in births that took place with a skilled health care provider (27% to 29%) and minimal change in number of TBAs referring mothers to health facilities

2. Rationale

Maternal mortality is largely a burden of developing countries.

The global safe motherhood initiative, launched in Nairobi in 1987, was aimed at drawing attention to the dimension and consequences of poor maternal health in developing countries. It was also to mobilize action to address the high rates of death and disability caused by complications of pregnancy and childbirth (25).

Several conferences held thereafter in different parts of the world resulted in global recognition of the problem of poor maternal health and a global commitment to take action.

In 2000, UN member states established Millennium Development Goals(MDGs) to be achieved by 2015. MDG number 5 concerns maternal health and aims to reduce maternal mortality by three-quarters between 1990 and 2015(3).

Kenya's national reproductive health strategy (1997-2010) was a response to the global safe motherhood initiative and subsequent conferences that addressed reproductive health issues. Its objectives include, among others:

- Establishing the magnitude of maternal morbidity and mortality
- Reducing maternal mortality from 365/100,000(1996), to 300/100,000 by year 2000; 230/100,000 by year 2005 and 170/100,000 by year 2010.

The purpose of this study was to:

- Fulfill the need for regular reviews of maternal deaths as part of the strategy to reduce maternal mortality
- Establish whether interventions so far (targeting all levels of health service provision i.e. community to national level) have influenced the patterns of maternal mortality at Kenyatta National Hospital, the largest referral hospital in Kenya, in this new millennium.

3. AIM OF STUDY

To describe the pattern of maternal mortality at KNH for the 9 year period beginning 1st January 2000 to 31st December 2008.

4. OBJECTIVES OF STUDY

- To determine the magnitude of maternal mortality
- To identify causes of maternal mortality
- To describe the factors contributing to maternal mortality
- To demonstrate the trends in maternal mortality

6. MATERIALS AND METHODS

Study design

Analysis of maternal deaths

Study population

All maternal deaths that occurred beginning 1st January 2000 to 31st December 2008

Setting

The study was conducted at Kenyatta National Hospital (KNH), Nairobi, Kenya from 1st September 2008 to 31st December 2008.

KNH is the largest national referral, teaching and research hospital in Kenya with a bed capacity of 1800 and staff strength of about 5000. On annual basis, the hospital caters for over 80,000 inpatients and 500,000 outpatients. Its catchment population is drawn from Nairobi and its environs which include Kiambu, Thika, Machakos, and Kajiado districts. Approximately 8000 deliveries occur at the hospital each year(26,27)

Inclusion criteria

All maternal deaths that occurred in pregnancy or within 42 days of its termination, irrespective of duration or site of implantation, were included in the study

Data collection

The inpatient numbers and date of deaths for all past cases of maternal deaths were obtained from the coding and indexing section of the records department; files were then retrieved from the secondary filing section by the researcher assisted by a record clerk.

Patient files for maternal deaths that occurred during the study period were obtained from the respective departments. The in-charges of the concerned departments had been informed both verbally and in writing about the study and contacted the researcher/his assistants immediately a maternal death occurred.

A questionnaire comprising both open and close- ended questions was then used in extracting required information. This included:

- Sociodemographic data: age, marital status, level of education, occupation, residence. These were retrieved from the central records registration form, nurses cardex as well as doctors notes – all in the patients file.
- Obstetric and gynaecological history: parity, previous pregnancies and their outcomes, contraceptive use
- Past medical history: chronic illness, previous surgeries(excluding C/S)
- History of antecedent pregnancy: where patient attended ANC, gestation at first ANC visit, basic investigations done
- Patients general condition at admission
- Interventions instituted(as well as lack of or delay in interventions) following admission
- cause of death
- timing of death(antepartum, intrapartum, postpartum etc)
- postmortem findings

Filling of questionnaires was done by two research assistants, trained and supervised by the researcher. The research assistants underwent two-day training on importance and purpose of the proposed study as well as appropriate filling of the questionnaire.

Pilot testing of the questionnaire using 20 patient files was initially done. These were then scrutinized and discussed by the researcher and his assistants and appropriate adjustments made before proceeding with the study. For maternal deaths that occurred during the period of study, the patient's personal details, medical history and obstetric history were confirmed, or clarified where necessary, by interviewing the next of kin after obtaining consent. As there was no death where the cause was in doubt, no postmortem examinations were requested

Data analysis

Data was analyzed using statistical computer programmes - Excel and SPSS. Statistical analysis was performed using the chi square test; p values of less than 0.05 were considered significant.

7. LIMITATIONS OF STUDY

- Incomplete data entry in patients' records
- Misplacement of patient records – in part or in whole

8. ETHICAL CONSIDERATIONS

- Permission to carry out the study was obtained from the Kenyatta National Hospital Ethical and Research Committee.
- Data collected was used for purpose of the study only
- Only inpatient numbers rather than names were indicated on questionnaires to ensure confidentiality was upheld.

9. RESULTS

9.1 File retrieval

The total number of coded maternal deaths (deaths occurring at KNH that were classified as 'maternal deaths', as per ICD-10) were 1336; of these, 1146 maternal death files were obtained/retrieved; therefore, the overall file retrieval rate was 85.8%. The actual number of maternal deaths (i.e. deaths confirmed as maternal among retrieved files) was 1024.

Table 1: Coded maternal deaths, retrieved maternal death files and actual number of maternal deaths over study period

YEAR	2000	2001	2002	2003	2004	2005	2006	2007	2008
CODED	146	125	138	154	164	184	167	142	116
RETRIEVED	98	94	108	135	146	139	163	137	126
ACTUAL	96	94	107	115	129	116	133	124	110

Except for 2005, the percentage of retrieved files improved with advancing years. Retrieval rate was poorest for the year 2000 at 67.1%. In 2008, where part of the data was obtained prospectively, the number of files retrieved exceeded the coded deaths – 108.6% retrieval rate - meaning that some maternal deaths were not coded.

Differences between retrieved maternal death files and actual maternal deaths were due to:

- exclusion of maternal deaths occurring after 42 days to one year following end of gestation
- errors in coding. For example, death of a baby or a man being coded as maternal death.

9.2 Levels of maternal mortality

There were a total of 1024 maternal deaths and 56,866 deliveries over the 9 year study period, giving an MMR of 1800/100,000 deliveries.

Table 2: Yearly MMRS over study period

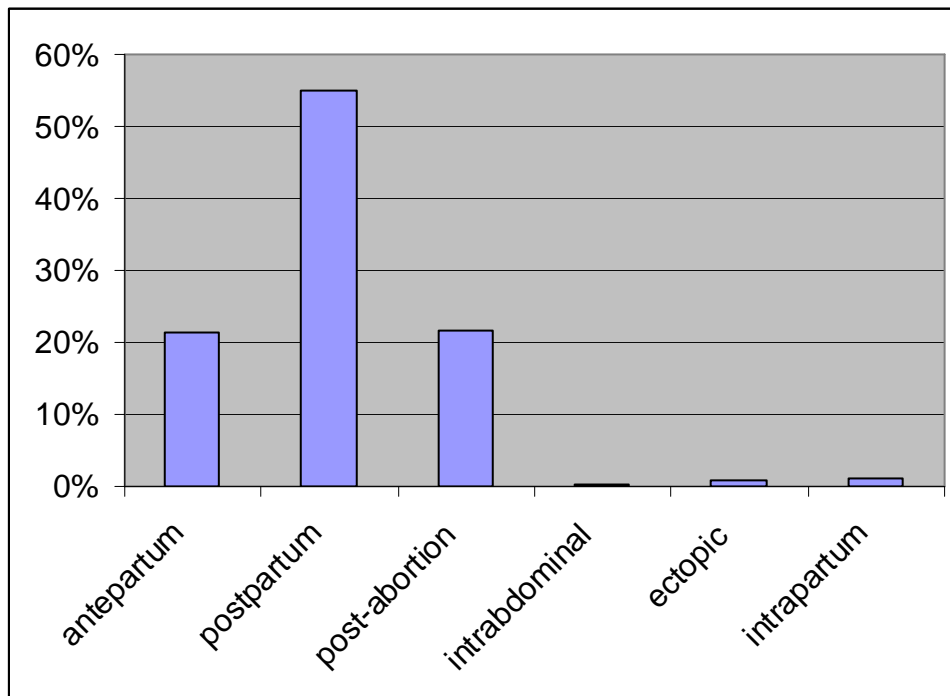
YEAR	2000	2001	2002	2003	2004	2005	2006	2007	2008
NO. OF DELIVERIES	4854	4131	4887	5271	6541	7064	7037	7850	9231
MATERNAL DEATHS	96	94	107	115	129	116	133	124	110
MMR	1977	2275	2189	2181	1972	1642	1890	1579	1191

Despite a steep rise in the number of deliveries with time, there was a steady decline in MMR over the same period.

9.3 Timing of maternal deaths (in relation to antecedent pregnancy)

More than half of the maternal deaths (55.1%) occurred in the postpartum period. The number of deaths in the antepartum period and following abortion were 21.3% and 21.6% respectively. Intrapartum deaths were only 1.2%. The remainder were associated with ectopic and intra-abdominal pregnancies.

Figure 1: Timing of maternal deaths

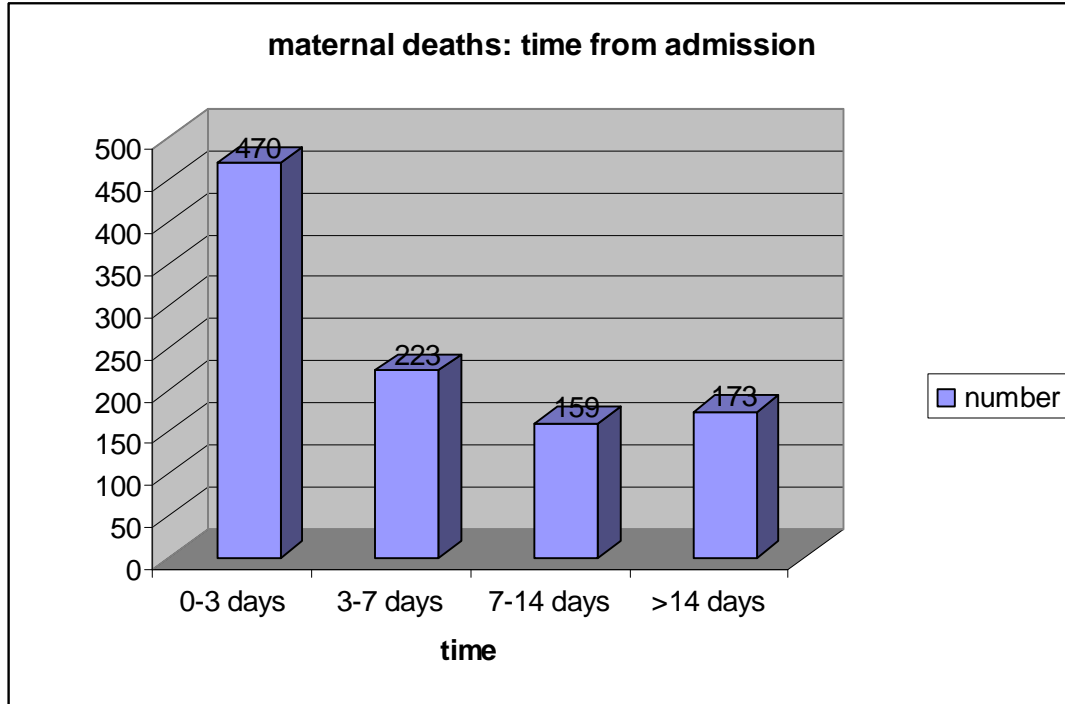


Half of the postpartum deaths (51%) occurred in the first postnatal week, two-thirds of these being within 72 hours of delivery. The distribution of antepartum deaths was: first trimester 11.3%, second trimester 56.5% and third trimester 32.2%

9.4 Time interval between admission and death

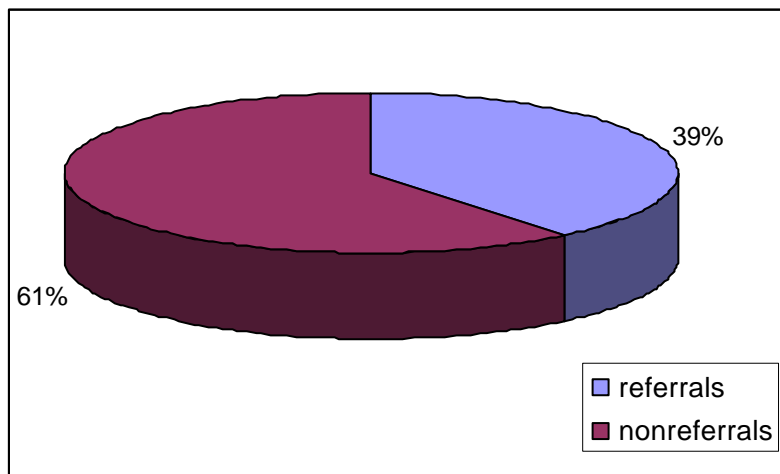
Two-thirds of maternal deaths occurred in the first week of admission; of these, two-thirds were within 72 hours.

Figure 2



9.5 Referral status

39.2% of all maternal deaths were initially referrals from peripheral facilities, private facilities accounting for a slightly higher number (54.6%) compared to government facilities(45.4%).



15% of all referrals were from Pumwani maternity hospital, the largest number for any single facility.

9.6 Causes of maternal mortality

More than half of all maternal deaths (54%) were as a result of direct causes. Those due to indirect, coincidental and unknown causes were 29%, 15%, and 2% respectively.

Overall, the leading causes of maternal deaths were HIV (18.8%), abortion complications(14.9%), eclampsia(13.9%) puerperal sepsis(12.7%) postpartum hemorrhage(5.1%) and anemia(4.7%)

Table 3: Overall top 10 causes of maternal deaths at KNH (2000-2008)

Cause	Frequency	Percent
HIV	193	18.8
Abortion	153	14.9
Eclampsia	142	13.9
Puerperal sepsis	130	12.7
Postpartum hemorrhage	52	5.1
Anemia	48	4.7
Pneumonia	42	4.1
Tuberculosis	36	3.5
Malaria	33	3.2
malignancy	26	2.5
Total	855	83.4

Direct maternal deaths

Over three-quarters of direct maternal deaths were due to abortion, eclampsia and puerperal sepsis in about equal proportions. Postpartum hemorrhage accounted for 9.5% direct maternal deaths. The MMR for direct maternal deaths was 967/100,000 deliveries

TABLE 4: Top 5 causes of direct maternal deaths at KNH (2000-2008)

Cause	Frequency	Percent
Abortion	153	27.8
Eclampsia	142	25.8
Puerperal sepsis	130	23.6
Postpartum hemorrhage	52	9.5
Severe preeclampsia	22	4
Total	499	90.7

Indirect maternal deaths

Most (64.4%) were due to HIV, followed by anemia(16.1%), malaria(11.1%) and cardiac disease(6.4%) The MMR for indirect maternal deaths was 524/100,000 deliveries

The commonest indirect comorbid conditions among women who died of direct obstetric causes were anemia (9.1%) and HIV (6.7%).

Table 5: Top 5 causes of indirect maternal deaths at KNH (2000-2008)

Cause	Frequency	Percent
HIV	193	64.5
Anemia	48	16.1
Malaria	33	11
Cardiac disease	19	6.4
hepatitis	4	1.3
Total	297	99.3

Coincidental maternal deaths

Almost half (49.4%) of these deaths were due to pneumonia and tuberculosis, while 13.9% were caused by meningitis. 16.5% were as a result of malignancies.

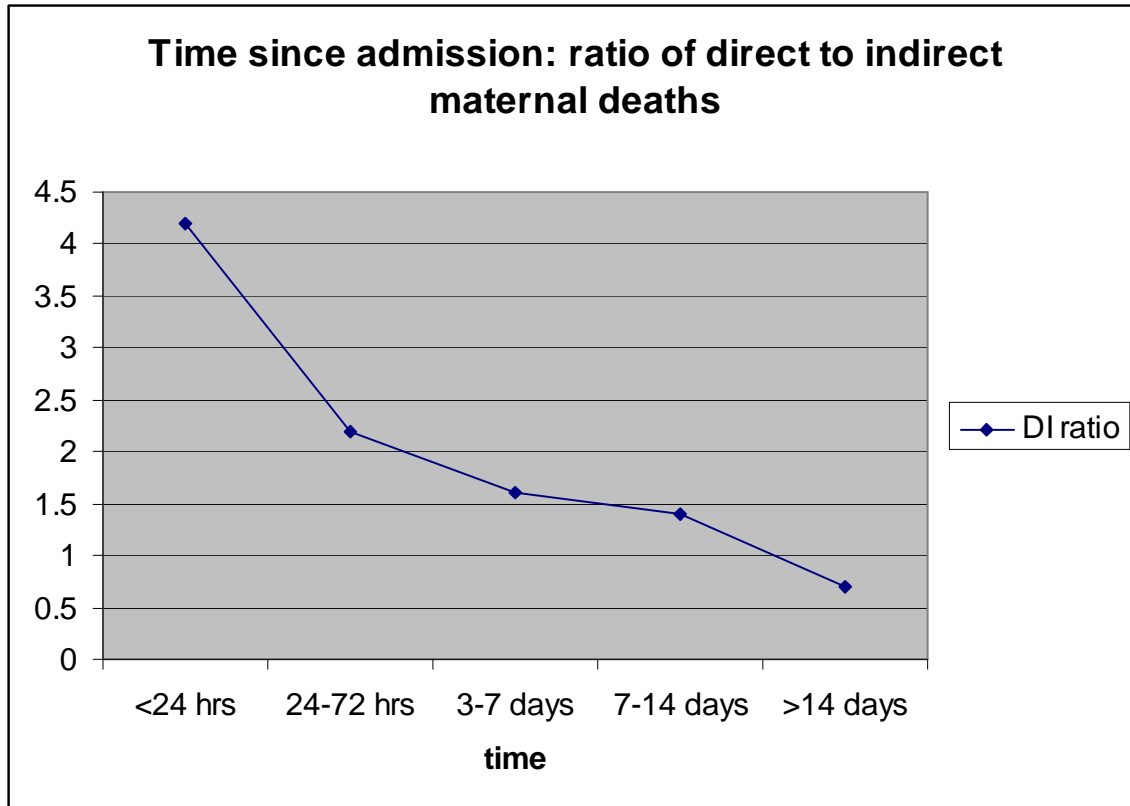
Table 6: Top 5 causes of coincidental maternal deaths at KNH (2000-2008)

Cause	Frequency	Percent
pneumonia	42	26.8
Tuberculosis	36	23.1
Malignancy	26	16.7
Meningitis	22	14.1
Upper gastrointestinal bleed	5	3.2

9.6.1 Interval between admission and death versus maternal death causes

The contribution of direct causes to maternal deaths declined with increase in interval between admission and death. The ratio of direct to indirect maternal deaths was 4:1 for deaths occurring within 24 hours of admission, while indirect deaths were 1.5 times more common for deaths that occurred more than two weeks following admission

Figure 3



Except for deaths occurring within 72 hours of admission, HIV was the commonest cause of death.

Within 24 hours of admission

Abortion(23.9%), eclampsia(15.4%), puerperal sepsis(10.4%), postpartum hemorrhage(8.2%) and anemia(6.8%) were the leading causes of death. Only 3.9% deaths were due to HIV.

24-72 hours of admission

Eclampsia(18.5%) and puerperal sepsis(16.4%) were the commonest causes of death. 12.2% of deaths during this period were HIV related. Abortion complications and postpartum hemorrhage were each associated with 9% maternal deaths.

3-7 days of admission

HIV related deaths were the commonest(23.8%). Eclampsia, abortion complications and puerperal sepsis caused 18.8%, 13%, and 10.3% maternal deaths respectively.

Second week of admission

Most deaths(22.6%) were HIV related; other leading causes during this period were puerperal sepsis(17%), abortion(12.6%), and eclampsia(9.4%).

More than 2 weeks after admission

40% deaths were HIV related. Puerperal sepsis and abortion were each responsible for 11.6% maternal deaths. 10.4% deaths were due to malignancies.

Table 7: Admission-Death(A-D) interval vs major maternal death causes(n=618)

Cause	A – D interval < 72 hrs	A-D interval ≥ 72 hrs	p value	Odds ratio; 95% CI
Abortion	84(32.8%)	69(19.1%)	.0001	2.07(1.41-3.08)
Eclampsia	78(30.5%)	64(17.7%)	.0002	2.04(1.37-3.03)
HIV	34(13.3%)	159(43.9%)	.0000	0.20(0.13-0.30)
Puerperal sepsis	60(23.4%)	70(19.3%)	.2576	1.28(0.85-1.92)
totals	256(100%)	362(100%)		

9.6.2 Timing of death versus maternal death causes

Postpartum maternal deaths

Puerperal sepsis accounted for most deaths (23.1%), followed by eclampsia (21%). 17.1% deaths were HIV related, while 9.2% were due to postpartum hemorrhage.

Post abortion maternal deaths

Two-thirds of these deaths were as a result of abortion complications. 12.6 % were due to HIV.

Antepartum maternal deaths

Indirect maternal deaths were much more common; the ratio of indirect to direct deaths was 4:1. Majority of the deaths were attributed to HIV(31.2%). Pneumonia and tuberculosis caused 18.8% deaths. 7.8% and 7.3% deaths were due to anemia and meningitis.

Table 8: Timing of maternal deaths vs major death causes(n=426)

Cause	antepartum	postpartum	P value	Odds ratio; 95%CI
Abortion	-	-	-	-
Eclampsia	14(17.1%)	118(34.3%)	.0037	0.39(0.20-0.76)
HIV	68(82.9%)	96(27.9%)	.0000	12.5(6.50-24.58)
Puerperal sepsis	-	130(37.8%)	-	-
total	82(100%)	344(100%)		

9.6.3 Referral status versus maternal death causes

Referrals

Direct and indirect causes accounted for 62.8% and 23.4% deaths respectively. Most deaths were due to eclampsia(20.9%). Other major causes of death were HIV(13.7%), abortion(12.2%), and puerperal sepsis(10.5%).

Non referrals

47.8% were direct maternal deaths and 32.7 % were indirect deaths. HIV was the commonest cause of death(22.2%). Deaths attributed to abortion, puerperal sepsis and eclampsia were 16.7%, 14.1% and 9.3% respectively.

Table 9: Referral status vs major maternal death causes(n=618)

cause	referrals	Non referrals	P value	Odds ratio; 95%CI
abortion	49(21.3%)	104(26.8%)	0.1513	0.74(0.49-1.11)
eclampsia	84(36.5%)	58(14.9%)	0.0000	3.27(2.18-4.91)
HIV	55(23.9%)	138(35.6%)	0.003	0.57(0.39-0.84)
Puerperal sepsis	42(18.3%)	88(22.7%)	0.229	0.76(0.49-1.17)
total	230(100%)	388(100%)		

9.8 Maternal deaths: Background characteristics

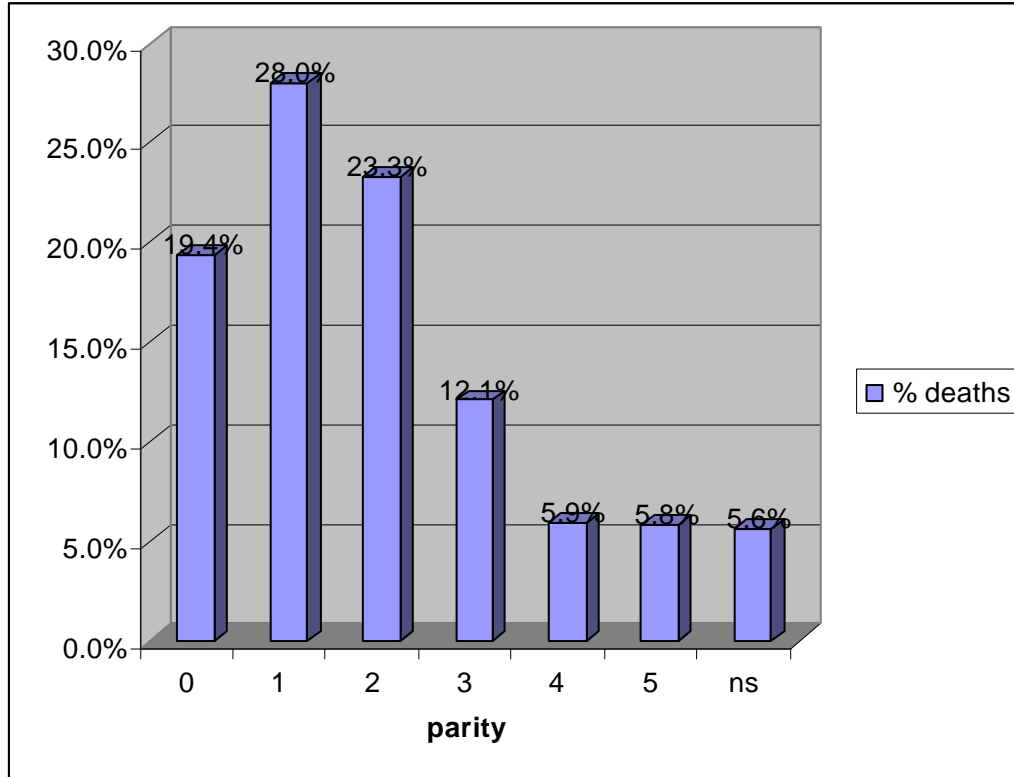
Table 10: Sociodemographic characteristics

Variable	frequency	Percent(%)
Age(yrs)		
<19	100	9.7
20-24	316	30.8
25-29	278	27.1
30-34	200	19.5
≥35	114	11.1
Not stated	16	1.6
Marital status		
Married	726	70.9
Single	219	21.4
Divorced/separated	40	3.9
widowed	14	1.4
Not stated	25	2.4
Education level		
primary	585	57.1
Secondary	290	28.3
College/university	41	4
None	41	4
Not stated	68	6.6
occupation		
business	128	12.5
Farmer	8	0.8
Formal	54	5.3
Informal	85	8.3
Student	22	2.1
Unemployed/housewife	692	67.6
Not stated	35	3.4

Parity

Majority were of low parity – 70.7% had 2 deliveries or less. The lowest and highest parities were zero and twelve respectively. Mean parity was 1.79.

Figure 5: Distribution of maternal deaths by parity



Place of delivery

Place of previous deliveries was indicated in 51.9% of the women. 36.9% of these had at least one home delivery.

Contraceptive use

Information on contraceptive use was recorded in 45.3% women; among these, only 43.3% had used a contraceptive, the commonest being “pills”

ANC Attendance

54% of women had a record on ANC attendance. Of these, 69.5% had attended ANC – at least one visit – at time of admission. Most women sought antenatal care in government facilities and had their first ANC visit in the second trimester

Figure 6

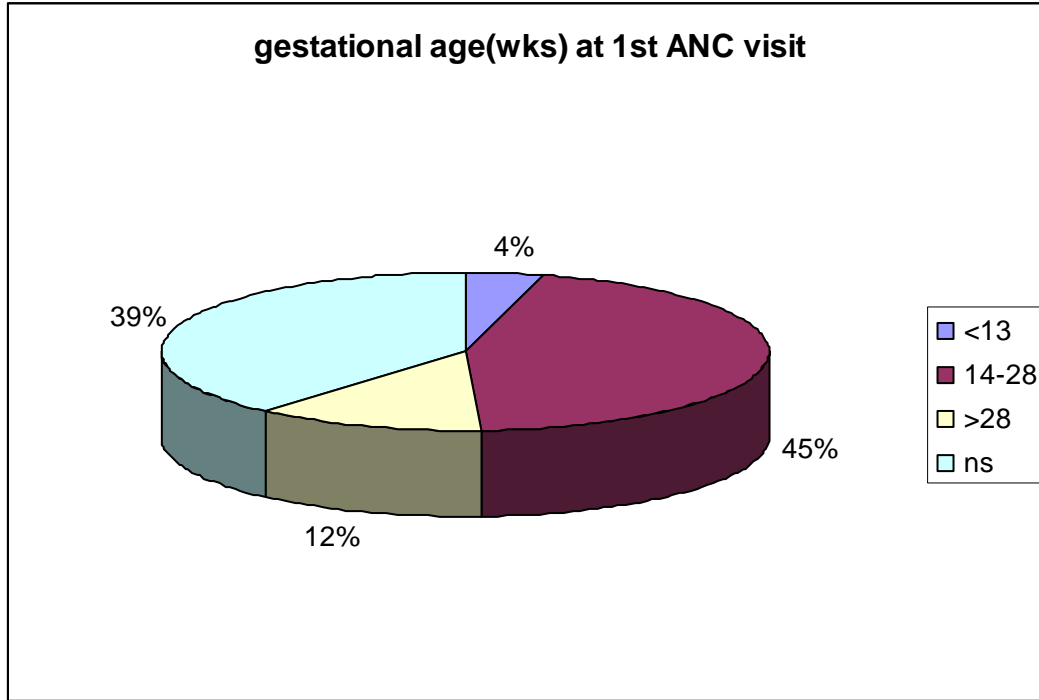
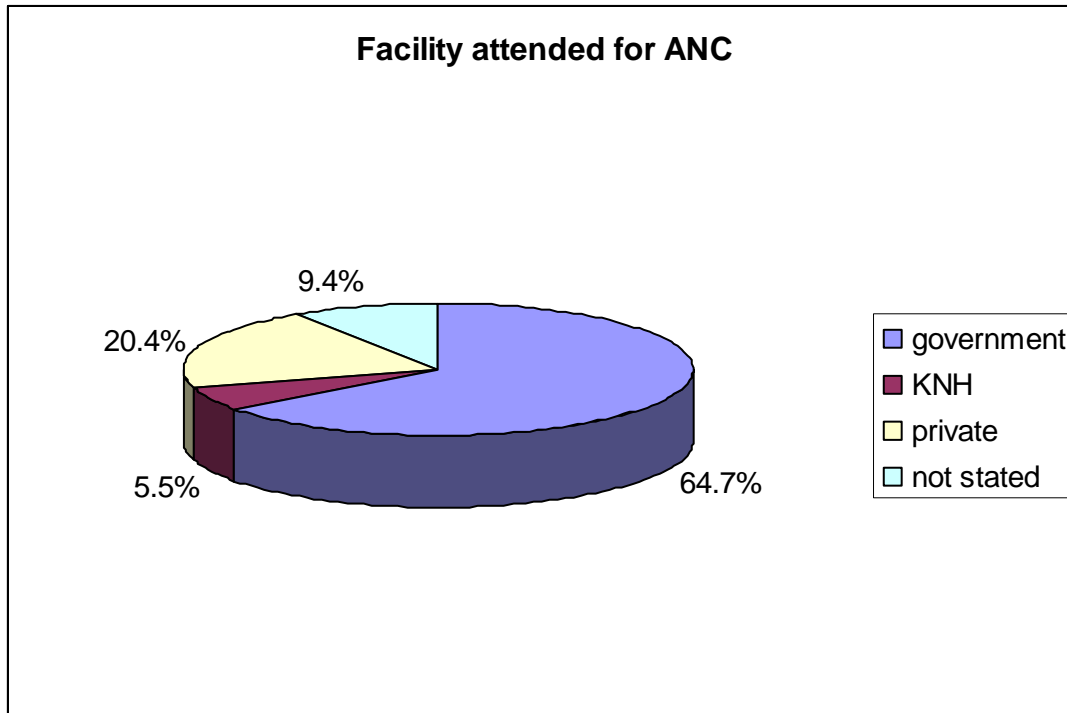


Figure 7

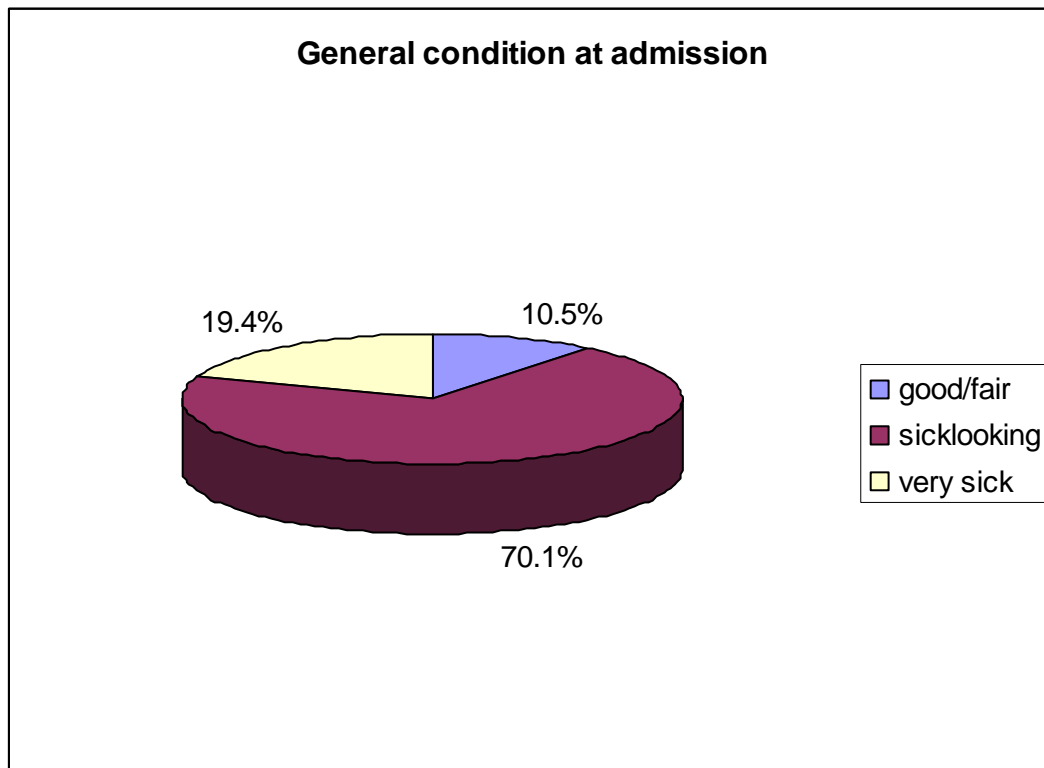


9.9 Delays contributing to maternal mortality

9.9.1 Patient's general condition at admission

19.4% of the women were in poor general condition/very sick at admission (those described as comatose, unconscious, semiconscious or gasping). The remainder were sick-looking or in fair/good general condition.

Figure 8



Two-thirds of patients in poor condition died within 72 hours while only 41% of those described as good/fair/sick-looking died over the same period.

Majority (59%) of patients in poor condition at admission were referrals; on the other hand, only 34% of patients described as sick-looking/good/fair at admission were referrals

Table 10: General condition at admission vs referral status(n=1024)

Referral status	Very sick	Good/fair/sicklooking
referrals	117(58.8%)	284(34.4%)
Non referrals	82(41.2%)	541(65.6%)
Total	199(100%)	825(100%)

P value .0000

odds ratio 2.72

95% Confidence interval 1.96-3.78

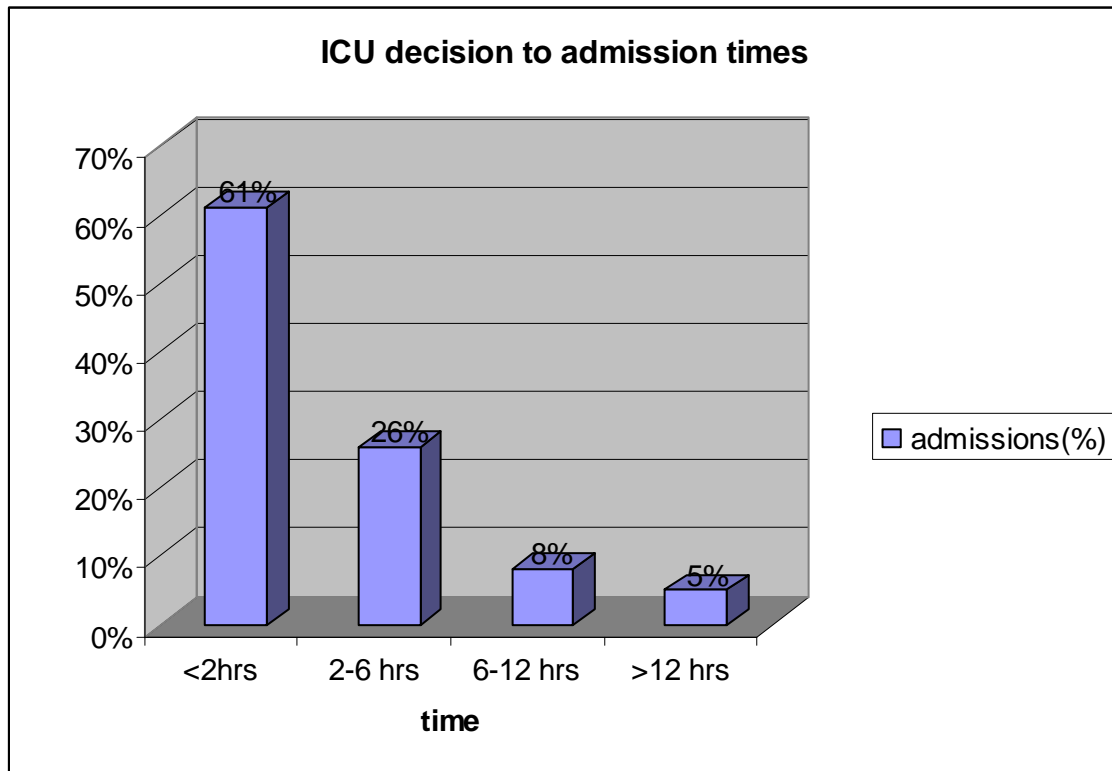
9.9.2 Admissions to ICU

A total of 268 patients required ICU care. 25(9.3%) and 68(25.4%) were admitted to ICU directly from A& E department and theatres respectively. The remaining 175(65.3%) were from inpatient wards – 140 were admitted while 35 died awaiting admission.

Most of the admissions were due to eclampsia(40.3%), followed by abortion complications(14.6%), postpartum hemorrhage(10%), and puerperal sepsis(6.3%).

Decision to ICU admission times from inpatient wards varied from within 2 hours to 46 hours, with 61% of patients being admitted within 2 hours

Figure 9



Of the deaths that occurred while awaiting ICU admission, 13 were within 2 hours of the decision to admit; the longest was 11 days.

The sole reason for delays in ICU admission was unavailability of an ICU bed.

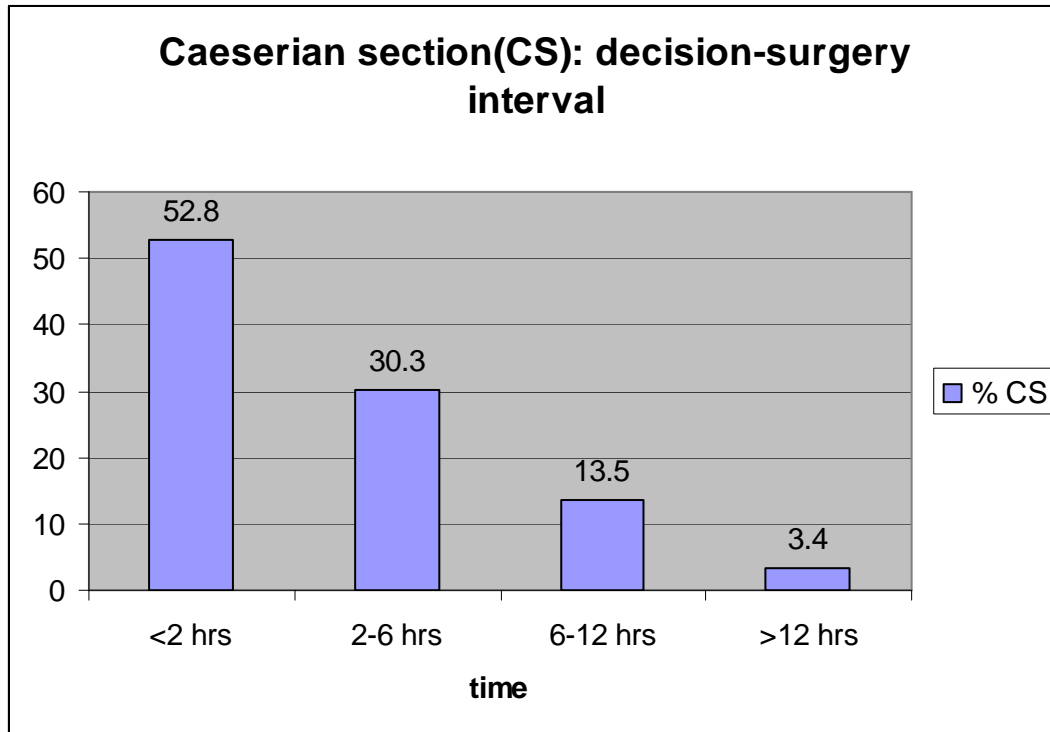
9.9.3 Decision to surgery interval

241 emergency surgeries were performed, 89(36.9%) being emergency caesarean sections. The other surgeries included 70 laparatomies(29%), 50 MVAs(20.7%), and 10 manual placenta removals(4.1%).

Caesarean sections

The interval between decision and surgery for caesarean sections ranged from within 2 hours to 19 hours; only 52.8% were within 2 hours.

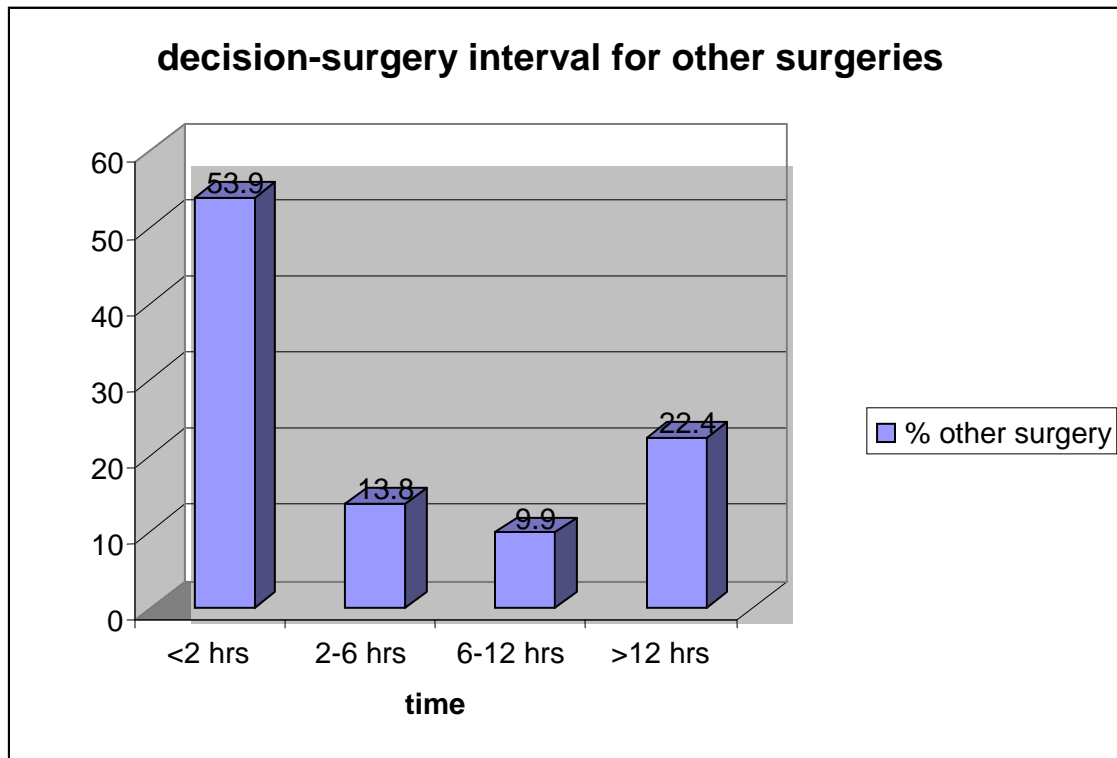
Figure 10



Other surgeries

The decision to surgery interval for other surgeries ranged from within 2 hours to 96 hours; only 53.9% were within 2 hours.

Figure 11



Reasons for delay of surgery

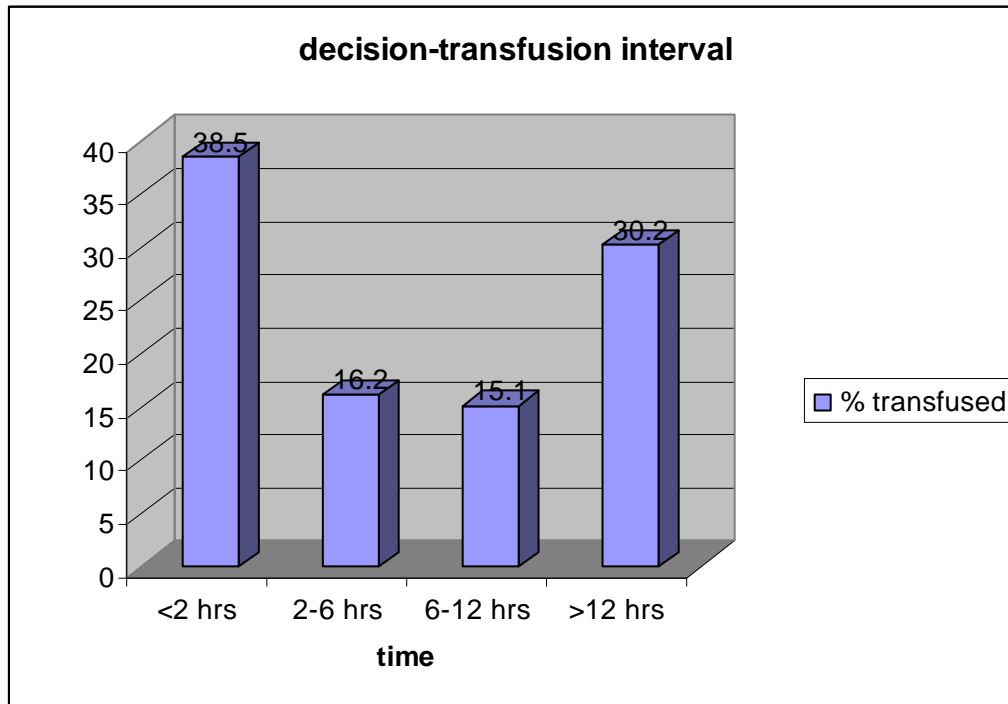
- Awaiting blood
- Awaiting theatre space
- Awaiting anaesthetist's review
- Anaesthetist not available
- Surgeon not available
- Awaiting investigation results
- To stabilize patient first
- Patient to be done during the day

9.9.4 Decision to transfusion interval

231 patients required urgent blood transfusion; 179(77.5) were transfused while 52(22.5) died awaiting transfusion.

The interval between decision to transfusion ranged from within 2 hours to 336 hours; only 69(38.5%) were within 2 hours.

Figure 12



16(30.8%) of the deaths before transfusion occurred within 2 hours of the decision to transfuse. The longest duration between decision to transfuse and death was 144 hours.

The commonest reasons for delay in transfusion (90% cases) were 'blood not ready' and 'blood not available'. The other reasons were:

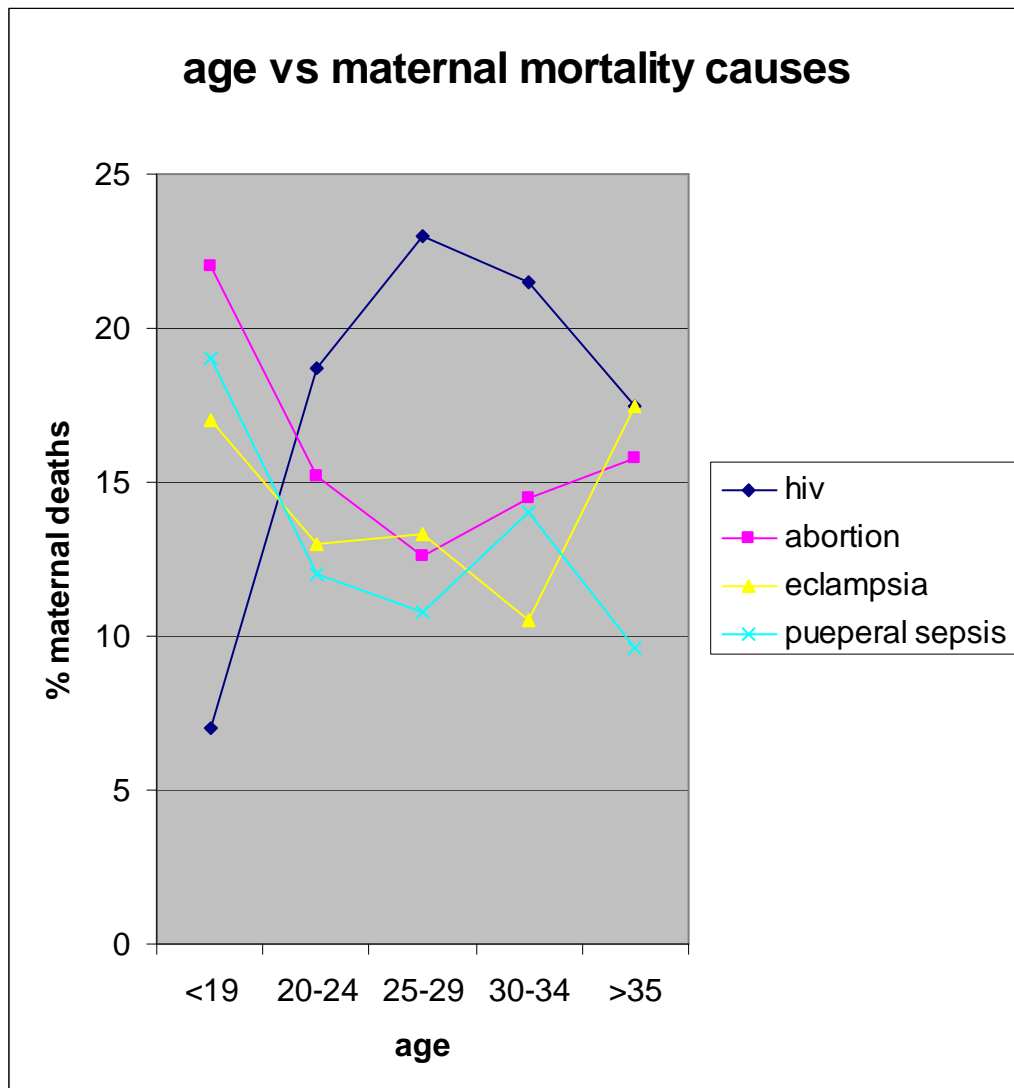
- Blood still warming
- Sample for grouping and cross match not taken
- Patient febrile
- Patient initially declined to be transfused

9.10 Relationship between background characteristics and causes of death

9.10.1 Age

HIV, abortion, eclampsia, and puerperal sepsis were the leading causes of deaths in all age groups. However, the proportion of deaths attributable to each of these 4 main causes varied depending on the particular age group.

Figure 13



HIV

HIV was the commonest cause of death in all age groups except those below 20 years. The proportion of HIV related deaths increased sharply (2-3 times) in women 20 years or older compared to younger women, and was highest in the 25-29 years age group.

Abortion

Abortion complications were the commonest cause of death in women below 20 years(22% deaths). In older women, 12-15% of all deaths were due to abortion.

Eclampsia

Deaths caused by eclampsia were highest in extremes of age(below 20 years and over 35 years), accounting for 17% deaths in these groups, compared to 10-13% deaths in the other age groups.

Puerperal sepsis

There was generally a decline in proportion of deaths due to puerperal sepsis with increasing age.

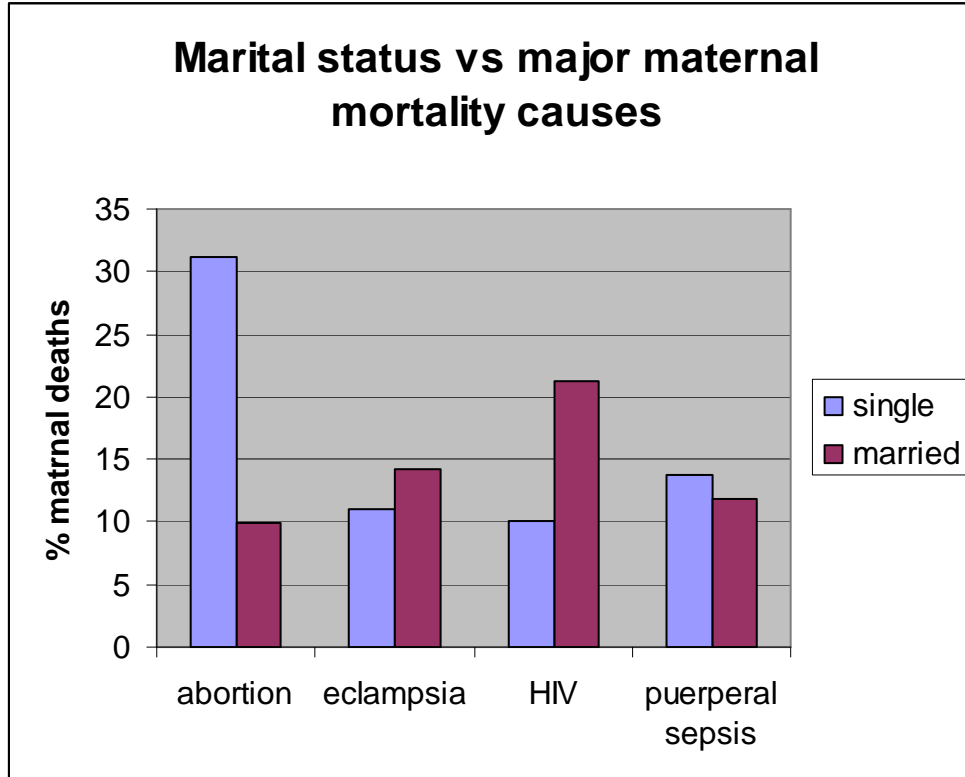
TABLE 10: AGE VS MAJOR MATERNAL DEATH CAUSES(n=607)

cause	< 25 yrs	≥ 25 yrs	P value	Odds ratio; 95%CI
abortion	70(27.9%)	82(23%)	0.2060	1.29(0.88-1.90)
eclampsia	58(23.1%)	78(21.9%)	0.8028	1.07(0.71-1.60)
HIV	66(26.3%)	127(35.7%)	0.0185	0.64(0.44-0.93)
Puerperal sepsis	57(22.7%)	69(19.4%)	0.3714	1.22(0.81-1.85)
totals	251(100%)	356(100%)		

9.10.2 Marital status

Abortion, eclampsia, HIV and puerperal sepsis caused most deaths in both single and married women.

Figure 14



Abortion was the commonest cause of death in single women (31.1%); in married women, HIV accounted for most deaths(21.3%)

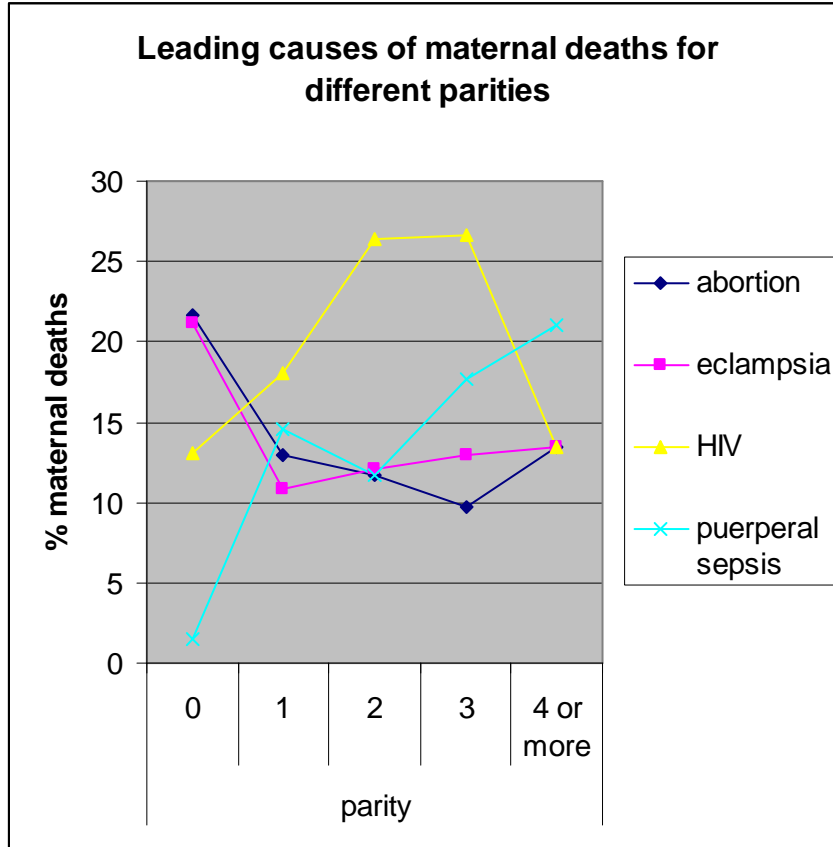
TABLE 11: MARITAL STATUS VS MAJOR MATERNAL DEATH CAUSES(n=560)

cause	Single	married	P value	Odds ratio; 95% CI
abortion	68(47.2%)	72(17.3%)	0.000	4.27(2.77-6.61)
eclampsia	24(16.7%)	103(24.7%)	0.0596	0.61(0.36-1.02)
HIV	22(15.3%)	155(37.3%)	0.0000	0.30(0.18-0.51)
Puerperal sepsis	30(20.8%)	86(20.7%)	0.937	1.01(0.62-1.65)
totals	144(100%)	416(100%)		

9.10.3 Parity

Abortion, eclampsia, HIV, and anemia were the leading causes of deaths in nulliparas; for other parities, most deaths were due to abortion, eclampsia, HIV, and puerperal sepsis

Figure 15



The proportion of deaths due to abortion and eclampsia in nulliparas was 1.5-2 times higher compared to other parities; that due to HIV related deaths increased gradually with increase in parity, peaking at parity of 2 and 3, then declined

Table 12: Parity(at admission) vs major maternal death causes(n=580)

cause	parity		P value	Odds ratio; 95% CI
	0	≥ 1		
abortion	43(37.7%)	93(20%)	0.0001	2.43(1.52-3.87)
eclampsia	42(36.8%)	92(19.7%)	0.0002	2.37(1.49-3.78)
HIV	26(22.8%)	164(35.2%)	0.0157	0.54(0.33-0.90)
Puerperal sepsis	3(2.6%)	117(25.1%)	-	-
totals	114(100%)	466(100%)		

9.10.4 Place of delivery

The proportion of maternal deaths caused by puerperal sepsis among patients who had a previous home delivery (32.2%) was four times higher compared to those who did not (8%).

Table 13: Place of delivery vs major maternal death causes(n=241)

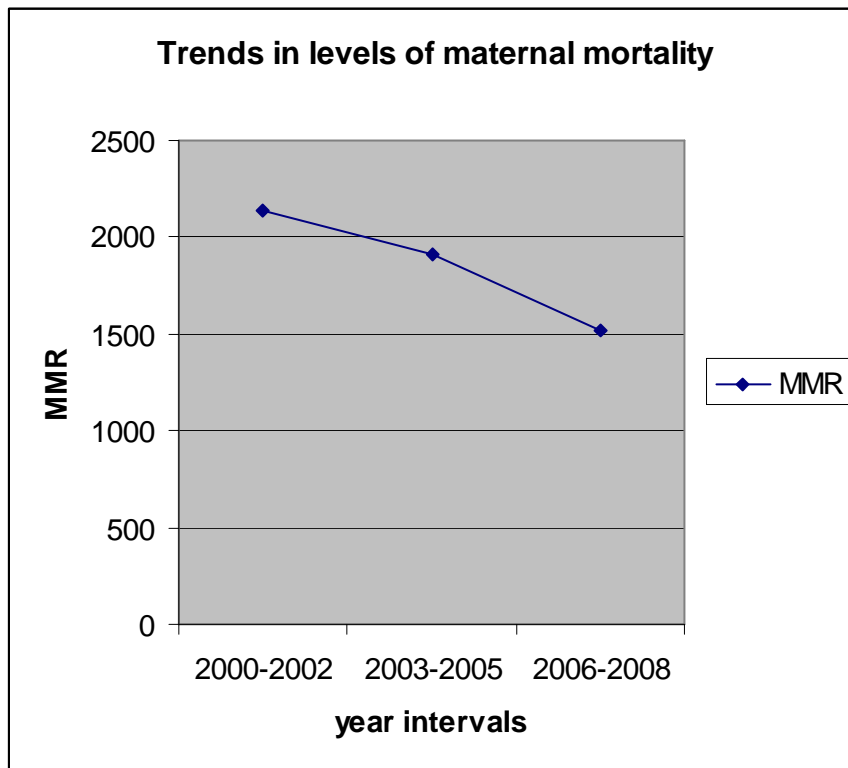
cause	Home delivery		P value	Odds ratio; 95% CI
	yes	no		
abortion	10(9.5%)	16(11.5%)	0.7729	0.81(0.32-1.99)
eclampsia	15(14.3%)	24(17.3%)	0.6508	0.80(0.37-1.70)
HIV	31(29.5%)	66(47.5%)	0.0068	0.46(0.26-0.82)
Puerperal sepsis	49(46.7%)	33(23.7%)	0.0003	2.81(1.57-5.05)
totals	105(100%)	139(100%)		

9.11 Trends of maternal mortality

9.11.1 Levels of maternal mortality

There was a decline in MMR over the study period; MMR was 2141/100,000 deliveries in the first 3-year interval(2000-2002), 1907/100,000 deliveries in the second 3-year interval(2003-2005), and 1521/100,000 deliveries in the third 3-year interval(2006-2008).

Figure 16

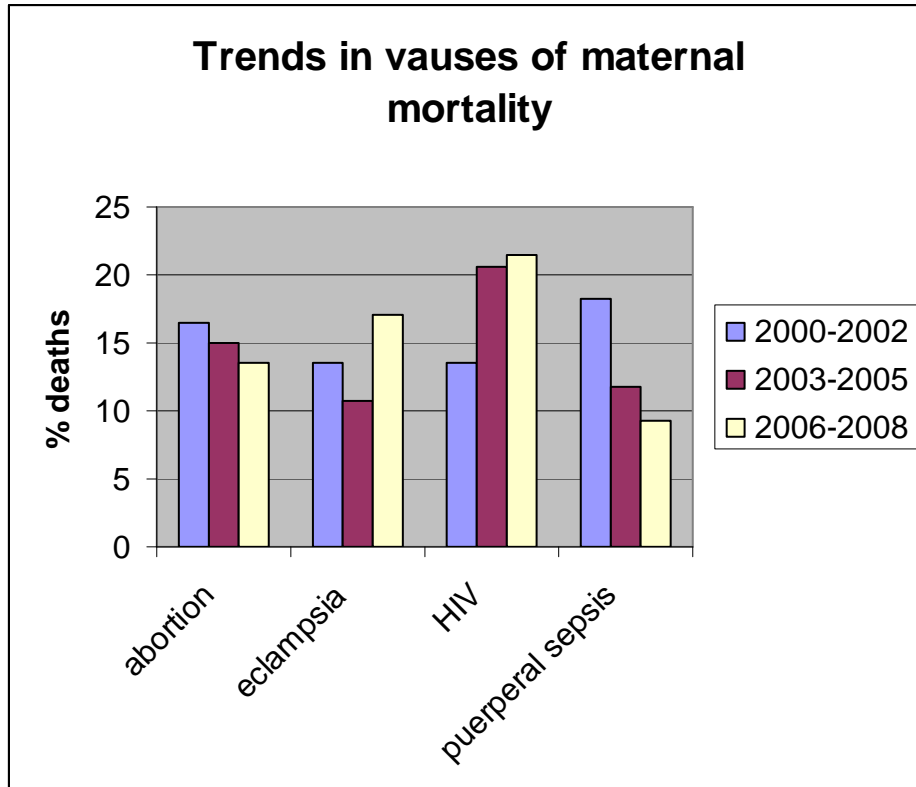


9.11.2 Causes of maternal mortality

There was a decline in the ratio of direct to indirect maternal deaths from 2.6:1 in the first 3-year interval to 1.5:1 and 1.8:1 in the second and third 3-year intervals.

The leading causes of maternal deaths were HIV, abortion, eclampsia and puerperal sepsis.

Figure 17



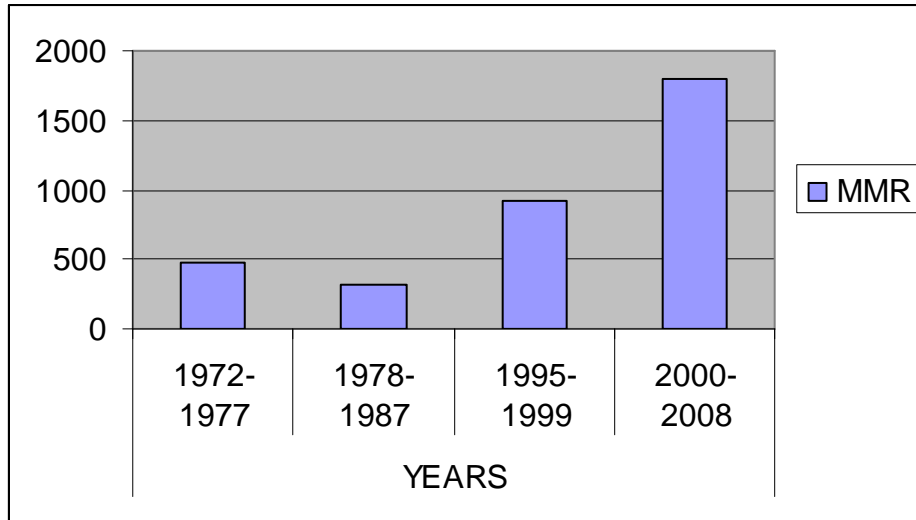
The proportion of maternal deaths attributed to HIV and eclampsia increased with time, while that due to puerperal sepsis and abortion complications declined.

10. DISCUSSION

10.1 Levels of maternal mortality

Maternal mortality at KNH has generally increased over the past two decades despite the slight decline observed during the study period.

Figure 18: Trends of maternal mortality at KNH in past 4 decades



MMR was 482 and 310 per 100,000 deliveries in 1972-1977 and 1978-1987 respectively. It rose sharply to 921/100,000 deliveries between 1995-1999 (mostly increased abortion/puerperal sepsis deaths) and 1800/100,000 deliveries between 2000-2008 (mostly increased HIV/eclampsia deaths) (See below).

The MMR in this study was much higher than the current national average (414/100,000 live births) due to bias associated with hospital studies as well as KNH being a national referral hospital. For example, maternal deaths that may have occurred following discharge (after delivery) from hospital could have been missed. On the other hand, mothers with complications following delivery at home/other health facilities (representing majority of the women) who were admitted and later died at KNH were captured in the study. In determination of MMR, therefore, the numerator (number of maternal deaths) was exaggerated and the denominator (number of deliveries) underestimated. In addition, coincidental and unknown maternal deaths were included in calculation of MMR because inadequacy/incompleteness of investigations made it impossible to distinguish many of these from indirect or, in some cases, direct maternal deaths. However, even when only direct and indirect maternal deaths were considered, the MMR remained high – 1491/100,000 deliveries.

10.2 Timing of maternal death (in relation to antecedent pregnancy)

Most maternal deaths reportedly occur during labor, birth or the 24 hours after birth (5). In this study, however, this pattern was not observed due to a large proportion of deaths attributed to HIV and abortion.

Only 55.1% of maternal deaths occurred in the postpartum period, half of these being within the first postnatal week. Almost two thirds (65%) of deaths in the first week postpartum happened within 72 hours of delivery. Very few deaths occurred intrapartum (1.2%). Maternal deaths in the antepartum period (mostly HIV related) and following abortion were 42.9%, in almost equal proportions.

An earlier study at KNH by Obore S. showed that 36.9% of maternal deaths occurred postpartum, 35.5% following abortion, 16.7% antepartum, 8.4% intrapartum and 2.5% were ectopic related (23).

10.3 Causes of maternal mortality

Three-quarters of all maternal deaths worldwide are due to direct obstetric causes. The leading causes of deaths are hemorrhage, infections, complications of abortion, eclampsia and obstructed labor (1).

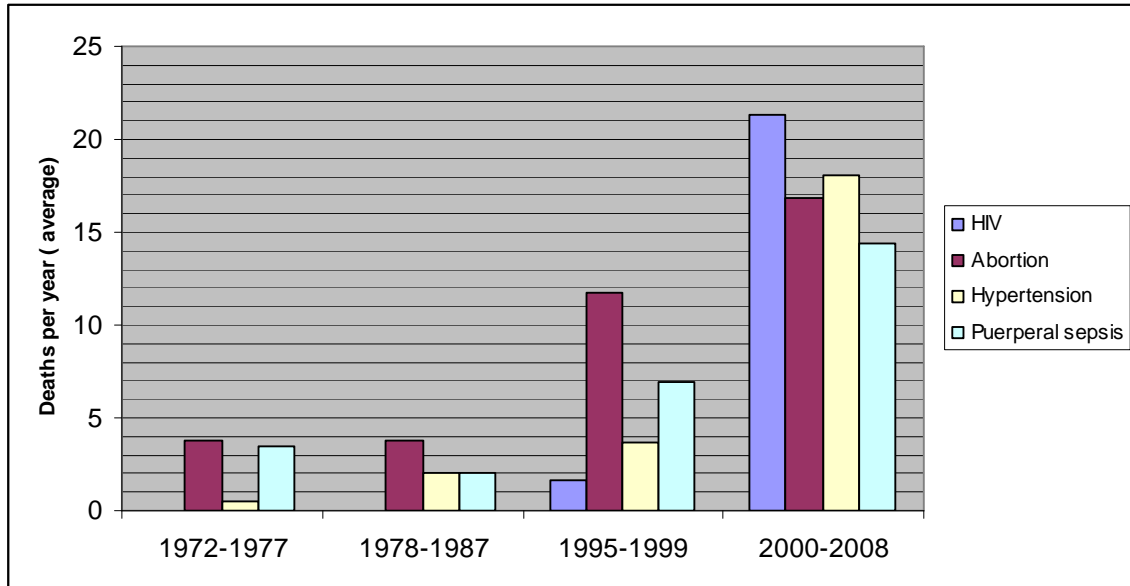
HIV was the overall leading cause of maternal deaths in this study, accounting for 18.8%, followed by abortion complications (14.9%), eclampsia (13.9%) and puerperal sepsis (12.7%). HIV was also by far the leading cause (64.4%) of indirect maternal deaths.

These findings are different from previous hospital based studies in Kenya and, specifically, at KNH. HIV surpassed all the traditional major causes of maternal deaths. In addition, majority of the coincidental deaths (63.3%) were due to pneumonia, tuberculosis, and meningitis. These are common opportunistic infections associated with HIV, implying that many of the coincidental deaths could have been HIV related and, therefore, indirect maternal deaths; however, they could not be classified as such because the HIV status of these patients remained unknown at death.

Trends in causes of maternal mortality

The average number of yearly deaths attributed to each of the four major causes of maternal deaths has risen over time

FIGURE 19: Cause specific maternal deaths per year at KNH over time



In the 90's, abortion complications and puerperal sepsis were largely responsible for the increase in maternal deaths (23).

In this new millennium, HIV and hypertensive disorders of pregnancy accounted for most of the increase in maternal deaths; there was a 5-fold and 13-fold rise in maternal deaths due to hypertensive disorders and HIV respectively compared to the last decade.

Recent studies in sub-Saharan Africa confirm that HIV has emerged as a major cause of maternal mortality. For example, the leading cause of maternal deaths in South Africa is non pregnancy related infections (mainly HIV/AIDS), accounting for 31.4% deaths, followed by hypertensive disorders in pregnancy (20.7% deaths). (28)

10.4 Outcomes of pregnancy

Outcomes of antecedent pregnancies associated with maternal deaths have not been evaluated in previous maternal mortality studies in Kenya. However, studies elsewhere have shown that the largest proportion of pregnancies result in a live birth. For example, in a population-based study of maternal mortality in Giza, Egypt, the pregnancy outcomes were live birth (48.7%), still birth (17.3%), abortion (4.5%) and undelivered (29.5%). (29)

The commonest outcome in this study was a live birth (34.4%). Stillbirths, abortions and those undelivered were 17.1%, 21.6%, and 22.5% respectively.

10.5 Factors affecting maternal mortality

Age

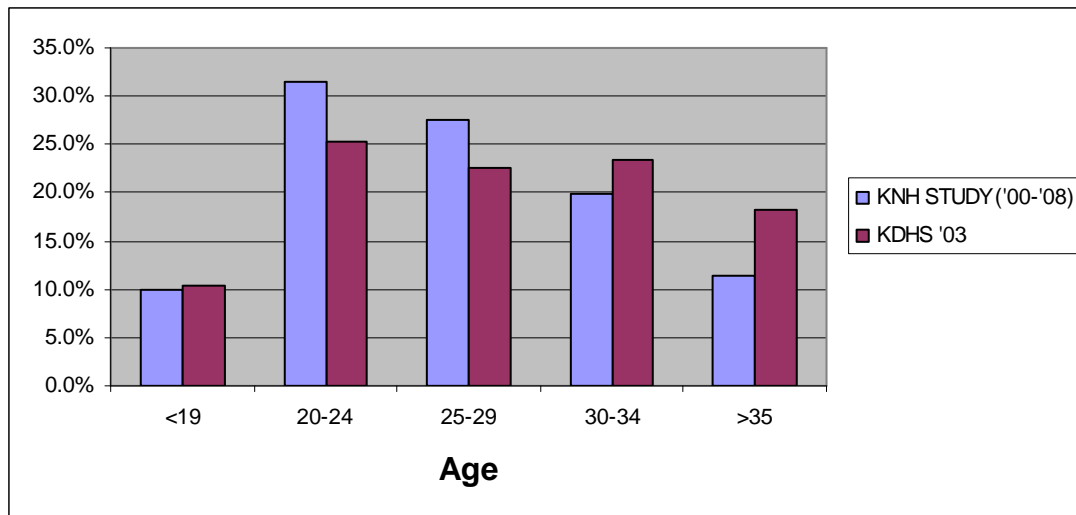
Age affects a woman's chance of dying a maternal death due to a range of biological and social factors. (6, 7)

In the young adolescent, pregnancy carries a higher risk due to preeclampsia, cephalopelvic disproportion (immature pelvis), and uterine inertia. Unwanted pregnancies and induced abortion are also more common in younger women.

Older women (>35 years) are more likely to develop complications such as hemorrhage, toxemia and prolonged labor. (30)

In this study, 78% of women who died were between 20-34 years, the peak of childbearing age in Kenyan women. The mean age was 26.61 years. A similar pattern was observed in KDHS 2003, where 71% of the maternal deaths were aged between 20-34 years.

FIGURE 20: Distribution of maternal deaths by age (KNH study vs. KDHS)



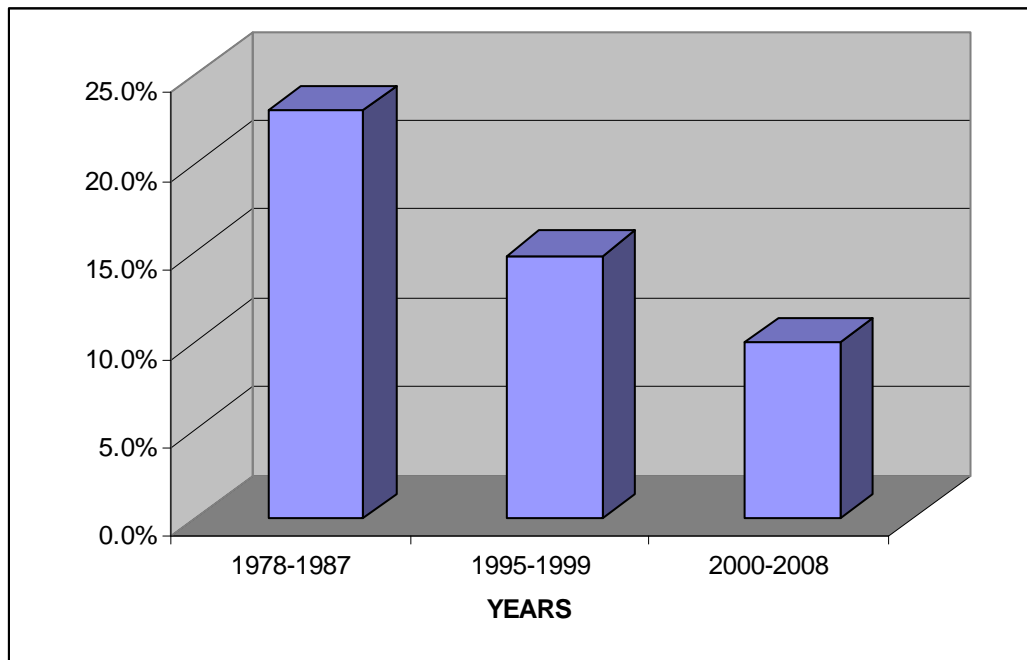
Abortion complications were the commonest cause of deaths in women below 20 years (22% deaths).

In women 20 years or older, HIV was the leading cause of death accounting for 17.5% – 23% deaths depending on the age group; the highest was in the 25-29 year group(23% deaths). The peak prevalence of HIV among Kenyan women is at age 25-29 years; this age also corresponds to the age of peak fertility among women living in urban areas. (15)

Deaths due to eclampsia were the highest in women below 20 years and above 35 years (about 17% maternal deaths each).

Earlier studies at KNH by Makokha and Obore S. showed that 60.9% and 79.3% of maternal deaths respectively were between 20-34 years (18, 23). Of note has been the steady decline in teenage maternal deaths at KNH over the past 3 decades. This is due to increase in age at first birth in Kenyan women over the years (15)

FIGURE 21: Trends in proportion of teenage maternal deaths at KNH over time



Parity

Women having their first pregnancy are more likely to die than those having a second or third child. With the fourth child, the risk increases again (6,7)

There is also an association between parity and cause of maternal death. For example, eclampsia is common in primigravidae while postpartum hemorrhage, malpresentation and rapture uterus are common in grandmultiparae. (30)

Majority of women in this study were of low parity- 70.7% had 2 deliveries or less; mean parity was 1.79. 63.5% and 78.4% of women had 2 deliveries or less in previous studies (KNH) by Makokha and Obore respectively. (18, 23)

The proportion of deaths due to abortion and eclampsia in nulliparas (about 21% each) was 1.5-2 times higher compared to other parities; that due to HIV was highest in women of parity 2 and 3. Most Kenyan women attain a parity of 3 at 25-29 years (median age at first birth is 20 years; median birth interval is 32.6 months) (15)

Place of delivery

The role of skilled attendance at birth in reducing maternal mortality is unquestionable. Professional midwifery care at childbirth reduced maternal mortality by half in the early 20th century, way before modern anaesthesia, antibiotics and safe transfusions as we know them today. (1)

During the past few decades, some developing countries e.g. Sri-Lanka and Thailand have reduced maternal mortality to very low levels by providing skilled birth attendants (midwives) at birth and improving access to health care facilities.(1)

On the other hand, only 40% of deliveries in Kenya occur in a health facility under the supervision of a health professional (15).

In this study, half (51.9%) of the women had the place of their previous deliveries indicated; among these, 36.9% had at least one home delivery. The proportion of maternal deaths due to puerperal sepsis among patients who had a previous home delivery (32.2%) was 4 times higher compared to those who did not, a reflection of the unhygienic conditions associated with home deliveries

Contraceptive use

Countries or regions with high fertility rates tend to have high maternal mortality levels. Contraceptives, by reducing the number of unplanned pregnancies and spacing births, lead to reduction in maternal mortality. (6,7)

In Kenya, TFR has recently been rising, from 4.7 children per woman (1998) to 4.9 children per woman (2003). Contraceptive prevalence rate has remained low (39%) (15)

Contraceptive use was recorded in 45.3% women in this study; among these only 43.3% had used a contraceptive.

ANC attendance

The overall aim of ANC is to produce a healthy mother and baby at the end of pregnancy. Screening for various risk factors is done, and any complications are detected and treated at the earliest opportunity.

Debate on effectiveness of ANC in reducing maternal mortality is ongoing. However, studies in Zaire found that ANC reduced maternal mortality 17-fold. The main impact was a reduction in severe anemia, cases of obstructed labor, and treatment of medical conditions. (31)

88% of women in Kenya receive ANC from a medical professional. The vast majority do so in government facilities (71%) while 28 % seek care in private facilities. The median number of months of pregnancy at 1st visit is 5.9.

Only 54% of women had a record on ANC attendance in this study. Of these, 69.5% had attended ANC – at least one visit – at time of admission. Majority (64.7%) were attended at a government facility; those who sought care at private facilities were 20%. Most (45%) made their 1st visit in the second trimester.

Socio-economic status

Residence, level of education, occupation and marital status reflect not only a woman's wealth status and ability to pay for professional health services, but also her autonomy in decision making.

Only 40% of women in Kenya make decisions on their own healthcare. This is especially important in relation to delays associated with maternal mortality. Women who have never been married, have no children, have only primary education and who are not employed are the least likely to participate in decision making in the household. (15)

In this study, most women were unemployed (70%), had no education or only primary education (61.1%), and resided in low income areas (over one-third of Nairobi residents – 37.1% - were from Embakasi division, the area with the highest number of informal settlements in Nairobi)

10.6 Delays contributing to maternal mortality

The three delays model developed by Thaddeus and Maine in 1994 identifies individual decision making, access to affordable health services, and service provision by skilled personnel as the main factors which can delay access to effective interventions to prevent maternal mortality. (32)

In this study, these factors were identified by examining the patient's general condition at admission and emergency interventions instituted thereafter.

Patient's general condition at admission

One fifth of the women were in poor general condition at admission (see above). This could have been due to:

- Rapidity of onset/progress of a given condition e.g. postpartum hemorrhage, eclampsia
- Delay in seeking professional help e.g. self treatment and seeking professional care only when a condition worsens
- Failure to recognize complications early
- Difficulty in accessing health services due to lack of bus fare/ money for transport
- Suboptimal care by a referring facility (majority – 60% - of the patients in poor general condition were referrals)

Emergency interventions following admission

For obstetric emergencies, an arbitrary time of 30 minutes is thought to be reasonable from the time of decision to appropriate intervention.

Decision to intervention interval was within 2 hours for only half of the emergency surgeries, 61% of ICU admissions (from inpatient wards) and 38.5% of blood transfusions.

This means that many of the maternal deaths would probably have been averted had the interventions been instituted more promptly.

11. CONCLUSION

- Maternal mortality at KNH has doubled over the past two decades largely due to increase in deaths due to HIV and eclampsia
- Most maternal deaths (two-thirds) occurred within the first week of admission.
- Majority of the women who died were aged between 20-34 years, the peak of child bearing age in Kenyan women.
- Most women were of poor socioeconomic status (more than two-thirds were unemployed)
- The leading causes of maternal deaths were HIV (18%), abortion complications (14.9%), eclampsia (13.9%), puerperal sepsis (12.7%) and postpartum hemorrhage (5.1%)
- HIV has emerged as an important cause of maternal deaths in Kenya.
- Suboptimal care by referring facilities and at KNH may have contributed to the large number of maternal deaths.

12. RECOMMENDATIONS

- Reporting and coding of maternal deaths should be more efficient and accurate, and storage of files better organized so that all maternal deaths are captured.
- Formulate SOPs especially for management of the major causes of maternal deaths.
- Regular CMEs on management of the major causes of maternal deaths should be organized.
- An obstetric critical care unit to cater for obstetric emergencies only should be established. This will ensure timely, more focused and efficient management of obstetric complications.
- An emergency laboratory and blood bank should be set up within labor ward so that blood can be obtained and investigations carried out faster when required
- Where a referred patient is found to have received suboptimal care, the referring facility should be notified and appropriate measures taken.
- Regular community obstetric outreach activities in informal settlements in Nairobi/its environs to educate women on various reproductive health issues should be organized.
- Maternal mortality studies at KNH should be done every four years so as to evaluate, on a regular basis, the pattern of maternal mortality as well as effectiveness of interventions.

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APPENDIX 1

Causes of all maternal deaths at KNH (2000 - 2008)

Cause	Frequency	Percent
HIV	193	18.8
abortion	153	14.9
eclampsia	142	13.9
pueperal sepsis	130	12.7
postpartum hemorrhage	52	5.1
anemia	48	4.7
pneumonia	42	4.1
tuberculosis	36	3.5
malaria	33	3.2
malignancy	26	2.5
menengitis	22	2.1
severe preeclampsia	22	2.1
cardiac disease	19	1.9
anteartum hemorrhage	10	1.0
rapture uterus	9	0.9
anaesthetic	8	0.8
ectopic pregnancy	7	0.7
<i>seizures</i>	6	0.6
obstructed labor	5	0.5
<i>stroke</i>	5	0.5
upper gastrointestinal bleed	5	0.5
burns	4	0.4
hepatitis	4	0.4
chorioamnionitis	3	0.3
deep venous thrombosis	3	0.3
gastroenteritis	3	0.3
intestinal obstruction	3	0.3
postpartum cardiomyopathy	3	0.3
abdominal pregnancy	2	0.2
bleeding disorder	2	0.2
brain abscess	2	0.2
<i>coma</i>	2	0.2
diabetes	2	0.2
<i>febrile illness</i>	2	0.2
abdominal wall abscess	1	0.1
<i>ards</i>	1	0.1
chicken pox	1	0.1
chronic renal failure	1	0.1
gbs	1	0.1
goitre with airway obstruction	1	0.1
hyperemesis gravidarum	1	0.1
liver abscess	1	0.1
ludwigs angina	1	0.1
measles	1	0.1
nephrotic syndrome	1	0.1
<i>shock</i>	1	0.1
sol	1	0.1
status epilepticus	1	0.1
<i>sudden collapse</i>	1	0.1
<i>sudden death</i>	1	0.1
total	1024	100.0

APPENDIX 2

Causes of direct maternal deaths(KNH 2000-2008)

cause	frequency	percent
abortion	153	27.8
eclampsia	142	25.8
puerperal sepsis	130	23.6
postpartum hemorrhage	52	9.5
severe preeclampsia	22	4
antepartum hemorrhage	10	1.8
rapture uterus	9	1.6
anaesthetic	8	1.5
ectopic pregnancy	7	1.3
obstructed labor	5	0.9
chorioamnionitis	3	0.5
deep venous thrombosis	3	0.5
postpartum cardiomyopathy	3	0.5
abdominal pregnancy	2	0.4
hyperemesis gravidarum	1	0.2
Total	550	100

Causes of indirect maternal deaths(KNH 2000-2008)

cause	frequency	percent
HIV	193	64.5
anemia	48	16.1
malaria	33	11
cardiac disease	19	6.4
hepatitis	4	1.3
diabetes	2	0.7
Total	299	100

APPENDIX 3

Causes of coincidental maternal deaths(KNH 2000-2008)

cause	frequency	percent
pneumonia	42	26.8
tuberculosis	36	23.1
malignancy	26	16.7
menengitis	22	14.1
upper gastrointestinal bleed	5	3.2
burns	4	2.6
gastroenteritis	3	1.9
intestinal obstruction	3	1.9
bleeding disorder	2	1.3
brain abscess	2	1.3
abdominal wall abscess	1	0.6
chicken pox	1	0.6
chronic renal failure	1	0.6
gbs	1	0.6
goitre with airway obstruction	1	0.6
liver abscess	1	0.6
ludwigs angina	1	0.6
measles	1	0.6
nephrotic syndrome	1	0.6
sol	1	0.6
status epilepticus	1	0.6
Total	156	100

APPENDIX 4

Questionnaire

IP NO.....Age..... Residence.....

Date/Time of admission: Date..... Time.....

Date/Time of death: Date..... Time.....

1. Social History

Marital status (tick as appropriate)

- a) Single
- b) Married
- c) Divorced/separated
- d) Widowed
- e) Others.....

Occupation(tick as appropriate)

- a) Formal employment
- b) Informal employment
- c) Business
- d) Student
- e) Unemployed
- f) Others.....

Level of education(tick as appropriate)

- a) None
- b) Primary
- c) Secondary
- d) College/university
- e) Others.....

2.Past medical history

History of chronic illness? a)Yes b) No c) Other.....

If yes, what chronic illness? (Tick as appropriate)

- a) Hypertension
- b) Diabetes
- c) Cardiac disease
- d) Epilepsy
- e) Others.....

History of previous surgery(other than c/s)? a) Yes b)No c)Other.....

If yes, indicate reason.....

3. Antenatal care (ANC) - for current/most recent pregnancy as at admission

Did patient attend ANC? a) Yes b) No c) Other.....

If yes, state:

a) Where patient attended ANC.....

b) Gestation when patient first attended ANC (tick as appropriate)

- i. 13 weeks
- ii. 14-28 weeks
- iii. 28 weeks
- iv. Others.....

c) Antenatal profile results

Hb Blood group..... VDRL..... Serology.....

4. Obstetric / Gynaecology history (as at admission)

Parity.....

Number of home deliveries.....

Number of hospital deliveries (including c/s).....

Number of previous caesarian sections (c/s) and indications.....

Year..... Indication..... Year..... Indication.....

Number of previous still births/neonatal deaths.....

Had patient ever used any Family Planning method ? a) Yes b) No c) Other.....

If yes, state method(s) used.....

5. Was patient referred from another facility?

a) Yes b) No c) Other.....

If yes, state the facility.....

6. Patient's condition at admission

Diagnosis at admission..... Gestation (wks).....

General condition on admission (tick as appropriate)

- a) good/fair
- b) sick-looking
- c) unconscious
- d) others.....

Vital signs at admission

BP..... TEMP..... RR..... PR.....

7. State date, time and mode of delivery following admission (where applicable)

- a) Vaginal delivery: Date..... Time.....
- b) Elective c/s : Date..... Time.....
- c) Emergency c/s: Date..... Time.....
- d) Other.....

8. Emergency surgery

a) Where emergency c/s was done, state the following:

- Time decision for surgery made: Date..... Time.....
- Time surgery done : Date..... Time.....
- Indication for surgery.....
- If emergency c/s was done more than 2 hours after decision for surgery was made state reason(s)

b) Was other emergency surgery (MVA, laparotomy, manual removal of placenta, D&C, repair of cervical/vaginal tears etc) done? a)Yes b) No

If yes, state the following:

- Time decision for surgery made: Date..... Time.....
- Time surgery done: Date..... Time.....
- Type of surgery.....
- Indication for surgery.....
- If emergency surgery was done more than 2 hours after decision for surgery was made state reason(s).....

9. What was the outcome of pregnancy - most recent pregnancy as at admission? (tick as appropriate)

- a) Undelivered
- b) Abortion
- c) Ectopic
- d) Live birth BWTAPS: 1min..... 5min.....
- e) FSB BWT.....
- f) MSB BWT.....
- g) Other.....

10. ICU admission

Was ICU admission requested? a)Yes b) No c) Other.....

If yes, state:

- Reason for admission.....
- Date/time of initial request for admission: Date..... Time.....
- Date/time of actual admission : Date..... Time.....
- Reason(s) for delay if actual admission more than 2 hours following initial request
- Reason(s)if patient was not admitted to ICU despite request

11. Transfusion of blood/blood products

Was a request for transfusion made? a) Yes b) No c) Other.....

If yes , state:

- Reason for transfusion.....
- Date/time of initial request for transfusion: Date..... Time.....
- Date/time actual transfusion started: Date..... Time.....
- Reasons for delay if actual transfusion started more than 2 hours following initial request.....
- Reason(s) if patient was not transfused despite request.....

12. If patient had eclampsia, what anticonvulsant(s) was/were used?

- a) Magnesium sulphate
- b) Diazepam
- c) Other.....

13. State diagnosis at death.....

14. Where did death occur? (tick as appropriate)

- a) Antenatal / postnatal ward
- b) Gynaecology ward
- c) ICU
- d) Theatre
- e) Labor ward
- f) Other.....

15. What was the timing of death? (tick as appropriate)

- a) Antepartum Gestation(wks).....
- b) Intrapartum Gestation(wks).....
- c) Postpartum No. of days post delivery.....
- d) Postabortal No. of days post abortion.....

16. Was postmortem done? a)Yes b) No

If yes, state postmortem diagnosis.....

APPENDIX 5

NEXT OF KINS CONSENT FORM FOR STUDY

IPNO.....

TITLE OF STUDY

Maternal mortality at Kenyatta National Hospital (Nairobi, Kenya) in the new millennium

INVESTIGATOR

Dr Nyaboga Edward Oburu

RESEARCH ASSISTANTS

1.....

2.....

Introduction

We are requesting you to voluntarily participate in a research study. The purpose of this consent form is to give you information you will need to help you decide whether to participate in this study or not. You are free to ask any questions about the study or this form that you are not clear about. When all your questions have been answered, you can then decide whether to participate in the study or not.

Purpose of study

The purpose of this study is to find out the reasons behind any deaths occurring as a result of pregnancy/delivery at Kenyatta National Hospital. Similar studies have been done before and they are important not only as an assessment of the services we offer to women during pregnancy /delivery but also for future plans aimed at reducing these deaths.

Procedure

After you have accepted to participate in the study and signed this consent form, we will ask you questions to confirm, or clarify where necessary, information in the patient's (deceased) file regarding her personal details (such as age, level of education, occupation) as well as medical history (i.e. state of health prior to pregnancy) and obstetric history (details about pregnancies and deliveries). We will also explain to you the cause of the patient's death as well as the interventions that were instituted prior to death. Where the cause of death is in doubt, you will sign a separate consent form for post mortem examination to be done.

Benefits of participating in study

All questions regarding cause of the patient’s death will be fully explained to the participant.

Risks/disadvantages of participating in study

There are no risks anticipated for those who will participate in the study

Voluntary participation

Your participation in this study is voluntary. You are free to decline consent and will not be victimized in any way or denied services for declining to be interviewed. Participation in the study does not entail any financial benefits

Confidentiality

All the information obtained will be held in the strictest confidence

Ethical considerations

This study has been approved by the ethical review committee of the Kenyatta National Hospital.

Do you have any questions?

Do you agree to participate?

NEXT OF KIN

The study described above has been explained to me. I have had a chance to ask questions. I am aware that participating in this study is voluntary and my declining will not result in any victimization whatsoever.

Having understood all the above:

I agree to be interviewed

I decline to be interviewed

Signature..... or Thumb print.....

Date.....

Signature of investigator/research assistant.....

Name of investigator/research assistant.....

APPENDIX 6

CONSENT FORM FOR POSTMORTEM EXAMINATION

IPNO.....

Name of deceased.....

Sex.....

Date of birth.....

Date of death.....

Department/ward.....

Introduction

This form provides you with information to make sure you know enough about post mortem examinations prior to giving consent to a post mortem examination on the body of the person above. Please read through it carefully. You are free to ask any questions regarding this form or the post mortem that you do not understand. You may also want to discuss the decision about a post mortem examination with other family members.

What is a post mortem examination?

A post mortem is an internal and external examination of a body after death. It's also called an autopsy.

Who does a post mortem?

Post mortems are carried out by pathologists – doctors who specialize in the diagnosis of disease and the identification of cause of death.

Importance of a post mortem examination

A post mortem examination can provide information about the illness or other cause of your relative's death. Sometimes, carrying out a postmortem is the only way to get information about an illness. Much of what we know about illness today came from such examinations. They help to:

- Identify the cause of death
- Confirm the nature of illness and / or the extent of disease
- Identify other conditions that may not have been diagnosed
- Identify complications or side effects of treatments and drugs

Unfortunately, however, it's possible that a post mortem examination will not always provide a reason for the death.

When is a post mortem examination done?

Post mortem examinations are usually carried out within 1-2 working days of death. They take place in the mortuary. If, because of your religion, the funeral must take place within 24 hours, please let us know; we will try to do the post mortem examination within this time.

About a postmortem examination

The pathologist will make incisions (cuts) in the body to remove and examine the major internal organs and will take various samples of tissue and fluid (such as blood) for later inspection in detail. All organs are usually returned to the body afterwards but they cannot be placed in their original position.

Your relative's body after the post mortem examination

After the post mortem examination, the mortuary staff will prepare the body for you to see again. We want to assure you that the body of your loved one is treated with respect and dignity. Evidence of the post mortem examination is not usually visible when the body is dressed.

Results of the post mortem examination

A copy of the post mortem report will be sent to the in-charge of the Obstetrics and Gynaecology Department and another placed in the patient's file. If you want one, you will be given an appointment to discuss the findings of the post mortem with the department in-charge.

Who can consent?

Consent is given by the next of kin. Next of kin are ranked in order of authorization as:

1. Husband or wife
2. Parent or child
3. Full brother or sister
4. Child of full brother or sister
5. Step mother or step father
6. Half brother or half sister
7. Friend of long standing

NEXT OF KIN

I fully understand all the above information about post mortem examination. All my questions have been answered to my satisfaction and understanding

I hereby:

Give permission for a post mortem examination to be performed on.....

Don't give permission for a post mortem examination to be performed on

Signed.....or thumb print.....

Relationship.....

Date.....

Name of health professional taking consent.....

Job title.....

Signature.....

Date.....