Maternal Near Miss Audit in Metro West Maternity Services

FACULTY OF HEALTH SCIENCES

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DECLARATION

I, Dr IBE E IWUH, declare that this dissertation is my original work and has not been published or presented for a degree in another University or anywhere else .

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APPROVAL AND DECLARATION BY SUPERVISOR

I, Prof Sue Fawcus declare that I supervised this research project and it is was original work by Dr Ibe Iwuh as part of fulfilment for the degree of masters in Obstetrics and Gynaecology.

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DEDICATION

This work is dedicated to my Mother, Mrs Pauline Iwuh and my Late father Chief, Sir Patrick Iwuh, for their unending love and for educating me.

My ever caring brothers, Mr Modestus, Venisius and Paschal Iwuh

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10) The Sisters –in – charge of the wards.

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ABBREVIATIONS

APH	Antepartum Hemmorhage
ACOG	American College of Obstetricians and Gynecologists
BMJ	British Medical Journal
BMC	Biomedical center
CFR	Case Fatality rate
C/S	Caesarean Section
CNS	Central Nervous System.
DVT	Deep Vein Thrombosis
DRC	Departmental research committee
GSH	Groote Schuur Hospital
HREC	Human Research Ethics Committee
ICU	Intensive Care Unit
LTC	Life threatening condition
LBR	Live birthrate
MMH	Mowbray Maternity Hospital
MD	Maternal death
MMR	Maternal Mortality Ratio
MI	Mortality Index
MNM	Maternal Near miss
MNMR	Maternal Near Miss
MOU	Midwife Obstetric Unit
NICE	National Institute for Clinical Excellence
NSH	New Somerset Hospital
NVD	Normal Vaginal delivery
NCCEMD	National Committee for Confidential Enquiry into Maternal Death
NPRI	Non-pregnancy related infections
PPH	Postpartum Hemmorhage
PET	Pre-Eclamptic Toxemia
PE	Pulmonary Embolus
PTB	Pulmonary Tuberculosis
PML	Progressive multifocal leukoencephalopathy
PPIP	Perinatal problem identification program

STAH	Subtotal Abdominal Hysterectomy
SAMM	Severe Acute Maternal Mortality
SMO	Severe Maternal Outcome
SMOR	Severe Maternal outcome Ratio
SAJOG	South African journal of obstetrics and gynecology
TAH	Total Abdominal Hysterectomy
UNICEF	United Nations Children Emergency fund
UCT	University of Capet Town
UKOSS	United Kingdom Obstetric Surveillance System
UK	United Kingdom
USA	United States of America
WHO	World Health Organization
LMIC	Low and Middle Income countries
ESMOE	Essential Skills in Managing Obstetric Emergencies

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ABSTRACT

Background

A near miss occurs when a pregnant woman experiences a severe life threatening complication during pregnancy or up to 42 days after the end of the pregnancy and survives. The near miss rate is defined as the number of near misses per 1000 live births.

In 2011, World Health Organization (WHO) produced a useful tool for identifying near misses according to composite criteria which include the occurrence of a severe maternal complication together with organ dysfunction and/or specified critical interventions.

The ratio of maternal near miss cases to maternal deaths and the mortality index both reflect the quality of care provided in a maternity service

Maternal deaths have been audited in the Metro West maternity service for many years but there has been no routine monitoring or evaluation of maternal near misses.

Aim of study

The study aim was to perform a near miss audit in Metro West, specifically (a) measuring the near miss rate, the maternal mortality ratio and the mortality index, (b) performing an in-depth investigation of the associated demographic, clinical and health system factors of the near miss cases, and (c) providing input into the development of an on-going system of auditing near misses cases in Metro West.

Methods

A retrospective observational study conducted over 6 months between mid-March 2014 to mid -September 2014. This service includes 9 level one maternity facilities which refer all complicated maternal cases to two secondary hospitals, New Somerset (NSH) and Mowbray Maternity (MMH); or to the tertiary hospital, Groote Schuur Maternity Center (GSH).

All cases of near miss managed at the three hospitals were identified weekly by the author with the assistance of onsite health providers. These cases included near misses that occurred at level one facilities and were referred on to one or more of the three hospitals. Strict criteria were used to ascertain a case as a near miss according to the WHO near miss definitions. The folders of all the near misses were reviewed and relevant data entered into a data collection form which was adapted from the WHO near miss data form. In addition, these identified folders were reviewed by two senior obstetric specialists to confirm adherence to the WHO inclusion criteria for near miss classification, and also to determine avoidable factors in the management of the near miss cases.
Maternal deaths occurring during the same time period of the Near Miss audit were identified from monthly mortality meetings and the ongoing maternal mortality audit system in Metro West.

Results

112 near miss cases and 13 maternal deaths were identified, giving a total of 125 women with severe maternal outcomes. There were a total of 19,222 live births in Metro West facilities. The Maternal mortality ratio (MMR) was 67.6 per 100,000 live births and the maternal near miss rate was 5.83 per 1000 live births. The maternal near miss to death ratio was 8.6:1 and the mortality index was 10.4%

Hypertension, obstetric hemorrhage and pregnancy related sepsis were the major causes of the near miss cases accounting for 50(44.6%), 38(33.9%), and 13 (11.6%) of near misses respectively. These three conditions all had low mortality indices; 1.9%, 1.9% and 0 for hypertension, pregnancy related sepsis and hemorrhage respectively. Less common conditions were, medical /surgical conditions, non-pregnancy related infections and acute collapse, accounting for 7 (6.3%), 2 (1.8%), and 2 (1.8%) of near misses respectively. Although these numbers were small, these three conditions accounted for more maternal deaths with mortality indices of 66.7 %, 33.3% and 33.3% for non- pregnancy related

infections, medical /surgical conditions, and acute collapse respectively.
There were 25 (22.3%) of the near miss cases who were HIV positive. The majority of near misses 99(88.4%) had antenatal care.

Analysis of avoidable factors showed that, the most common problems were lack of antenatal clinic attendance (11.6%) and inter-facility transport problems (6.3%).
For health provider related avoidable factors, the highest number of avoidable factors were identified at level 2 (38.2%), followed by level one (25.9%) and level 3 (7.1%). The most common factors were problem recognition, monitoring and substandard care

Discussion and Conclusions

The near miss rates and maternal mortality ratio in Metro West were lower than for some other developing countries, but higher than rates in high income countries.
The mortality index was low for direct obstetric conditions such as hypertensive disorders, obstetric hemorrhage and pregnancy related sepsis, reflecting good quality of care and referral mechanisms for these conditions. The mortality indices for non-pregnancy related infections, medical /surgical conditions and acute collapse were much higher and, suggest that medical problems may need more focused attention.
Ongoing near miss audit would be valuable for Metro West but would require identification and monitoring systems to be institutionalized.

CHAPTER 1 INTRODUCTION

1.1 **Background**

Obstetric near miss, also called severe acute maternal morbidity refers to women who nearly or would have died from severe obstetric complications but survived probably from timely, and adequate interventions. Near misses include complications occurring during pregnancy or within 42 days after the end of pregnancy, and the rate is measured per 1000 live births (1).

Maternal mortality is defined as the death of a woman while pregnant or within 42 days after the end of the pregnancy irrespective of the duration and the site of the pregnancy from any cause related to or aggravated by the pregnancy or its management and not from accidental or incidental causes and measured per 100 000 live births(1).

Life threatening conditions (LTCs) are defined as severe pregnancy related complications that cause organ dysfunction and/or require major interventions and may result in maternal death. Thus LTCs lead to severe maternal outcomes (SMORs) and include both women with maternal near misses and those with maternal deaths.

There is usually a sequence of events leading to the occurrence of a maternal death. Many maternity services in developed countries have managed to investigate and intervene to prevent the end point of that sequence, notably maternal death resulting from severe acute maternal morbidity. Some morbidity and mortality is a direct result of a pregnancy complication whereas others are related to a pre-existing morbidity which is aggravated by the pregnant state.

In resource poor countries where over 90% of the global maternal mortality occurs, much of which is avoidable, the morbidity rapidly deteriorates to mortality probably due to lack of expertise or lifesaving technology.

In the UK, where the maternal mortality rate is low (12 per 100,000 live births in 1997 -1999), they have developed an ongoing national surveillance system called UKOSS, which measures and monitors all cases with severe acute maternal morbidity (near misses). This includes obstetric conditions implicated in maternal near-miss such as eclampsia, obstetric haemorrhage, pulmonary embolus and peripartum cardiomyopathy (2).

The Millennium Development Goal 5a targets a drop in the maternal mortality of 75% by 2015(3). A woman in sub Saharan African has a 1 in 16 chance of death from obstetric complications as compared to 1 in 4000 in developed countries (3). Maternal mortality ratio has been the maternal health indicator mostly used in most parts of the world including Africa, until recently when near miss audits have been introduced.

The Confidential Enquiry into Maternal Deaths in South Africa was introduced in 1998 and estimates the MMR to be much higher than in developed countries but slightly lower than the average for sub-Saharan Africa (4). Recent statistics for 2012 by the Health Data and Monitoring group estimate the overall MMR to be 410 MDs per 100,000 live births (5). However the institutional MMR as measured by the NCCEMD and presented in Saving Mothers reports has dropped from 176.2 per 100,000 in 2008- 2011 to 146.7 per 100,000 in 2011-2012 (4).

The five main causes of maternal mortality in South Africa for 2008-2010 were: Non pregnancy related infections including HIV related infections such as tuberculosis and pneumonia (40.5%), Obstetric Haemorrhage (14.1%), Hypertension (14%), Medical and surgical disorders(8.8%), and Pregnancy related sepsis (5.3%).

Maternal death meetings should be organized after a maternal death has occurred, and are an opportunity to improve the care in the maternity service by identifying the various factors that contributed to each case of maternal death, which can be modified.

In the effort to identify another instrument for assisting health systems to evaluate and improve their care, near miss audits have been introduced as an additional process to maternal mortality audits. The use of near miss as an obstetric outcome has become part of ongoing monitoring systems in many well-resourced countries; and it is now being introduced in several poorly resourced settings.

The WHO has developed a very useful tool to assist countries and facilities to set up their own Near Miss audits (6). The tool aids to standardize the identification of women with life threatening conditions, and near misses. It also includes useful definitions as well as data collection forms which can be adapted to local settings. This will be described in more detail in the literature review.

Audits of maternal near-misses provide the health care system the opportunity to have a better insight into the issues surrounding quality of care, because they are more common than maternal deaths. The fact that these women experienced a life threatening condition and survived, enables the practitioner not only to identify the positive or negative components of their care, but also to elucidate any problems the women had in seeking care or understanding their own health problems.

Also, clinicians and other obstetric care givers are so focused on survival that they may neglect the long term physical and health problems faced by these survivors, for example impaired quality of life, stress disorder, reproductive dysfunction or difficulty, and post-partum depression.

Recent studies, have shown that a woman who experiences a near miss has a 3.5 times higher risk for hysterectomy during the index pregnancy, compared to controls and a five times higher risk of complications in subsequent pregnancies(7). This illustrates that the occurrence of near misses reduces future reproductive potential and increases the risk of complications in subsequent pregnancies, thus near misses do warrant further investigation.

1.2 Rationale of the study

There is a long tradition of measuring maternal mortality in Metro West (formerly the Peninsula Maternal and Neonatal service), as shown by Fawcus et al in 2006 (8), but there has not been a system for systematically monitoring maternal morbidity or near misses although such cases are discussed in clinical review meetings.

It thus would be of value to use the WHO methodology to audit near misses in our setting and analyze the causes, contributory factors and associated avoidable factors. This could form the basis of routine near miss surveillance and allow a baseline measurement against which the impact of future interventions could be assessed.

1.3Aim of the study

To perform a maternal near miss audit in the Metro West Maternity Service

Primary Objectives

1. To identify all women with life threatening obstetric conditions and estimate the near miss rate, maternal mortality ratio, and mortality index.
2. To identify the severe maternal complications causing the near misses and the maternal deaths.
3. To perform an in-depth investigation of the near miss cases for demographic, clinical, and avoidable factors occurring within the health system.

Secondary Objective

To provide input to the future development of an ongoing system for monitoring near misses in Metro West

CHAPTER TWO: LITERATURE REVIEW

2.1 Maternal health in sub-Saharan Africa

In the year 2010, there were 287,000 maternal deaths globally and less than 50% of these women had access to skilled birth attendants (9).

The Maternal mortality ratio estimates for some areas of Asia and for the whole of Sub-Saharan Africa are amongst the highest in the world. Recent estimates from data on maternal mortality in the world published by UNICEF has placed Afghanistan as having the highest maternal mortality ratio at 1800 per 100,000 live births, followed by Sierra Leone with 1033 per 100 000 live births , Nigeria 630 per 100, 000 live births and Malawi 450 per 100, 000 (9)

Programs to reduce maternal mortality in Sub Saharan Africa need to be accelerated. Near miss audits could assist in identifying quality of care issues and determinants of survival.

2.2 Definitions of near misses and case ascertainment

The various near miss audits and cross sectional studies that have occurred in different settings have used different definitions of a near miss.

In some settings and articles it is described as SAMM (severe acute maternal morbidity) and the estimated incidence ranges from 0.7 to 82 per 1000 live births, with case fatality rates of 0.02 to 37%, but this also varies and depends on which part of the world is involved; being lower in developed countries and higher in developing countries (10).

An article by Ronsmans et al reviewed published studies reporting on the measurement of severe acute maternal morbidity in low income countries (11). They found 37 studies from 24 countries and the authors describe the differing definitions and methods of case ascertainment of severe acute maternal morbidity which have been used in the different studies.

Defining and classifying near misses or severe acute maternal morbidity has been the subject of much intellectual debate. It has been approached from many viewpoints, and the different approaches involve definitions based on:

A Clinical signs and symptoms

B Organ system dysfunction

C Management or interventions based

A. Clinical based criteria

For this definition, specific diseases and symptoms are used as the starting point and then for each disease the morbidity is defined.

For example; severe preeclampsia is the disease entity and can cause complications such as renal failure, eclampsia and pulmonary edema (6, 12).

B. Organ System Dysfunction based criteria

This is based on the concept that there is a sequence of events leading from good health to death. The sequence is clinical insult, followed by a systemic inflammatory response syndrome, organ dysfunction, organ failure and finally death.

Under this criteria maternal near miss cases would be those women with organ dysfunction and organ failure who survive.

The criteria for defining a maternal near miss are defined per organ system and markers for organ system dysfunction or failure are specified (6).

C. Intervention based criteria

In this system, an intervention such as admission to intensive care unit (ICU), the need for an emergency hysterectomy, and the need for blood transfusion are used as marker of maternal near miss.

In the recently published guideline, WHO has developed a standardized set of definitions which are shown in Appendix A.
The guideline also includes a tool for identifying near misses which uses a combination of the three above approaches and therefore can be adapted for use in different work settings (6).

The inclusion criteria employed by the WHO for near misses are shown in Table 1.

According to the WHO audit tool, a case can be classified as a near miss if (a) the woman sustained a near miss defining severe maternal complication such as eclampsia or ruptured uterus, or (b) had a severe maternal complication which on its own was insufficient to classify it as a near miss, but had in addition, one or more specified organ dysfunction, and/or one or more defined critical intervention.

Table 1. WHO composite Inclusion criteria for Near Miss cases*

A) SEVERE MATERNAL COMPLICATIONS	Severe PPH , severe PET, Eclampsia, sepsis or severe systemic infection , ruptured uterus , severe complications of abortion
B) CRITICAL INTERVENTION OR ICU USE	Admission to ICU, interventional radiology, laparotomy, (hysterectomy. excludes caesarean section) use of blood products for resuscitation.
C) LIFE THREATENING CONDITIONS	Cardio vascular dysfunction : shock , cardiac arrest , loss of consciousness , use of vasoactive drugs , CPR resuscitation , severe hypo perfusion (lactate >5 mmol/L or 45mg/dl, ph<7.1)
	Respiratory dysfunction : acute cyanosis , gasping, tachypnea , intubation and ventilation not related to anaesthesia, severe hypoxaemia (O2 sats<90%, for > 60mins)
	Renal dysfunction(oliguria not responsive to fluids or diuretics , dialysis for acute renal failure severe azotemia (creatinine> 300micomol/L or >= 3/5mg/dl)
	Coagulation dysfunction (failure to form clots, massive transfusion of blood or red cells > = 5 units, severe acute thrombocytopenia ,(< 50, 000 platelets)
	Hepatic dysfunction (jaundice in the presence of preeclampsia , severe acute hyperbilirubinaemia (> 100micromol/L or >6.0mg/dl)
	Neurological dysfunction (prolonged unconsciousness >12 hrs. /coma including metabolic coma, stroke, uncontrollable fits /status epilepticus, total paralysis.
	Uterine dysfunction (uterine hemorrhage or infection leading to hysterectomy).Definitions for the above found in appendix 8.1

**Source: WHO NEAR MISS AUDIT TOOL (6)*

Indicators that can be measured in Near Miss audits include the following:

1) Near Miss rate: the number of near miss cases1000 live births

2) Mortality Index: the index of quality of health care. This is the number of maternal death divided by the number of women with life threatening conditions (MI = MD /MNM+ MD) and it is expressed in percentage. The higher the mortality index, the lower the quality of care.

3) Severe maternal outcome ratio (SMOR) refers to the number of women with life threatening conditions (maternal near misses plus maternal deaths) per 1000 live births.

4) Live Births: the birth of an offspring who breathes or shows evidence of life. This statistic is required as the denominator for measuring both maternal mortality rate and near miss rate.

5) Outcome audit, this is a retrospective analysis of events that were associated with the particular outcome and to be of use, the outcome must be important, clearly defined and occur frequently enough such as near misses, so that the information gained will be useful for the population being studied.

2.3 Near miss audits in developed countries

As well as the UKOSS system in the UK, mentioned in the Introduction, the US has experience of auditing near misses

A retrospective audit was done between the year 2000 and 2006 in the US in which the etiology and preventability of maternal death was investigated. It revealed an estimated maternal mortality rate of 6.5 per 100, 000 live births and the leading causes of death were complications from pre-eclampsia, pulmonary embolus, amniotic fluid embolus, obstetric hemorrhage and cardiac disease (13). However the maternal near miss rate in the USA was estimated to be 8.1per 1000 (14), thus emphasizing the fact that the maternal near misses are more common than maternal deaths.

The estimates of maternal mortality in the USA have shown a 99% reduction over 100 years to current figures. (14).

2.4 Near miss audits in developing countries

Although there will be practical and clinical challenges in conducting near miss audits in poorly resourced settings, these audits would be beneficial for further assisting the evaluation of the quality of care and intervention provided to the clients. This section provides the results of near miss audits that have been conducted in developing countries

In 1998, Mantel et al in Pretoria , South Africa , audited near misses in a cross sectional prospective study and found that delays in transport and lack of ICU facilities occurred significantly more in maternal deaths than women who had near misses . The delays were due in part to the lack of a decentralized obstetric service with the majority of maternal deaths coming from provinces outside Pretoria. The upgrading of a hospital in one of the provinces led to a significant reduction in deaths (15).

In Nigeria, which has the record of having the tenth highest maternal mortality rate in the world, a retrospective study was done over 3 years in a state owned maternity unit. The study findings supported the notion that appraisal of near miss gives a larger sample to assess threats to maternal health , and would be an effective way of monitoring the quality of maternal health care (16).

In Malawi, a retrospective audit carried out in Thyolo District in the Southern region of Malawi using the WHO criteria, showed some limitations in very resource limited settings, in describing the organ failure aspect of near- miss (17). This study illustrated the need for a broader definition for near miss than organ failure, and also demonstrated the applicability of such an audit in settings where maternal deaths are less frequent

A prospective study in Sao Paolo, Brazil identified 158 admissions of women with life threatening conditions out of 9683 live births over 4 yrs. There were 5 maternal deaths and 43 near misses. The near miss rate was was 4.4 per 1000 live births, and the ICU admission rate was 1.6 %. The maternal near miss rate to maternal death rate was 8.6 to 1. An important aspect in this study is that, the near misses were mostly identified as ICU admissions, therefore mostly intervention based criteria were used to qualify a woman as a near miss (18)

A similar study was carried out involving 27 different hospitals, also in Brazil to validate the WHO tool for identifying a near miss, and during this time a 'benchmark' tool was devised to compare the observed mortality to the expected mortality; this enabled the investigators to get some sense on the appropriateness of care offered to the women experiencing a near miss event. In this study done over 12 months, there was a total of over 84000 deliveries from 82 000 patients (19).The study showed that the WHO tool is valid for identifying maternal near misses, but the usefulness of the Mortality Index should be further tested in other similar audits or studies.

In Bagdad, an in-hospital cross sectional audit was done in 2010, using the WHO near miss approach to analyze maternal near-miss cases.
The MNM rate was 5.06 per 1000 while the overall MNM: Mortality was 9:1. Despite 30% of the MNM having been referred from other facilities the mortality indices were the same, being 11% for both in-hospital and referred cases. The ICU admission rate was 37% with all having severe maternal outcomes (SMO). This supports the fact that admission to ICU can also be used as an intervention which qualifies a case as a near miss. Anemia and previous caesarean section were the most common conditions associated with severe maternal morbidity (20).

A small cross sectional study done in Karachi, Pakistan, during a period of 12 months with 868 women, identified 44 with near misses and 6 maternal deaths (21). This study had a maternal near miss ratio as 7:1, meaning that for every 7 women who had a near miss, one died. The mortality index was 12% and the most common maternal complications causing the near-miss cases were: obstetric hemorrhage (51%), anemia (21.2%), dystocia (14.8%), severe hypertensive disorder (8.5%) and infections (4.2%). The mortality index was higher for infections (33.3%) than for haemorrhage (17.2%) and organ system dysfunction was diagnosed in 18.1% of cases (21).

2.5 Assessing quality of care in Near miss and mortality audits.

Investigating near misses requires an assessment of quality of care and prevention possibilities. The WHO audit tool provides some checklists in which to record delays in clinical management and whether appropriate clinical interventions were performed for near miss cases(6) . South Africa, through its confidential enquiry into maternal deaths, has developed an approach to analyzing avoidable factors by categorizing them into patient related, administrative related and health personnel related (4). Such an approach could be adapted for analysis of modifiable factors for near miss cases.

CHAPTER THREE: STUDY METHODOLOGY

3.1) **Study design**

This study was a retrospective observational study performed over a period of 6 months in the obstetric hospitals in the Metro West.

3.2) **Study setting**

The Metro West maternity services include three levels of care according to obstetric risk factor, location, patient population, available skills and services provided.

Primary (Level 1) includes the MOUs, and some district hospitals which refer patients to secondary level and include Guguletu, Retreat, Mitchells Plain , Hanover Park , Vanguard, while the level 1 hospitals are False bay Hospital , Vredenburg Hospital , Mitchells Plain district hospital, and Wesfleur Hospital. The primary level units provide services which include conducting low risk antenatal clinics and low risk deliveries, and refer patients to the secondary and tertiary levels according to defined referral criteria. The secondary hospitals have general specialists. They manage patients with intermediate risk and also perform obstetric interventions such as caesarean section, instrumental deliveries as well as manage patients with severe pre-eclampsia and obstetric haemorrhage.

Tertiary level manages patients who require sub-specialist attention and multidisciplinary or other services, such as the ICU, interventional radiology, specialized blood products etc.

The organizational structure is such that the very sick patients with potentially life threatening conditions will eventually be managed in the secondary hospitals or tertiary hospital level as required.

At the secondary hospitals, there are special wards for these patients.
For NSH, this is called High Care Ward while for MMH, it is called Special Care Ward.
Many women who have life threatening conditions managed initially at level 2 hospitals are subsequently referred to GSH (level 3) for ongoing critical care.
The category of potential near miss cases managed completely at these secondary level hospitals are those, for example who had HELLP syndrome, and those who required massive transfusion with hysterectomy for obstetric haemorrhage, but who stabilized quickly and did not require further critical care or ICU admission.
The tertiary (level 3) is GSH, which receives patients with level 3 requirement from the two level 2 hospitals, and also can directly accept patients from the level 1 or MOUs depending on their Obstetric risk at the time of referral.
At the Tertiary Hospital (GSH), there are five wards where high risk patients are managed:
1) The Maternity ICU
2) The Maternity High care ward (B side)
3) The main ICU
4) The gynecology wards
5) Obstetric wards

Near miss cases were identified for the study from the two secondary Hospitals (NSH and MMH), and from the above wards at GSH. Due to the referral system described above, most 'near miss cases would be eventually referred to the tertiary level, with none remaining at level one, but some being completely managed at level 2.

3.3) **Identification of near miss cases**

All women were included in the audit who had an identified life threatening condition (i.e. those with near misses as well as those who died) according to the WHO inclusion criteria.

Multiple sources of information for identifying the patients were used as follows:

1. Sensitization of the staff on the importance of identifying all near misses by meetings with staff in relevant areas and by displaying a study research poster in the relevant work areas (Appendix C).
2. Periodic Visits (weekly) to the above mentioned wards. There is a register for all admissions in the hospitals and this was reviewed by the principal investigator who also reviewed the critical care ward registers to identify patients that may have been missed in the register.
3. Hospital Mortality and morbidity meetings: Monthly maternal mortality meetings were used to identify women with maternal deaths and the causes of the death. In addition, gynaecological morbidity meetings were cross checked with the other data sources to ensure that all near misses had been identified

3.4) **Inclusion criteria**

The WHO definitions for life threatening conditions were used and these are summarized in appendix A (Adapted from WHO Near miss definitions):

(a) **Severe maternal complications**, such as eclampsia, ruptured uterus or pulmonary embolus.

(b) **One or more organ dysfuntion/**; For example a patient with severe PET who developed renal failure and/or pulmonary edema was identified as a near miss

(c) **One or more critical intervention** For example, a case of severe PPH who required a hysterectomy and/or massive blood transfusion, was identified as a near miss

3.5 **STATISTICS AND DATA MANAGEMENT**

3.5.1 **Sample size**

The sample size was a practical sample of six months data.

There are approximately 38000 deliveries per year in Metro West with on average 20 to 30 maternal deaths per annum. We used a presumed mortality index of 10%, and estimated that there would be at least 100 women with life threatening conditions in 6 months.

3.5.2) **Data collection**

Folders were retrieved for those identified as maternal near misses according to the WHO near miss criteria, and data were abstracted from the folders.

Data was entered onto a data collection form which was adapted from the standard WHO data collection form for local use (Appendix B).

The adaptation included:

a. The inclusion of pulmonary embolus as a severe maternal complication.
b. The severe maternal complications which caused the near miss were divided into causal sub-categories. The causal subcategories are the same as those used to classify maternal deaths in the Saving Mothers process in South Africa. For example sepsis was divided into pregnancy related sepsis and non-pregnancy related infections.
c. Demographic data were added to the form egg Age, parity, place of residence, booking status HIV status.
d. Additional management procedures were added egg uterine compression sutures for obstetric haemorrhage.
e. A section on avoidable factors was added .The form used for this was adapted from the NCCEMD assessors form and was included as a separate page at the end of the data collection sheet (Appendix C).

All data was abstracted from the patient records and entered into the Microsoft data spreadsheet by the principal investigator (author) and statistical analysis was done using STATA 12.

For the item (d) above on avoidable factors the folders were in addition, assessed by an 'expert reviewer' who identified any substandard care/ avoidable factors and categorized them according to patient related, administration related and health personnel related factors. The expert reviewers utilized the approach used for assessing avoidable factors for maternal deaths in South Africa developed by the NCCEMD.

The expert reviewer for tertiary cases was Dr L. Schoeman and for the secondary level cases Prof S. Fawcus. Both are assessors for the South Africa Confidential enquiry into Maternal Deaths.

For maternal deaths, the only information collected were numbers and causes of death; and this was obtained from the maternal and gynecology mortality meetings and reports from the maternal mortality data coordinator for the department of Obstetrics and Gynecology, UCT.

The denominator for estimating near miss rates and maternal mortality ratio, was the total number of live births in all facilities of Metro West over the same time period. This was obtained from CLINICOM and routinely collected hospital and MOU statistics, and also from the PPIP reviews.

3.5.3) **Data Analysis**

The information obtained from the folders were entered into a UCT data collection sheet adapted from the WHO data collection form and this was done by the principal investigator.

Outcomes included the maternal near-miss indicators described under the definitions in the introduction; numbers of women with life threatening conditions, maternal near miss rate and mortality index. The definition of these indicators and formula for their calculation are shown in the literature review and results section.

Data were entered into Excel and analyzed upon consultation and collaboration with a clinical statistician in accordance with the above parameters using STATA 12

Most of the other outcomes such as obstetric causes and avoidable factors have been expressed as frequencies and rates.

3.6) **ETHICAL CONSIDERATIONSAND RESEARCH APPROVAL**

All data were treated confidentially, patients were identified by folder numbers and forms were kept in a locked cabinet at the office of the obstetric senior registrar; only accessible to the principle investigator and supervisors.

Since this was an audit and all data were abstracted retrospectively from folders there was no need for individual consent from subjects.

Ethical approval was obtained by the University of Cape Town Human Research Ethics Committee and the study only commenced after approval had been granted (Appendix E).

CHAPTER FOUR: RESULTS

4.1 Numbers of near miss cases, maternal deaths and near miss indicators.

There were a total of 112 maternal near miss cases and 13 maternal deaths identified between the 15th of March 2014 and the 15th of September 2014 in the Metro West Maternity service. Therefore, the total number of women with life threatening conditions (severe maternal outcomes) was 125 (total maternal deaths plus total near miss cases).

There were 19,524 deliveries and 19,222 Live births in Metro West maternity facilities between March and September 2014. Table 2 shows the breakdown of deliveries and live births per facility.

Table 2. Number of deliveries at different facilities of Metro West during 6 month study period

HOSPITAL / (MOU)	Number deliveries	Live Births
Mowbray Maternity Hospital	6190	6110
New Somerset Hospital	3921	3860
Grooteschuur Hospital	1770	1634
Mitchells Plain Hospital	1074	1074
Mitchells Plain MOU	1227	1354
Gugulethu MOU	1132	1117
Retreat MOU	1082	1216
Hanover Park MOU	1051	1046
Vanguard MOU	993	985
Wesfleur MOU	606	604
Vredenberg MOU	441	431
False Bay hospital	337	336
TOTAL	**19524**	**19222**

4.1.1 Ascertainment of near miss cases

The ascertainment of near miss cases was done by strict adherence to the standardized WHO criteria which involve three major elements for diagnosing a near miss (as described in Table one in chapter 2, page 23). The three major elements were:

(a) ***A severe maternal complication*.** The occurrence of some major complications such as eclampsia (n=40) or uterine rupture (n=2) was sufficient to classify a case as a near miss.

For other severe complications such as severe pre-eclampsia, obstetric haemorrhage, pregnancy related sepsis etc. there had to be, in addition, organ dysfunction and/or a specified critical intervention in order to classify them as a near miss ,

(b) ***One or more organ dysfunction***, defined according to strict criteria (see chapter 2, Table 1, page 23). Under this criteria there were 52 (46.4%) cases with one or more organ dysfunction; 30(26.8%) with one organ dysfunction and 22(19.6%) with more than organ dysfunction.

(c) ***One or more critical intervention*** defined according to strict criteria (see chapter 2, Table 1, page 23). Under this criterion, there were 141 critical interventions for the 112 near miss cases; some cases requiring more than one critical intervention. All patients in the study required some form of critical intervention.

4.1.2 Near miss rate, maternal mortality rate and mortality index

Table 3 shows the near miss and maternal mortality indicators together with the formulae used to calculate them

Table 3 Near miss and maternal death rates and ratios

NEAR MISS INDICATOR	Numbers, Rates, Ratios
Number Near Miss cases (NM)	112
Number Maternal Deaths (MD)	13
Number Total Deliveries	19524
Number live births	19222
Near miss rate (NMR)*	5.83
Maternal mortality rate (MMR) **	67.6
Severe maternal outcome rate(SMOR)***	6.5
Near miss : Maternal death Ratio	8.6 : 1
Mortality index****	10.4%

*NMR = MNM/ live births X 1000

**MMR = MD/live births X 100,000

***SMOR = MDs + MNMs / live births X 1000

****Mortality index = MDs/ MNMs+MDs x 100%

The maternal near miss rate was 5.83 near miss cases per 1000 live births and the maternal mortality rate was 67.6 maternal deaths per 100,000 live births The maternal near miss to maternal death ratio was 8.6:1; for every 9 near misses there was one maternal death. The mortality index was 10.4%; this means that of the 125 cases with life threatening conditions (severe maternal outcomes), 10.4% of them died.

4.1.3 Mortality index for each severe maternal complication

Severe maternal complications were classified according to the system used for classifying causes of deaths in the Saving Mother reports for South Africa. The Severe Maternal Complications associated with the maternal near miss cases and maternal deaths are shown in Table 4 and Figure 1.

Table 4. Severe maternal complications associated with maternal near miss cases and maternal deaths.

	OH N (%)	HYP N (%)	NPRI N(%)	M&S N(%)	PRS N(%)	AC N(%)	TOTAL N(%)
Near miss (N)	38(33.9)	50(44.6)	2(1.8)	7(6.3)	13(11.6)	2(1.8)	112 (100%)
Maternal deaths (N)	-	1(7.7)	4(30.8)	4(30.8)	3(23.0)	1(7.7)	13 (100%)

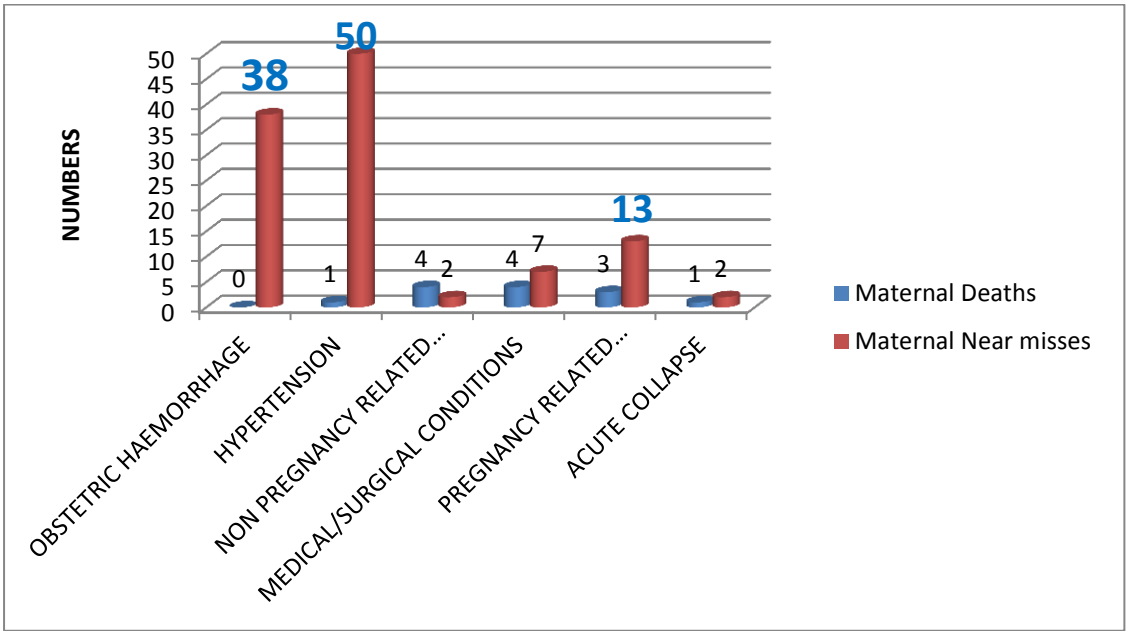
OH - obstetric haemorrhage
HYP – hypertensive disorders
NPRI – non pregnancy related infections
PRS – pregnancy related sepsis
M&S – medical and surgical disorders
AC – acute collapse

As shown in table 4 above, there was no maternal deaths from obstetric haemorrhage, thus the mortality index, as will be shown in Figure 2, is zero. The significance of this finding will be discussed in detailed in chapter 5. NPRI and medical / surgical conditions have the highest numbers of maternal deaths but were not a main contributor to the maternal near misses.

Figure 1 provides a visual depiction of how the respective complications contributed to the occurrence of maternal deaths and near misses (the life threatening complications).

It clearly shows that obstetric haemorrhage and hypertension contributed to the largest numbers of near misses while non-pregnancy related infections and medical / surgical conditions contributed more to the numbers of maternal deaths.

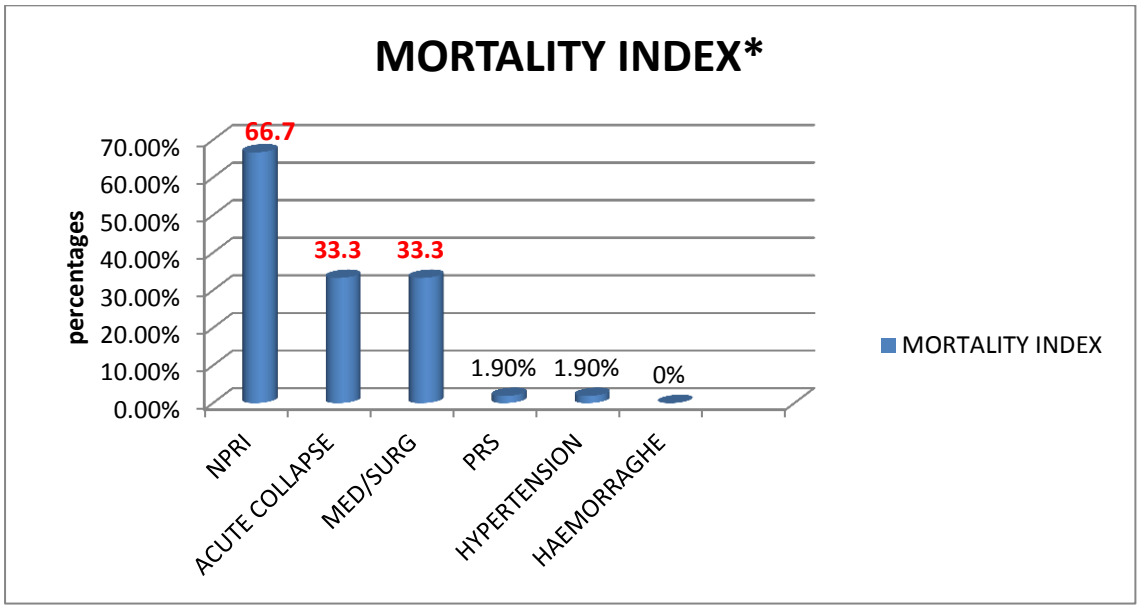
Figure 1 Severe maternal complications associated with near miss cases and maternal deaths



The mortality index for each severe maternal complication is shown in Figure 2.

The mortality index for NPRI was the highest at 66.7 %, followed by acute collapse and medical/surgical conditions at 33.3% for each respectively. Although Obstetric Haemorrhage , Hypertensive disorders and Pregnancy related sepsis constituted the largest number s of near misses, the mortality index for these three complications was very low (0%, 1.9% and 1.9% respectively).

Figure 2 the mortality index for each severe maternal complication



*Mortality index (MI = MD / (MD+ MNM) X100)

NPRI- Non pregnancy related infections

PRS- Pregnancy related sepsis

Med/Surg – Medical and surgical conditions

The following sections, 4.2 to 4.7, provide further details of the 112 near miss cases.

4.2 Socio-demographic and clinical details of near miss cases (N=112)

4.2.1 Maternal age

Table 5 Age Distribution of near miss cases (N=112)

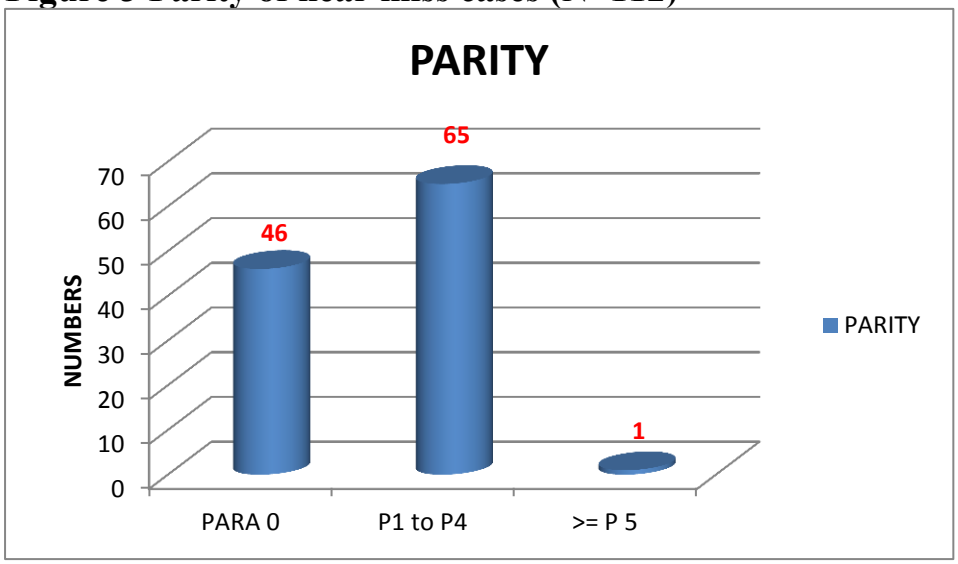
AGE RANGES	NUMBERS	PERCENTAGE %
< 18	4	3.6
18-34	95	84.8
>= 35	13	11.6
TOTAL	112	100 %

The mean age was 27.3 years with range from 15 to 42 years.
The largest age group was 18-34yrs while the smallest group was less than 18 yrs.

4.2.2 Parity

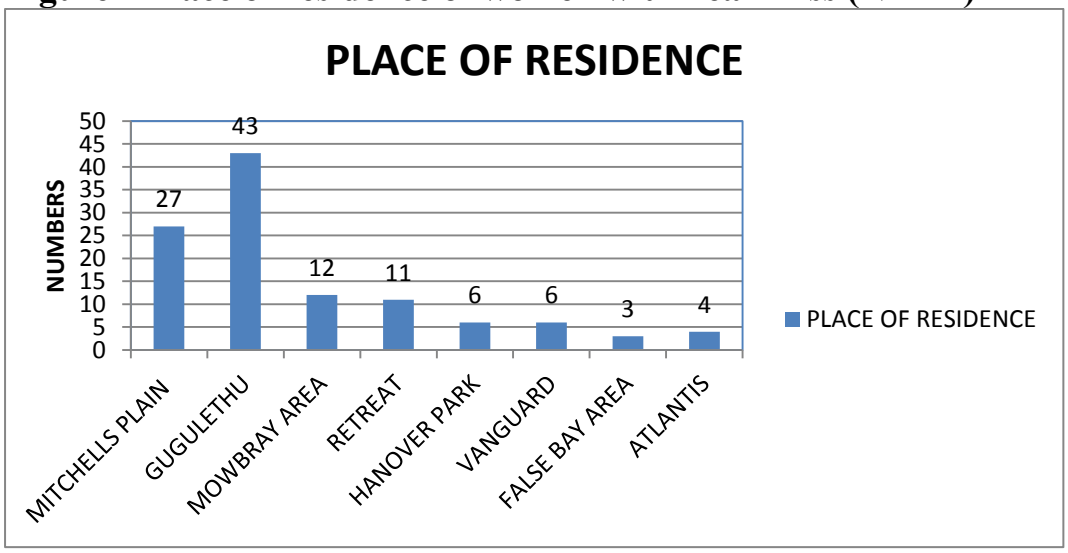
The term Parity refers to parity at the time of delivery. The median parity was 3 with a range from 0 to 6 (see figure 3)
Most of the women with near misses (58.9%) were multiparous.

Figure 3 Parity of near miss cases (N=112)



4.2.3 Place of residence

Figure 4 Place of residence of women with near miss (N=112)



The largest number of women with near misses (72.5%) came from the Gugulethu area (38.4%) and Mitchells Plain area (24.1%). These are both historically disadvantaged areas of Cape Town.

4.2.4 HIV Status.

Of the 112 women with near misses, 85 (75.9%) were HIV negative, 25 (22.3%) were HIV positive and 2(1.8%) had unknown status .

Table 6 HIV status and severe maternal complications associated with Near misses

MATERNAL COMPLICATION	**HIV NEGATIVE %**	**HIV POSITIVE %**	**UNKNOWN %**	TOTAL
HAEMORRHAGE	29 (76.3%)	9(23.7 %)	-	38(100%)
HYPERTENSION	43 (86%)	5(10%)	2(4%)	50(100%)
PRS*	5 (38.5%)	8(61.5%)	-	13(100%)
NPRI**	2 (100%)	0	-	2(100%)
ACUTE COLLAPSE	2(100%)	0	-	2(100%)
MEDICAL /SURGICAL	4 (57.1%)	3 (42.9%)	-	7(100%)
TOTALS	85 (75.9%)	25(22.3)	2 (1.8%)	112(100%)

*pregnancy related sepsis

** Non pregnancy related infections

Table 6 above shows the HIV status of the women with near misses and the respective groups of near miss complications.

A greater proportion of near misses associated with haemorrhage, hypertension and medical/surgical disorders were HIV negative. For pregnancy related sepsis the larger proportion (61.5%) were HIV positive, Surprisingly both women with NPRI were HIV negative which is not consistent with national trends, but the numbers in this group were very small

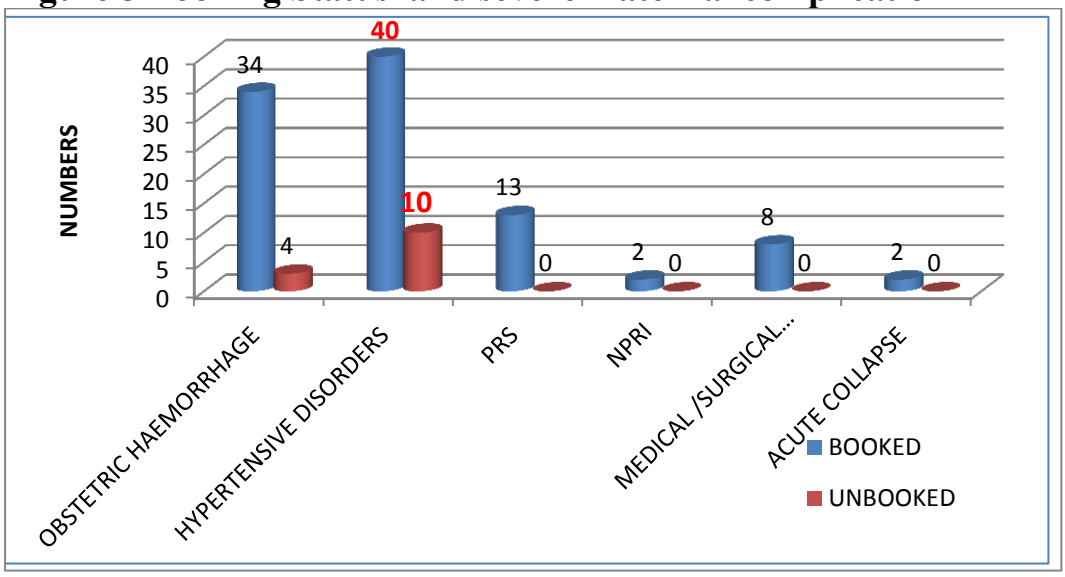
4.2.5 Booking Status

Of the 112 women, 99 (88.4%) had booked for antenatal care, and 13 (11.6%) were unbooked .

Figure 5 shows the booking status of women for each severe maternal complication.

The majority of women for all maternal complications associated with near miss were booked while about 10 women who had hypertensive conditions were unbooked and only 4 of those who had obstetric haemorrhage did not book.

Figure 5 Booking Status and severe maternal complication



4.2.6 Underlying Antenatal and labour complications in near miss cases

Table 7 Antenatal and labour complications in near miss cases (N=112)

COMPLICATION	N	%
Previous Caesarean Section	18	16.1%
Anaemia*	18	16.1%
Obesity**	11	9.8%
Prolonged labour***	3	2.7%

- *Haemoglobin<10gms/dl
  **BMI >30 kgms/M²

*** Total labour>18hrs and/or active phase >10hrs

Table 7 shows that 16.1% of near misses had had a previous C section and 16.1% were anaemic. Obesity was present in 9.8% and only 2.7% were noted to have had prolonged labour.

4.2.7 Timing of severe maternal complications causing Near Miss

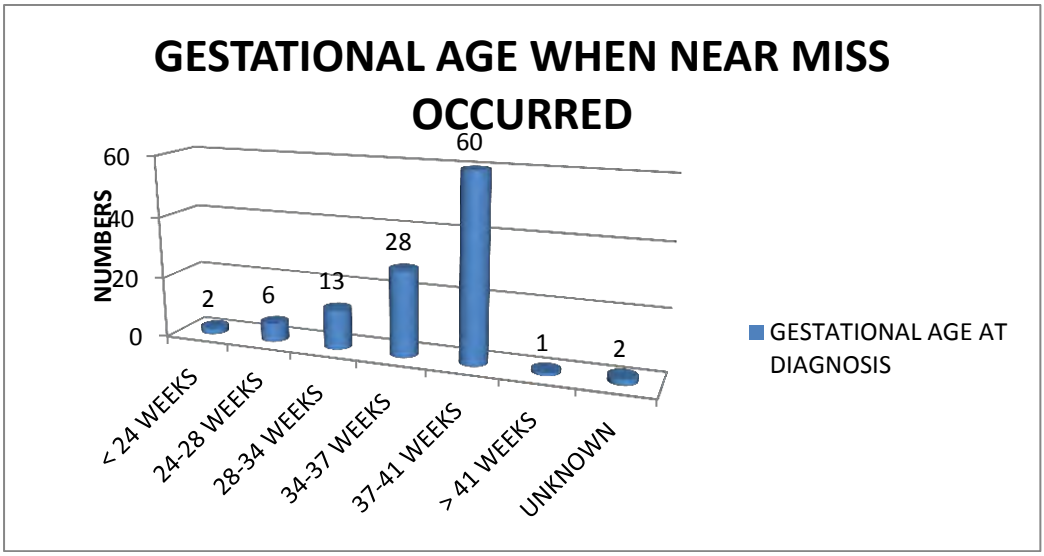
Table 8 shows that most of the near misses (47.3%) happened during the antenatal period, followed by the postnatal period (30.4%). Two occurred during anaesthesia.

Table 8. Time period of onset of near miss

TIME PERIOD	N	%
Antenatal	53	47.3%
Intrapartum	23	20.5%
Postpartum	33	29.5%
During anaesthesia	2	1.8%
Postabortal	1	0.9%
TOTALS	112	100%

Figure 6 shows that the most common gestational age for occurrence of near miss (if occurred before delivery), or for delivery (if near miss occurred post delivery) was 37-41 weeks (60 women, 53.6%); followed by 34-37 weeks (28 women, 25%).

Figure 6 Gestational age at the occurrence of near miss, or at delivery



4.2.8 Mode of delivery and timing in relation to near miss

Table 9 Mode of delivery and timing in relation to near miss (N = 112)

Mode of delivery	Within 12 hrs of near miss diagnosis	After 12 hours of near miss diagnosis	Total Numbers (%)
Caesarean section	47 (42%)	23(20.5%)	70(62.5%)
NVD	28 (25%)	9 (8.0%)	37 (33%)
Laparotomy	5 (4.5%)	0	5(4.5%)
TOTALS	80 (71.4%)	32(28.6%)	112 (100%)

Table 9 above shows that caesarean section was the most frequent mode of delivery (62.5%), followed by NVD (33%), and then by laparotomy

The category 'laparotomy' refers to 5 women who had: ruptured ectopic (1), extra uterine pregnancy (2) and uterine rupture(2) .

For 71.4% of near misses, the delivery or laparotomy occurred within 12 hours of diagnosis of the near miss.

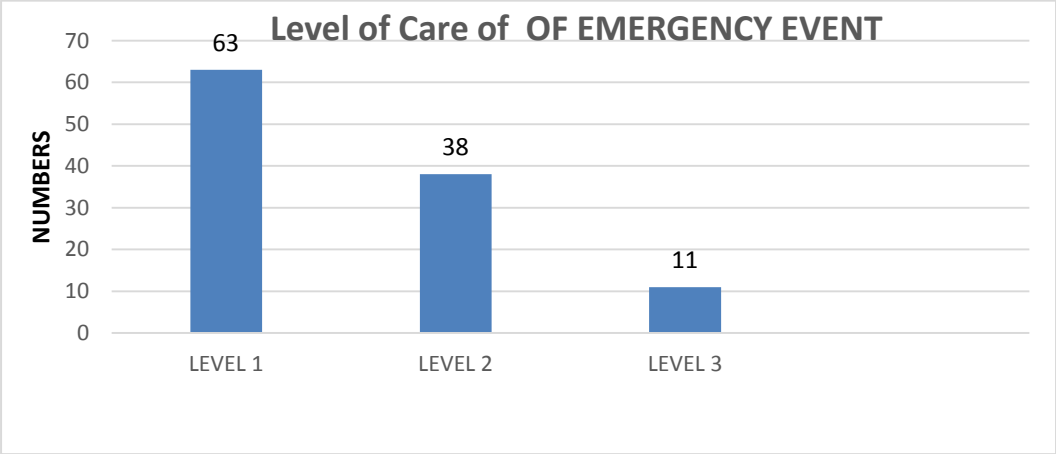
4.3. Level of care and referral characteristics of women with near miss

4.3.1 Level of care where severe maternal complication resulting in near miss occurred

Figure 7 shows the level of care where the near miss event initially occurred The referral system in Metro West enables referral of severe maternal complications occurring at level one (MOU or district hospital) to a level 2 hospital or directly to the level 3 hospital (ie bypassing level 2), if the patient's condition was thought to be a life threatening complication (for mother or baby).

Most of the severe maternal complications 63 (56.3%) which resulted in near misses occurred initially at level 1 facilities, 38(33.9%) at level 2 facilities and 11(9.8%) at level 3 facilities.

Figure 7. Level of care where severe maternal complication causing near miss occurred



4.3.2 Referrals of women with near misses

Table 10 shows the referrals made for the severe maternal complications that resulted in near misses. The term 'Referral' refers to a referral from one level of care to another performed for the severe maternal complication or emergency that resulted in the near miss; and not for referrals that might have occurred earlier during the antenatal period for previously identified obstetric risk factors.

TABLE 10 Referrals of near misses N=112)

REFERRAL ROUTE	NUMBER OF PATIENTS	PERCENTAGE
LEVEL 1 TO LEVEL 3	63	56.3
LEVEL 2 TO LEVEL 3	26	23.2
OCCURRED IN LEVEL 3	11	*9.8*

All 63 near misses originating at level one facilities were referred directly to L3. In addition 26 (23.2%) near miss cases originating at L2 were referred after emergency management, for further critical care and/or ICU admission to L3. There were 12 (10.7%) near misses for whom the severe maternal complication was managed and the patient stabilized at the level 2 hospital so they were not referred on to L3. L3 thus eventually managed a total of 100 women (89.3% of the total near misses); this included the 11 women for whom the near miss originated at L3, the 26 women referred from L2 and the 63 referred from L1.

4.3.3 Length of hospital stay for women with near misses.

The average length of stay for near misses was 11 days with a range from 2 to 34 days.

4.4. Further details of Near Miss criteria for 112 cases: Severe Maternal Complications, Organ dysfunction and Critical Interventions

The next section describes in more detail the three essential components used to identify the near miss cases; severe maternal complication, organ dysfunction and critical interventions.

4.4.1 Maternal complications

The classification into subcategories is the same as that used for the Saving Mothers reports.

There were 38 women who had obstetric haemorrhage and out of these, 11 were due to uterine atony,7 were due to abruptio placentae, 3 were due to placenta praevia,5 were due to bleeding associated with CS , 2 were from ruptured uterus, and 2 cases occurred from morbidly adherent placentae . In addition there was one case from postabortal haemorrhage, uterine inversion, ruptured ectopic pregnancy respectively, and 2 due to extra uterine pregnancy. There were 3 women for whom the cause of the PPH was not specified.

In relation to hypertensive conditions in pregnancy, there were 40 cases of eclampsia, 6 cases with severe PET with HELLP syndrome, 2 with retinal detachment, and 2 with pulmonary oedema.

There were 2 cases with NPRI, one was PCP pneumonia and the other was an unspecified pneumonia. Both these patients were HIV negative, a strange finding because epidemiologically one would expect the patient with PCP to be HIV positive.

The main causes for the medical/surgical conditions category were cardiac conditions and included two cases of peripartum cardiomyopathy, one case of valvular heart disease and one of congestive cardiac failure.

Table 11 Details of the causal subcategories of the severe complications.

Table 11 Severe maternal complications (N=112)

SEVERE MATERNAL COMPLICATIONS	SUBCATEGORIES	TOTAL NO
OBSTETRIC HAEMORRHAGE	Uterine Atony (**11**) Abruption with hypertension (**6)** Abruption without hypertension (**1)** Placenta Praevia **(3)** Uterine rupture without prior CS (**2)** Bleeding at CS(**2**), Bleeding after CS(**3)** Ruptured Ectopic **(1)** Extra uterine pregnancy **(2)** Uterine inversion **(1)** **P**ostabortal Haemorrhage **(1)** Morbidly Adherent Placenta **(2)** PPH unspecified **(3)**	**38**
HYPERTENSIVE DISORDERS	Severe PET with HELLP syndrome (**6**) Severe PET with retinal Detachment (**2**) Severe PET with Pulmonary Edema (**2**) ECLAMPSIA **(40)**	**50**
PREGNACY RELATED INFECTIONS	Puerperal sepsis after CS (**8**) Puerperal Sepsis after NVD (**5**)	**13**
ACUTE COLLAPSE	Pulmonary Emboli (**1)** Unknown Cause **(1)**	**2**
NON PREGNANCY RELATED INFECTIONS	PCP pneumonia **(1**) OTHER pneumonia**(1**)	**2**
MEDICAL /SURGICAL CONDITIONS	Cardiac **(4**) Status Asthmaticus (**1**), Chronic Renal Disease **(1**), Status Epilepticus (**1)**	**7**

4.4.2 Organ Dysfunction

There were 52 near misses (46.4%) who sustained 99 organ dysfunctions; several women had more than one organ dysfunction. Organ dysfunction was Described according to the strict WHO near miss organ dysfunction criteria

Figure 8 Frequencies of Organ dysfunction

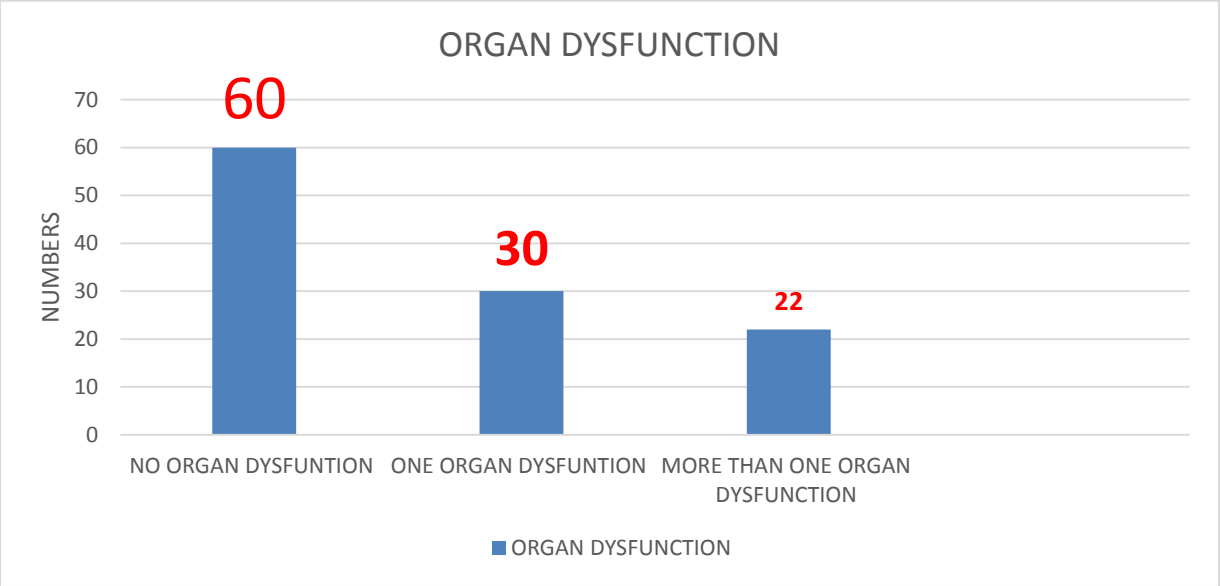


Figure 8 above shows that 60 (53.6%) had no organ dysfunction 30 (26.8%) sustained one organ dysfunction while 22 (19.6%), had more than one organ dysfunction.

Table 12 shows the different types of organ dysfunction and relates these to the type of severe maternal complication.

Table 12 Types of organ dysfunction in near miss cases.

ORGAN	OH	HYP	PRS	NPRI	AC	M&S	TOTALS
CARDIOVASCULAR	26	9	2	0	2	2	41
RESPIRATORY	8	12	0	0	1	4	25
RENAL SYSTEM	7	8	0	0	0	0	15
HEPATIC	3	0	0	0	0	0	3
COAGULATION	9	2	0	0	0	0	11
NEUROLOGICAL	2	2	0	0	0	0	4
							99

OH- obstetric hemorrhage; HYP – Hypertensive disorder; PRS-pregnancy related sepsis
NPRI- Non pregnancy related infection; AC-Acute collapse; M&S-medical/surgical disorders

Table 12 shows that the most common type of organ dysfunction was cardiovascular 41 (41.4%) followed by respiratory 25 (25.2%) and renal 15 (15.1%), then coagulation 11(11.1%) and less commonly hepatic and neurological 3 (3.1%) and 4(4.1%) respectively.

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4.4.3 Critical Interventions

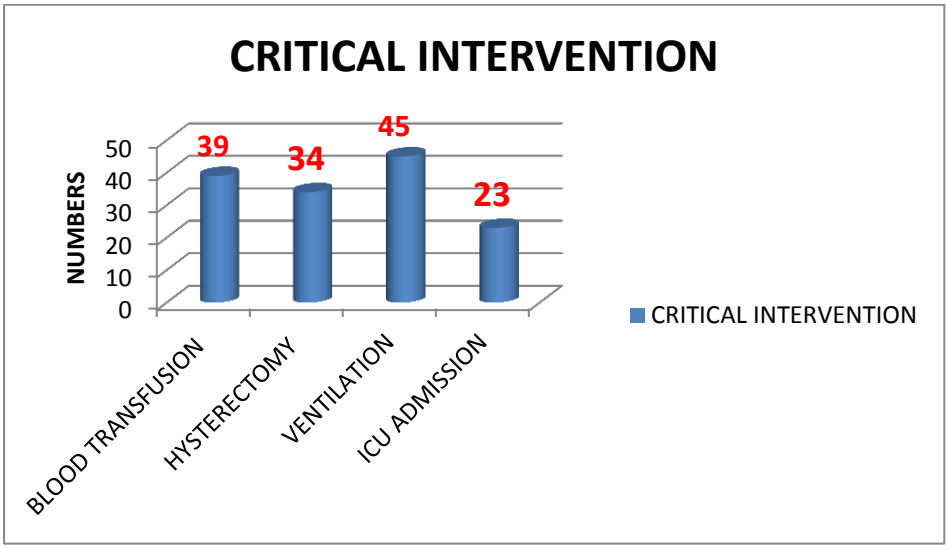
Critical interventions were defined according to the strict WHO near miss criteria .There was no patient in the study who did not require some form of critical intervention.

The total number of critical intervention was 141 for the 112 near miss cases. This exceeds the number of near miss cases because some individual near miss cases required more than critical intervention during their admission. For example, a patient with severe PPH who had a hysterectomy, massive blood transfusion, ICU care and ventilation.

In Figure 9 below, there were 141 critical interventions for the 112 near misses (some women had more than one). It shows that ventilation was a common critical intervention involving 45 (31.9%) of the women with near miss. It also included 39 (27.6%) of near miss cases who had massive blood transfusion, 34(24.1%) who had a hysterectomy, and 23 (16.3%) who were admitted to the tertiary hospital main Intensive Care Unit (ICU).

Some of the ventilated patients were in the Obstetric high care ward and only transferred to main ICU if long term ventilator or inotrope support was needed In Figure 9, ICU admission represents patients who were transferred to the main hospital ICU, and not those managed with ventilation in the maternity high care Unit

Figure 9 Frequencies of critical interventions performed for near miss cases.



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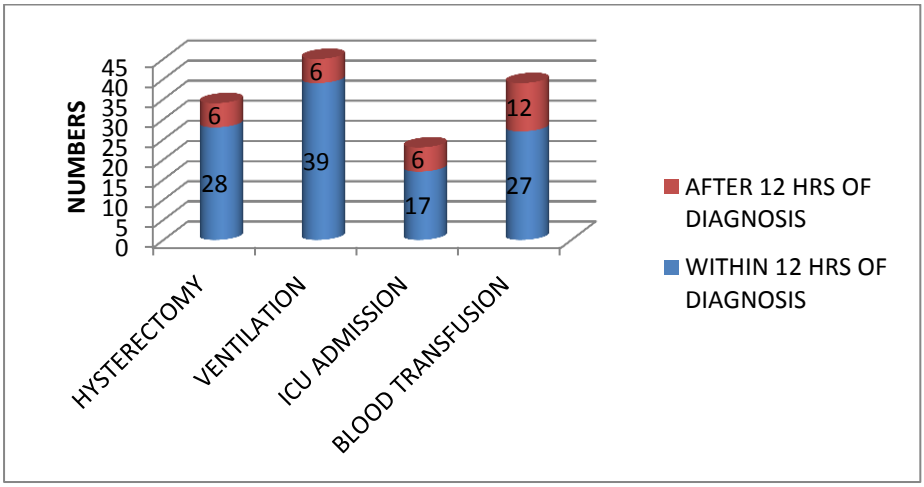
Most of the interventions were put in place promptly within 12 hours of the diagnosis of the near miss (see figure10).

Figure 10 Timing of Critical intervention in relation to near miss diagnosis



Those patients who had the critical interventions within 12 hours were patients who were diagnosed with a near miss and the need for critical intervention was considered necessary in order to prevent death. Examples of this were severe PPH requiring massive blood transfusion or peripartum hysterectomy, and also some patients who required urgent ICU support for inotropes and resuscitation.

However, there was also a group of patients who had severe complications but only had critical intervention after 12 hours.

These are patients who were stable within the 12 hours and thus critical intervention would be required if the condition deteriorated.

Examples of these are the patients with uterine sepsis who required hysterectomy after initial management with antibiotics, and patients with PPH, who were had bleeding arrested after medical or surgical management but remained clinically hypovolemic, requiring further blood transfusion to be stabilized.

4.5 Clinical management of three major maternal complications causing near miss.

4.5.1 Obstetric Haemorrhage

Table 13 Medical management Obstetric haemorrhage (N = 38)

Intervention	N	%
Oxytocin	25	65.8%
Misoprostol	20	52.6%
Ergometrine	13	34.2%
Tranexamic Acid	0	0
Blood transfusion	38	100%

Table 13 above shows the medical management of obstetric hemorrhage according to the standard WHO NM audit tool.

The numbers of the individual medical treatments equals to more than 38, the number of patients with obstetric haemorrhage ; this is because in the management of PPH, more than one agent is used in a step wise approach.

Oxytocin was the most widely used first line uterotonic (65.8%), followed by misoprostol (52.6%), and ergometrine (34.2%) was less frequently used.

Massive blood transfusion was defined according to the WHO strict inclusion criteria as transfusion of more than or equal to 6 units of blood products.

In our study, all near miss cases with Obstetric haemorrhage were transfused more than or equal to 6 units of any blood products, for example red blood cells, platelets, fresh frozen plasma or cryoprecipitate.

Table 14 Surgical management of Obstetric hemorrhage (N =38)

Intervention	N	%
Hysterectomy	19	50%
Laparotomy	25	65.8%
Uterine compression sutures	8	21.1%
Balloon tamponade	12	31.6%
Uterine evacuation	5	13.2%

In table 14 above there were a total of 69 different surgical interventions for the 38 patients with obstetric haemorrahge, this is so because the surgical management usually follows step wise approach to control the bleeding and thus salvage the uterus but there are cases where this was not possible in view of their blood loss and clinical stability, so a hysterectomy was performed.
Laparotomy (25 near misses) was the most frequent surgical procedure performed; this included laparotomy for PPH following NVD (6 near misses) and relook laparotomy following an initial CS (14 near misses), primary laparotomy for ruptured ectopic (1 near misses) and for ruptured uteri (2 near misses) and for extra uterine pregnancy (2 near misses)
Hysterectomy was performed for 19 (50%) of the OH near miss patients.
Uterine compression sutures and intrauterine balloon tamponade were also frequently used surgical procedures performed; for 21.5% and 31.6% of near misses respectively.

4.5.2 Management of Hypertensive Disorders in Pregnancy

Magnesium sulphate was administered for 96% of the near misses with maternal hypertensive disorder. Information was not collected on the use of rapid acting anti-hypertensive agents

Table 15 Management of hypertensive disorders (N=50)

Medications	**N**	**%**
Magnesium Sulphate	48	96%
Other Anti Convulsants	14	28%

4.5.3Management of near miss cases with pregnancy related sepsis

Table 16 shows that, in almost half of the patients, prophylactic antibiotics were not given, but all the patients were given therapeutic antibiotics and all had a hysterectomy performed.

Table 16 Management of pregnancy related sepsis (N = 13)

Intervention	**N**	**%**
Prophylactic Antibiotics	6	46.2%
Therapeutic Antibiotics	13	100%
Hysterectomy	13	100%

4.6Avoidable factors for Near miss cases

Avoidable factors were classified into patient related, administrative related and health care provider related according to the system used in the SA Saving Mothers reports.

Table 17. PATIENT ORIENTED AND ADMINISTRATIVE ORIENTATED AVOIDABLE FACTORS

Table 17 a PATIENT ORIENTATED PROBLEMS:

Lack of information:	**2 (1.8%)**
No avoidable factor:	**88(78.6%)**
No antenatal care:	**13(11.6%)**
Infrequent antenatal care:	**7(6.3%)**
Delay in accessing medical help:	**2(1.8%)**
Community problem	**1(0.9%)**

Table 17 b ADMINISTRATIVE PROBLEMS:

Lack of information:	**2(1.8%)**
No avoidable factor:	**91(81.3%)**
Transport problems	
ii) Institution-institution	**7(6.3%)**
Delay in initiating care due to overburdened services (eg long queues, competing emergencies	**4(3.6%)**
Lack of accessible health care facility	**1(0.9%)**
Lack of health care facilities	**3(2.7%)**
Lack of appropriately trained staff	**3(2.7%)**

4.6.1 Patient oriented and administrative factors for near miss cases

Table 17 above shows that for both the patient oriented and administrative avoidable factors , there was a high number of near miss cases where no factor was identified ; 78.6 % and 88.1 % respectively.
However the avoidable factors that occurred frequently in these two categories were lack of antenatal clinic attendance and inter-facility transport problems particularly from L1 to L3.

In table 17a above, there were 88(78.6%) patients in whom no avoidable factor was identified, no antenatal care / infrequent care was identified in 13(11.6%) and 7(6.3%) respectively; while delay in accessing medical help was a contributing avoidable factor in 2 patients.
In table 17 b, no avoidable factor was present in 91(81.3%) of the patients, transport problems occurred for 7 (6.3%) near misses; and delay in initiating care due to overburdened service (for example due to long queues , and competing emergencies) was identified to be a factor in 4(3.6%) of the patients. Lack of appropriately trained health staff was seen in 3 (2.7%) of near misses.

4.6.2 Heath care provider related avoidable factors for near misses

Table 18 shows the problems in clinical management at different levels of care by the health care providers.

Table 18. Health Provider Factors for near misses at different Levels of care

FACTORS INVOLVED	LEVEL 1	LEVEL 2	LEVEL 3
Not managed at this level	-	-	0
Lack of information	4	1	2
No factor identified	83(74.1) %	69(61.6%)	104(92.9%)
Initial assessment	2	2	2
Problem Recognition	3	3	0
Delay in referring	1	-	0
Managed inappropriate		-	0
Wrong diagnosis	2	3	0
Substandard care	2	10	1
Monitoring problems	4	7	3
Totals	102	92	112

The highest number of avoidable factors were identified at Level 2 (38.2%), followed by level 1 (25.9%), and L3 (7.1%).

Substandard care was the most common health care provider factor at level 2, (eg delay in intervening in prolonged labour with augmentation or delay in decision for CS), followed by monitoring problems (eg discovery of a shocked patient a few hours after delivery) .

At level 1, the most frequent avoidable factor was poor problem recognition and inadequate monitoring.

At level 3, the main avoidable factor was delaying in initiating appropriate treatment, for example delay in starting magnesium sulphate and planning delivery in a patient who had imminent eclampsia...

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CHAPTER 5: DISCUSSION

The current study used the WHO Near miss audit tool for defining and investigating near misses, as well as calculating rates and ratios (as described in the methodology section, Chapter 3). The 112 near miss cases in the study were identified either by having a specified near miss defining severe maternal complication (eclampsia, uterine rupture), or by having a severe maternal complication (which on its own was insufficient to define it as a near miss), together with one or more organ dysfunction and / or one or more specified critical interventions. There were 13 maternal deaths during the study period giving a total of 125 women with life threatening conditions (severe maternal outcomes)

5.1 Use of WHO near miss audit tool.

The WHO definitions for near miss, and maternal death were strictly adhered to. However we adapted the WHO list of severe maternal complications to including additional categories; acute collapse/thromboembolism, non-pregnancy related infections and medical/surgical disorders. We also divided severe maternal complications into sub categories. The WHO criteria for organ dysfunction and critical interventions were strictly followed in order to identify cases as near misses. We added a section to the audit tool which enabled a quality of care assessment by two independent specialist assessing cases for avoidable factors. These modifications of the WHO audit tool appeared to add value to the data and could be considered when the WHO Near Miss audit tool is next updated.

5.2 Near Miss indicators

This study found the near miss rate to be 5.83 per 1000.

This is similar in studies done in other developing countries such as Pakistan with maternal near miss rate of 8.6 (21), India at 3-4.4 per 1000 (22), and Bagdad 5.06 per 1000 (20).

In developed countries, such as Canada, UK and Scotland the MNMR is at 0.7 1.2 and 1.34 per 1000 respectively , which is very low compared to the rest of the African continent as well as some parts of Asia, but this is an indication of standard of care and service provision in these individual countries (22).

Mortality and morbidity studies in the US found a MMR of 6.5 deaths per 100,000 LBs which is 10 times less than what we found in our study (13).

However the maternal near miss rate (MNM) rate in the US of 8.1 per 1000 is higher than the NMR of 5.83 in our study (14).The above findings support the suggestion that where there is low maternal mortality it might translate to high maternal near miss because those who survived but almost died will join the pool of women who are near misses.

In our study, the maternal death to near miss ratio is 1:8.6 this means that for every 9 women who survived severe complications from pregnancy, 1 died.

This finding of MD: MNM is similar to what they found in a prospective study in Brazil and Bagdad 1:8.6 and 1:9 respectively. However, in the Brazilian study they identified patients as ICU admissions, while in the study done in Bagdad, they followed the WHO strict near miss criteria; making the two studies not strictly comparable (18, 20).

The mortality index is used as an important parameter that expresses the quality or standard of care offered to patients in a particular system ,the higher the figure, the poorer the quality of care provided, and vice versa.

Our study found an overall mortality index of 10.4 %, this is relatively higher that some Western countries, however comparable if not better than some other countries.

A study in Karachi (21), had a MI of 12 %, and in Bagdad, where they also used similar methodology involving the WHO criteria, the MI was 11% (20).
Our MI was very low for Hypertensive disorders, PRS and OH at 1.9 %, 1.9% and 0% respectively. While for NPRI, AC and Med/Surgical disorders were 66.7%, 33.3 % and 33.3% respectively.
In the Metro West Maternity Service, most of the practices and interventions for major obstetric emergencies such as APH, PPH, hypertensive disorders in pregnancy follow international standards set by WHO, NICE and even the RCOG or the ACOG
The MMR of 67.6 in our study is lower than for most other countries in sub Saharan Africa. For example, In Malawi the MMR I is 450 per 100, 000, in Nigeria it is 630, while in Sierra Leone it is 1003 per 100,000 live births (9). However the figure for the Metro West is higher when compared with some countries in Europe or the American continent; for the UK it is 12, for the Netherlands it is 3-4 per 100, 000 and for the US it is 8-12 per 100, 000(9).
The major cause of maternal deaths in our study was NPRI, which included HIV associated infections such as TB, PCP pneumonia and meningitis.
In our study obstetric haemorrhage did not feature as a cause of maternal death but was the second most frequent maternal complication associated with near miss. This is an important finding , reflecting that despite high numbers of patients with severe obstetric hemorrhage, the prompt and timely interventions according to protocols , prevented them from dying .Whereas our study had an OH MI of zero; other studies have shown higher OH MI, for example in Karachi they found the OH mortality index to be 17.2 %.

However, while commending appropriate and timely management of obstetric hemorrhage in preventing death, it is also important to investigate whether any of the OH near misses could have been avoided by better preventative maternity care .Obstetric haemorrhage remains the second most frequent cause of maternal

death in South Africa except for the Western Cape which is the only province where MMR from this cause has reduced. Thus, more in depth analysis of the OH near miss cases in the Metro West district of Cape Town could enable better identification of the factors that ensure survival from OH and this information could assist other provinces tackling their higher OH MMRs.

In our study 50 (45%) of the 112 near misses were associated with hypertensive disorders of pregnancy. However, the MI for hypertensive disorders in our study was found to be at 1.9%, this is relatively low compared to the Karachi study were the mortality index was 8.5% for hypertensive disorders

The reason for our lower MI for hypertensive disorders could be related to the strict and streamlined referral protocols in Metro West, effective emergency transport s services between levels of care, timely intervention and extensive use of drugs such as magnesium sulphate and rapid acting antihypertensive agents. For example, in our results, out of the 50 patients with hypertensive disorders, 48 were given magnesium sulphate and all patients with Eclampsia received magnesium sulphate promptly within 12 hours. The above is according to standard WHO and international recommendations. It is unfortunate that the data collection tool did not include use of rapid acting hypertensive agents and it is recommended that this should be included in future adaptations of the WHO near miss audit tool.

The high mortality indices associated with NPRIs (66 %) and Acute collapse (33%) is consistent with other studies, such as the Karachi study, but our MI for NPRI was twice what they found. In our study medical / surgical disorders in pregnancy had the third highest mortality index. It is possible that the MIs for these condition were high in our study because care algorithm for managing these three conditions (NPRI, acute collapse, medical and surgical disorders) may not be as streamlined as that for hemorrhage or that patients presented for care late in the disease process. However, the numbers of these three conditions in our study were too small to draw conclusions.

5.3 Demographic and clinical details of near miss cases

Age and Parity. It is not possible to comment on age and parity as risk factors for near miss cases since there was no data available for the whole obstetric population with which to compare.

A cross sectional study in Brazil in 27 different referral hospitals over one year period found that for women in the extreme of ages , for example over 35 years, the risk of near miss was 25 times higher (23).

Place of residence. The Results show that the majority of near misses came from two disadvantaged high density suburbs of Cape Town, Gugulethu and Mitchells Plain; both locations of low socio economic status. This supports the common theory of increased adverse outcomes amongst people of lower socio – economic class or status. In a country such as South Africa which is classified as being low to middle income, the place of residence of the patients has a strong bearing to their easy access to good quality health care and timely interventions. It is assumed that the closer a patient is to a health facility the earlier they can access health services.

In South Africa, there are major inequities in health status between rich and poor; and also major inequities in access to health care.

HIV status .The prevalence of HIV amongst near miss cases was 22.3 %, while about 1.8 % were unknown.

This is an important statistic , because non pregnancy related infections such as TB ,PCP , and meningitis commonly seen amongst HIV positive people , are a leading cause of maternal death in South Africa contributing to 40.1% of maternal deaths in 2008-2010. In our study, NPRI accounted for 30.7% of maternal deaths but only 1.7% of the maternal near misses, with a high mortality index of 66.7%.

We did not look at the treatment status of the HIV positive patients, to see if those on HAART had a lower NPRI MI than those who were untreated. However the numbers would have been too small to make any conclusions.

Booking status. The majority of near miss cases (88.4%) were booked while 11.6% were unbooked up until they experienced the near miss.
Access to antenatal care is an important aspect of primary health care, and has the potential to prevent some severe maternal complications which result in near misses and maternal deaths.

Mode of delivery. The results showed that a high proportion of the near miss cases were delivered by the operative abdominal route (C/S and laparotomies), making up 62.5 % while the remainder were by normal vaginal delivery (37.5) %. The higher rate of operative delivery in near misses, was particularly noted amongst women with hypertensive disorders in our study. However it is important to recognize that the intervention of caesarean section was often done because of the underlying condition eg placenta praevia or eclampsia with previous CS, and was indicated as part of the definitive management of the condition in order to prevent the progression of the condition into a possible maternal death.
The maternal mortality study in the US , in addition to investigating the etiology and the preventability of maternal death, looked at the causal relationship of C/S delivery to maternal death .The leading causes of death were complications from pre-eclampsia, , pulmonary embolus, amniotic fluid embolus, obstetric hemorrhage and cardiac disease. In relation to mode of delivery, the rate of maternal death was 0.2 per 100, 000 for vaginal birth and 2.2 per 100,000 for caesarean delivery (13). However, it was concluded that for most cases the caesarean section was an associated factor but not the direct cause of the maternal death which was usually due to the primary condition eg

PET. Concern about the deaths from thromboembolic events after CS, led to recommendations to roll out routine thromboprophylaxis for all women undergoing C section delivery in the US (13).

In Tanzania, Litorp et al examined maternal near miss and death and their association with C section complications at the University Hospital and regional referral hospital. The study was conducted over a 5 month period during which there were 467 near miss cases and 77 maternal deaths (24).

The MNMR was 36 per 1000 while the MMR was 587 per 100,000 both figures about 10 times what we found in our study.

In their study, the main causes of morbidity and mortality were eclampsia and obstetric haemorrhage (PPH) but they also detected some severe maternal outcomes occurring from iatrogenic complications. Complications of C/S accounted for 7.9% of the maternal near misses and 13% of the maternal deaths. The authors recommended reduction of the CS rate.

It is must be borne in mind that caesarean section can be a lifesaving operation both for the mother and the baby. In countries where there is lower than the WHO recommended caesarean rate of 10 to 15 % of 1985 , there seem to be higher rates of mortality as compared to regions where the rates are higher.

The most recent Saving Mothers report for 2011-2013 shows that MMR for South Africa is 3 time higher for CS delivery than vaginal delivery (4).

However; there was no analysis of the CS cases to examine whether they were all clearly indicated. Also in our near miss study, the files were not examined to see if the CS were all indicated. It would be an important suggestion to incorporate investigation of indications and appropriateness of CS delivery into future near miss auditing.

The only conclusions that can be drawn from the observation in our study and in the literature, of high CS rates in the near miss cases and maternal deaths, is the importance of focusing on the safety of CS. This would cover aspects such as adequate surgical skill, prophylactic antibiotics and thromboprophyllaxis.

Timing of emergency. Most of the near misses 50 (47.3%), occurred during the antenatal period; 33 (29.5%) in the post natal period and 23 (20.5%) were intrapartum. Obstetric care tends to focus more on antenatal and intrapartum care. This study finding stresses the importance of emphasizing good quality postnatal care which is often neglected but can be a critical time for the patient.

Level of care and referral characteristics for women with near misses.
The majority of the near misses originated at level one facilities (Midwife obstetric units) and district hospitals; and level 2 (regional hospitals). However at least 88% were eventually managed at level 3 care (tertiary hospital) and most critical interventions were performed within 12hours of the emergency event. This suggests that there is a well-functioning referral system within the Cape Metro.

Length of hospital stay. The average length of stay was 11 days, with the cases of hypertensive disorders and haemorrhage having longer hospital stay than the other categories. This shows the burden of disease that is carried by the maternity services in the management of near misses

Organ dysfunction. Organ dysfunction was seen in almost half of the near miss cases, with some patients having more than one organ dysfunction.
The most common organ dysfunction observed was cardiovascular dysfunction, and many of these women required inotropic support.
There were 52 (46.4%) of the 112 near miss cases who sustained organ function; this is higher compared to findings in other studies such as the one done in Karachi where they found rates of 18.1% (21).
The higher incidence of organ dysfunction could mean that the intervention was early enough to prevent the progression of the morbidity to mortality sequence such that it ended at the point of organ dysfunction.

In the Karachi study, they had much smaller study population and sample size but found a higher mortality index.

The other possible explanation for lower levels of organ dysfunction in other developing country settings could be the poor availability of laboratory facilities and sophisticated diagnostics such as for liver functions and renal functions analysis in poor resource settings. This would limit the diagnosis of organ dysfunction. This is supported by a near miss audit done in Thyolo district in Southern Malawi where the authors acknowledged that the diagnosis of organ dysfunction was limited by the poor availability of laboratory equipment. The authors argued that, in this type of setting, the disease specific criteria (occurrence of a severe maternal complication) as well as performance of critical clinical interventions, need to be relied upon for case ascertainment of near miss, rather than organ dysfunction (17). In the first South African near miss audit conducted by Mantel et al in Pretoria, organ dysfunction was used and was the main criterion for the identification of near misses (15).

Critical interventions and Clinical management of near misses in relation to the severe underlying maternal complication.

There were four main critical interventions that were included in our study, namely ICU admission, Ventilation. Massive Blood transfusion (more than or equal to 6 units of blood) and Hysterectomy done for sepsis or intractable haemorrhage as shown in the Results section

ICU Admission. Admission to ICU was provided for 23 of the 112, making up 20.5% of the near misses. The main reasons for ICU admission was hemorrhage followed by hypertensive disorders; the patients required ventilation, inotropes or fluid management.

In Mantel's near miss audit in Pretoria lack of ICU facilities occurred more frequently in maternal deaths than near miss cases (15).

The Brazil study, found a maternal near miss rate (MNMR) of 4.4 and had an ICU admission rate of 1.6% (18). However, they had half of our number of deliveries over four years, and this must have been in a small maternity unit with lower number of deliveries. .

The near miss study done in Bagdad which had a similar rates and ratios as our study (MNMR of 5.06 and MNM: Mortality of 9:1), the ICU admission rate was 37%, more in keeping with our study (20). In our study, hemorrhage was the most common indication for ICU admission contributing to more than 50 % of the ICU admissions.

One explanation for the above differences between centres in terms of ICU admissions could be due to differences in definition of ICU. In our study, most of our patients required high care unit admission at the tertiary unit where patients can be kept ventilated, fluids are strictly managed and even inotropes are administered. Near miss cases only went to the main ICU when prolonged ICU care was needed; we did not count patients who were in the maternity high care unit as ICU admissions, even though there were ventilated.

Massive Blood transfusion. The importance of blood transfusion in acute obstetrics and especially in the scenario of near misses is very clear.

In our study, massive transfusion was defined as equal to or more than 6 units of blood; and was administered to 39 of the near misses (34.8%). In this study we did not quantify the total or average number of blood and other blood products administered for OH near miss cases, but this would have been interesting information to have obtained in terms of resources used and outcomes achieved. Of the 39 who received massive transfusion, 27 of the patients had this initiated within 12 hours of diagnosis of near miss, while 12 occurred after 12 hours.

Emergency hysterectomy. Hysterectomy is a critical intervention and was performed as a life-saving intervention for 50% of the OH near misses and 100% of the pregnancy related sepsis cases.

Additional clinical management of cases of severe near miss

The different clinical modalities of treatment for OH are shown in the results. It shows that frequently used interventions in decreasing order, were oxytocin infusion, rectal misoprostol, balloon tamponade, uterine compression sutures, laparotomy and hysterectomy. The lower usage of ergometrine may reflect high numbers of women with pre- eclampsia for whom it is contraindicated; and non-use of tranexamic acid is due to the fact it is not in the current protocol for managing PPH in the Metro West, Use of tranexamic acid for managing PPH is still under investigation by the large randomized WOMAN trial TRIAL(25).
The relatively high use of misoprostol is in keeping with the FIGO guideline of 2012 and recommendations from other authors demonstrating that misoprostol is effective in managing primary PPH (26). However , WHO evidence based guidelines have been more cautious in promoting its use, acknowledging that its low cost , ease of storage and administration, make it valuable in low resource settings where lack of cold chain and skilled birth attendants limits the use of parenteral oxytocic agents.
For near misses related to hypertensive disorders, 96% received intravenous magnesium sulphate, all of these patients had varying forms of hypertensive disorders. The mortality indices for hypertensive conditions is 1.9% which translates to 1in 50, this could be due to 80% of the patients with hypertensive conditions having eclampsia and being a more severe form of the disease spectrum.

Although in the Metro West maternity service, the protocol for management of hypertensive disorders in pregnancy follows international guidelines and incorporates use of rapidly acting anti- hypertensive agents for acute severe pregnancy hypertension; use of this type of medication was not included on the WHO Near Miss audit tool. This is a shortcoming that needs to be addressed in future versions of the form.

Pregnancy related sepsis was the complication that accounted for 13 (11.6%) of near miss cases , while this was twice as much when looking at maternal deaths , 23.1% (3 out of 13).The mortality index was 1.9%. However the numbers are too small for drawing conclusions

The proportion of maternal deaths from PRS in our study is 4 times higher than the national proportion, described in the Saving Mothers Confidential Enquiry report for of 2008 -2010 where pregnancy related sepsis contributed nationally to 5.3 % of maternal deaths. This difference is difficult to interpret, but since it is a percentage could reflect relatively lower proportions of deaths from other causes (eg OH, hypertension and NPRI) compared to nationally.

From other studies such as the Karachi study, PRS are also a significant group with a mortality index of 33.3 %. When put in perspective, this translates to 1in 3 women who had pregnancy related sepsis dying from this condition which is very high compared to our study. However in our study, there was 100% use of hysterectomy as part of management of PRS, as well as intravenous antibiotics and supportive care which could be a reason why the mortality index was not as high when compared to the Karachi study.

Other near miss audits have not used the WHO strict near miss inclusion criteria which include details on critical interventions such as hysterectomy; thus making it difficult to compare our figures on hysterectomy for PRS with other audits. A study by Bauer et al on maternal sepsis morbidity and mortality in the US shows that sepsis complicates 1in 3,333 deliveries; severe sepsis is seen in 1in 10,823 deliveries , and sepsis related deaths occurs in 1in 105, 263 deliveries (27).

5.4 Avoidable factors for near misses

Avoidable factors in relation to near misses can be also considered as preventive factors or poor/incorrect/substandard care which could have prevented the occurrence of the near miss and/or enabled it to be managed better.

There were three aspects to the avoidable factors assessment; patient oriented factors, administrative factors and health care provider factors. This approach was adapted from the assessments done for maternal deaths in SA in the Saving Mothers reports and represented a new approach for assessing quality of care for near misses.

In our study, there were very few patient factors identified, but the study did not include a component of interviewing these women or their families about such factors. However it was shown in our study that lack of antenatal care and transportation problems contributed to 10.6% and 6.25% respectively

Other studies have shown multiple patient limitations to accessing health services, which have impacted on health outcomes. A good example is a cross sectional study by Ernistina David et al in 5 referral hospitals in Mozambique, where they found that near misses were frequent and related to delay in reaching and receiving adequate care (28).

Health care provider problems were identified more at level 2 hospitals and level one facilities than at level 3. The majority of near misses originated at the lower levels of care which reflects the main service burden of initial management of the near miss emergency. However deficiencies of care were identified at these levels of care more commonly than at tertiary level... These would be important to interrogate at audit meetings if near miss audit meetings are instituted, so modifiable factors can be addressed

5.5 Study limitations

The study was only done over a six month time period , so although 125 women with life threatening conditions were identified , the numbers were not sufficient to compare maternal deaths with near misses or to draw conclusions about the less common causes of near misses. In addition risk factors for near misses could not be identified since there was not background demographic and clinical data on the whole obstetric population during the study period

The study period did not allow adequate time for in depth review of other very important aspects of the study such as follow up of the patients to explore how their lives have been affected by near death experience and their perception towards maternity staff and their future fertility plans or intentions.

A study by L Hinton where they interviewed women who had near miss experiences about how they perceived their quality of care. The study findings suggested that health care givers may not be sensitive to the mental health and emotional needs of women during the near miss management process. Patients remembered the comments that individual doctors made and their attitude towards the patients throughout the near miss events (29). In addition women did not feel they had been given sufficient counseling about their future reproductive health.

Thus it would be a good clinical exercise and also a rewarding one to follow up these patients in our setting and find out about their own perceptions, other health problems, community incorporation, going back to normal life and long term fertility plans for those who did not have hysterectomy.

The data collection was done mainly by the principal investigator, however these near misses were occurring in several maternity facilities in the Metro West, so the modality of obtaining the data would have been better and easier if there were research assistants assigned to collect or identify the cases for the principal investigator. Given this limitation, there might have been some missed

cases of near miss.

For future routine auditing of near misses, it would need the system of reporting to be institutionalized.

Also as indicated in the Discussion, some deficiencies of the WHO audit tool, such as the omission of including antihypertensive treatment as a management for hypertensive cases was only noted after the study was underway.

CHAPTER 6: RECOMMENDATIONS AND CONCLUSION

6.1 RECOMMENDATIONS

1. There is need for an ongoing system of audit of maternal near miss cases. This requires an action plan put in place for devising a mechanism for ongoing identification and investigation of near misses. Selected ones could be presented for discussion at the departmental maternal mortality meeting held at GSH; and also in the secondary hospitals; with the aim of improving the quality of care
2. A larger study which would look at knowledge, attitude and practice or perception of patients after a near miss experience would be beneficial. This should include gaining a better understanding of any difficulties they had accessing health care as well as the emotional and physical impact of the near miss event.
3. Follow up of near miss cases at 6 weeks would further aid understanding of long term sequelae for women with near misses**.**
4. Ongoing training of obstetric staff at peripheral units to be able to identify obstetric emergencies and institute appropriate management. Regular emergency drills would assist in this process as proposed by the ESMOE/EOST programmer (30).

6.2 CONCLUSIONS

The near miss rate (5.83 per 1000 live births) and maternal mortality ratio (67.6 per 100,000 live births) in Metro West were lower than for some other developing countries, but higher than rates in high income countries. The overall mortality index (MI) was 10.4%. The MI was much lower for direct obstetric conditions such as hypertensive disorders, obstetric haemorrhage and pregnancy related sepsis, reflecting good quality of care and referral mechanisms for these conditions. The mortality indices for non-pregnancy related infections, medical /surgical conditions and acute collapse were much higher and, although numbers were small, suggest that medical problems may need more focused attention.

Further developments for near miss auditing could include acquiring information from the women themselves about their access to care and the impact of the near miss for them personally.

The WHO near miss audit tool was found to be implementable but the changes made to the data collection form were thought to add value to the data collected.

Ongoing near miss audit would be valuable for Metro West but would require identification and monitoring systems to be institutionalized.

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APPENDICES

A).WORLD HEALTH ORGANISATION DEFINITIONS USED FOR DEFINING NEAR MISSES AND LIFE THREATENING CONDITIONS

SEVERE AZOTEMIA	CREATININE >=300mcmol/l 0r >=3.5mg/dl
CARDIAC ARREST	Sudden absence of pulses and loss of consciousness
CARDIOPULMONARY RESUSCITATION	A set of emergency procedures including chest compressions and lung ventilation in cardiac arrest victims.
COAGULOPATHY	The clinical inability to form clots, disseminated intravascular coagulation, Clinically , the absence of clot forming in the IV site or suture after 7-10 minutes .Tested by bedside test of failure of a clot to form after 7minutes or soft clott that breaks down easily. Or the use of Laboratory test , platelets <50 , low fibrinogen(<100mg/dl), prolonged prothrombintme (>6 s , INR>5) D-dimer > 1000ng/dl
MATERNAL NEAR MISS	A woman who nearly died but survived a complication that occurred during a pregnancy, delivery or postpartum until 42 days .
MORTALITY INDEX	The ratio of the maternal deaths by the sum of maternal deaths and near miss. MI =MD/MD+MNM
MATERNAL MORTALITY	Death of a woman while pregnant or within 42 days after the end of the pregnancy irrespective of the duration and the site of the pregnancy from any cause related to or aggravated by the pregnancy or its management and not from accidental or incidental causes and measured per 100 000 live births.
LIFE THREATENING	Severe complication causing organ dysfunction in

COMPLICATIONS	the near miss context , and can lead to maternal death.
HYSTERECTOMY	Surgical removal of the uterus. In the near miss context usually following severe infection or haemorrhage
MASSIVE TRANSFUSION	Transfusion of considerable amount of blood or red cells,> 6 units of blood or red cells.
METABOLIC COMA	Loss of consciousness and the presence of glucose and ketoacids in the Urine
PROLONGED UNCONSCIOUNESS	Any loss of consciousness lasting > 12 hrs. , involving complete or almost complete lack of responsiveness to external stimuli. A state compatible with GCS of <10
OLIGURIA NOT RESPONDING TO FLUIDS OR DIURETICS	Urinary output of <30 mls /hr for 4 hours or <400mls over 24 hrs not responding to fluids or diuretics
SEVERE ACIDOSIS	A blood PH , < 7.1
SEVERE ACUTE HYPERBILIRUBINEMIA	Bilirubin >100mcmol/l or >6.0mg/dl
SEVERE ACUTE THROMBOCYTOPENIA	Acute reduction in the blood of platelet count , < 50 000/ml
SEVERE BRADYPNEA	Respiratory rate <8 breaths per minute.
GASPING	Terminal Respiratory pattern, the breath is audible .
SEVERE HYPOPERFUSION	Lactate in the blood >5 mmol/l or >45 mg /dl

B) UCT NEAR MISS DATA COLLECTION TOOL (ADAPTED FROM WHO MATERNAL NEAR MISS TOOL)

Study number Age Parity Residence	**Gestational age**

SCREENING QUESTIONS (Specify In the questions Ao to A7)

0 – condition not present on arrival, 1 condition present within 12 hrs of arrival

2- condition developed after 12 hours of arrival

3- information not available

1SEVERE COMPLICATIONS

A0	Severe Postpartum Hemorrhage	
A1	Severe preeclampsia	
A2	Eclampsia	
A3	Sepsis /severe systemic infection	
A4	Ruptured uterus	
A5	Ruptured ectopic	

A6	Pulmonary embolus	
A7	Other: specify	

2CRITICAL INTERVENTION /INTENSIVE CARE UNIT ADMISSION

B0	Use of blood products	
B1	Interventional radiology (UAE)	
B2	Laparotomy	
B3	Admission to maternity critical care unit	
B4	Admission to main ICU	
B5	Hysterectomy	
B6	Ventilation	

3ORGAN DYSFUNCTION

C0	Cardiovascular dysfunction	
C1	Respiratory dysfunction	
C2	Renal Dysfunction	
C3	Coagulation dysfunction or hematologic dysfunction	
C4	Hepatic Dysfunction	
C5	Neurological Dysfunction	

MATERNAL INFORMATION

4	Date of hospital admission	DD MM YY E0
5	Date of delivery or uterine evacuation or surgery for ectopic	DD MM YY E1
6	Date of hospital discharge	DD MM YY E2

7 **FINAL MODE OF DELIVERY /END OF PREGNANCY**

D1	Vaginal delivery	
D2	Caesarean section	
D3	Complete abortion	
D4	Currettage /Vacuum aspiration	
D5	medical methods	
D6	Laparotomy for ectopic pregnancy	
D7	Women discharged still pregnant	
D8	Laparotomy for ruptured uterus	
D9	Unknown /other	

8 Best Estimate of gestational age in completed weeks

Delivery or Aborti☐

hospital discharge☐

9. PROCESS INDICATOR S

9- Conditions on arrival at facility & Referral process

F 0	Delivery or Abortion before Arrival	
F 1	Life threatening complications present on arrival	
F 2	Life threatening complications developed in facility	
F 3	Women referred from other hospitals	
F 4	Women referred to higher levels	

(0=No, 1 =Yes)

10 **USE OF INTERVENTIONS**, please specify (0=NO, 1=YES)

10a **PREVENTION OF PPH**

☐ G0= OXYTC☐N G1 OTHER UTEROTONICS

10b **TREATMENT OF PPH**

H 0	Oxytocin	
H 1	Ergometrine	
H 2	Misoprostol	

H 3	Other uterotonics	
H 4	Tranexamic acid	

H5	Removal of retained placenta	
H6	Balloon or condom tamponade	
H7	Artery ligation, hypogastric artery	
H8	Hysterectomy	
H9	Abdominal packing	
H1 0	Uterine compression sutures	

USE OF ANTICONVULSANTS IO MAGSO4 I1 OTHER ANTICONVULSANTS

USE OF ANTIBIOTICS J0 PHYLACTIC J1 THERAPEUTIC

11.CAUSE OF NEAR MISS(Adapted from Saving mothers report) ***0 = NO 1 = YES***

(Tick 1 main primary obstetric problem and circle the sub-category)

11A	**Medical and Surgical disorders:** Cardiac disease, endocrine, GIT, CNS, respiratory, haematological, genito-urinary, auto-immune, skeletal, psychiatric, neoplasm, other (specify)	

	11B	**Non-pregnancy-related infections:** PCP pneumonia, other pneumonia, TB, influenza, endocarditis, UTI, appendicitis, malaria, cryptococcal meningitis, other meningitis, Kaposi's sarcoma, toxoplasmosis, cholera, hepatitis, gastroenteritis, wasting syndrome, other (specify)		
	11C	**Ectopic pregnancy:** <20 weeks, >20 weeks		
	11D	**Miscarriage:** Septic miscarriage, haemorrhage (non- traumatic), uterine trauma, GTD, following legal TOP		
	11E	**Pregnancy-related sepsis:** Chorioamnionitis with ruptured membranes, chorioamnionitis without ruptured membranes, puerperal sepsis after NVD, puerperal sepsis after c/s, bowel trauma at c/s		
	11F	***Obstetric haemorrhage*** Abruption with/without h/t, praevia, other APH not specified Ruptured uterus with/without previous c/s, Retained placenta, morbidly adherent placenta, uterine atony, vaginal/cervical trauma, inverted uterus, bleeding during c/s, bleeding after c/s, other PPH not specified		
	11G	**Hypertension:** Chronic hypertension, proteinuric hypertension, eclampsia, HELLP, liver rupture.		
	11H	**Anaesthetic complications :** General / epidural / spinal anaesthetic		
	11I	**Adverse drug reactions:** ARV meds, TB meds, other meds, herbal meds, blood transfusion reaction		

11J	**Embolism:** Pulmonary embolus, amniotic fluid embolus		
11K	**Acute collapse – cause unknown**		
11L	**Miscellaneous** Hyperemesis gravidarum Acute fatty liver		

12 **CONTRIBUTORY FACTORS** (0=NO 1=YES)

M0	Anaemia	
M1	HI V-related infections	
M2	Previous caesarean section	
M3	Prolonged Obstructed labour	
M4	Obesity , BMI>30	
M5	Other: specify	

C) FORM FOR AVOIDABLE FACTORS

STUDY NO.....

Assessment of avoidability*Adapted from NCCEMD assessors form 2008 version*

8.31 PATIENT ORIENTATED PROBLEMS:

8.31A	Lack of information:	
8.31B	No avoidable factor:	
8.31C	No antenatal care:	
8.31D	Infrequent antenatal care:	
8.31E	Delay in accessing medical help:	
8.31F	Declined medication/surgery/advice	
8.31G	Family problem:	
8.31H	Community problem:	
8.31I	Unsafe abortion	

8.31J	Other (specify)	

8.32 ADMINISTRATIVE PROBLEMS:

8.32 A	Lack of information:	
8.32 B	No avoidable factor:	
8.32 C	Transport problems i) home-institution	
	ii) Institution-institution	
8.32 D	Lack of accessibility i) barriers to entry	
	ii) other:	
8.32 E	Delay initiating critical care due to overburdened service e.g. long queues, competing emergencies.	
8.32 F	Lack of health care facilities: ICU	
	Blood/blood products	
	Other	

8.32 G	Lack of appropriately trained staff: i) Doctors ii) Nurses	
8.32 H	Communication problems: i) technical **ii)** interpersonal	
8.32I	Other (specify):	

CLINICAL MANAGEMENT AND EMERGENCY CARE PROBLEMS (Tick type & level where problem occurred - each column must have at least 1 tick):

8.33 TIMING of <u>EMERGENCY</u>:

8.33A	Early pregnancy: <20w			
8.33B	Antenatal period:≥20 w			
8.33C	Intrapartum period:			

8.33D	Postpartum period:			
8.33E	Anaesthesia			

8.34 MEDICAL CARE		1º	2º	3º	RESUSCITATION	
8.34A	Not managed at this level					
8.34B	Lack of information:				Lack of information:	
8.34C	No avoidable factor:				No avoidable factor:	
8.34D	Initial assessment:				Airway problems:	
8.34E	Problem recognition/diagnosis:				Breathing problems:	
8.34G	Delay in referring patient:				Circulation problems:	
8.34H	Managed at inappropriate level:				Drugs problems:	
8.34I	Incorrect management (wrong diagnosis):				Investigation problems:	

8.3 4J	Sub-standard management (correct diagnosis):				Monitoring problems:	
8.3 4L	Monitoring problems:				Not attempted	
	i) not/infrequently done					
	ii) Prolonged abnormal observations with no action					

D) RESEARCH POSTER

TITLE OF RESEARCH -
Near miss Audit

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SUPERVISORS
PROF FAWCUS AND DR SCHOEMANN

SUMMARY
I Dr Ibe Iwuh, in conjuction with Dr Lean Schoeman and Prof Sue Fawcus are conducting a near miss audit.
A near miss occurs when a woman has a severe life threatening condition but survives, and this is also known as severe acute maternal morbidity.
This event has been shown to occur more frequently than maternal deaths. In the Metro West, there are about 38000 deliveries per year, and it will be interesting to evaluate how many of these women severe obstetric complications and the factors associated with this survive.
The research will be prospective type involving folder reviews of the possible near miss admissions in the three hospital(NSH, MMH and GSH) in the Metro West, over a period of 6 months .
PLEASE CAN YOU ASSIST WITH IDENTIFYING THE PATIENTS IN YOUR WARD
BY PLACING A STICKER IN THE A5 NEAR MISS BOOK AT THE NURSES STATION..

Thank you

Appendix E: Research approval letter from UCT HREC *(attached)*