Maternal near miss and maternal mortality and their determinants among pregnant women at a rural tertiary centre in the Eastern Cape Province, South Africa: A cross-sectional study

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Background. Maternal near miss (MNM) is a significant entity in the assessment of the quality of obstetric care, particularly at institutional level. It renders possible the assessment of events surrounding a woman surviving what would otherwise have been a fatal outcome during childbirth or within 42 days post termination of pregnancy. The World Health Organization (WHO) introduced a tool that eases the identification of such cases and the interventions that were offered during their care. There have been several assessments of maternal deaths within South Africa (SA), but no audit of maternal near-miss cases has been carried out in rural Eastern Cape Province.
Objectives. To establish the period prevalence of MNM and mortality index, and to compare near-miss cases with maternal mortality and to identify their risk factors and causes.
Methods. A prospective cross-sectional study was carried out at Nelson Mandela Academic Hospital, a rural tertiary hospital in the Eastern Cape Province, over a 6-month period between January 2019 and June 2019. All cases that met the WHO criteria for MNM, together with maternal mortality cases, were identified and included in the study.
Results. There was a total of 1 706 live births, 228 maternal near-miss cases and 24 maternal death cases. The institutional severe maternal outcome ratio was 147/1 000 live births, with an overall mortality index of 9.5%. The MNM ratio (MNMR) was 133.6/1 000 live births, the maternal mortality ratio was 1 406.8/100 000 live births and the MNM/maternal mortality ratio (MNMR/MMR) was 9.5:1. The stillbirth rate was found to be 95.0/1 000 births. The leading causes of MNM were eclampsia (47.8%), abruptio placentae (19.7%) and postpartum haemorrhage (8.3%), and the leading causes of maternal death were eclampsia (29.2%), puerperal sepsis (25%) and postpartum haemorrhage (12.5%).
Conclusion. The MNMR and the MMR found in this study were comparable with other reports from sub-Saharan Africa, although these ratios were notably higher than in urban areas within SA. The conditions that resulted in the highest fatality rate were potentially preventable, namely eclampsia and puerperal sepsis. Many patients with life-threatening conditions were low-risk patients, and this emphasises the need for more vigilant surveillance of patients during the antenatal, intrapartum and postpartum periods.

Keywords: Maternal near miss, maternal death, severe obstetric morbidity, severe maternal outcome.

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Over 1 000 women still die daily from pregnancy-related causes around the world, and a vast majority of these deaths occur in low- and middle-income countries (LMICs) and are a result of preventable causes.[1] Globally, >70% of maternal deaths (MDs) occur because of complications of pregnancy and childbirth such as haemorrhage, hypertensive disorders, sepsis and abortion.[2] Traditionally, MD enquiries have been the backbone for evaluation of maternal healthcare services to improve the quality of obstetric services and obstetric care. With quality of care being a central element in the United Nations Global Strategy for Women's, Children's and Adolescants' Health, it is essential to continue improving not only accessibility, but the quality of the obstetric care offered to pregnant women globally. Maternal near-miss audits have emerged as a better tool in assessing and evaluating the quality of maternal healthcare services and outcomes, as maternal near-miss cases occur up to 100 times more often than MDs.[2-4] A maternal near miss (MNM) is defined as 'a pregnant woman who nearly died but survived a complication that occurred during pregnancy, childbirth or within 42 days of termination of pregnancy'.[5] These near-miss events are acute obstetric complications that immediately threaten a woman's survival but do not result in her death, either by chance or because of medical intervention received during pregnancy or labour, or after termination of pregnancy or delivery.

The World Health Organization (WHO) defines quality of care as the extent to which healthcare services for individuals and patient populations increase the likelihood of desired health outcomes. To achieve this, healthcare needs to be safe, effective, timely, efficient, equitable and people centred.[6]

Studying near-miss cases and understanding the events that led to them, and how patient survival was achieved, leads to an improved understanding of MDs. This is particularly important if survival in near-miss cases is because of care available to those women.[7] Reviewing these near-miss cases has the advantage of highlighting both deficiencies and adequacies in the provision of obstetric healthcare services. It also has the potential to provide data about the epidemiology of severe obstetric cases but, more importantly,

by putting the lessons learnt from these cases into practice, lead to reduction in maternal mortality rates.[8] An understanding of the aetiology of MDs, and a subsequent improvement in obstetric care offered, has been one of the main reasons for improvement in maternal mortality rates.[9] The study of maternal near-miss cases can directly provide detailed information about the obstacles and problems that have had to be overcome when managing these cases, which gives an idea of the health systems in place, and is considered a more useful approach to improve maternal healthcare.[9,10]

Methods

This was a prospective cross-sectional audit of all patients with severe maternal outcome (SMO) that included MDs and maternal near-miss cases admitted in the labour ward at Nelson Mandela Academic Hospital (NMAH) between January and June 2019. MNM and SMO were defined according to the WHO criteria,[2,5] and MD was defined according to the International Classification of Diseases (ICD-10).[5]

Study setting

NMAH is a rural tertiary teaching hospital of the Faculty of Medicine and Health Sciences, Walter Sisulu University, which is in the OR Tambo Region in Eastern Cape Province of South Africa (SA). It serves as the referral hospital for 19 district hospitals, 2 regional hospitals and 10 healthcare centres in the north-eastern part of the province. Some patients are referred by private obstetricians and gynaecologists and some by general practitioners, with few self-referrals. This catchment region has a population of ~2 - 3 million, and 95% of this population comprises rural, black indigent patients, for whom NMAH serves as the only referral centre.

Inclusion and exclusion criteria

All women seen and admitted at NMAH during pregnancy, at delivery or within 42 days of termination of pregnancy who had severe obstetric morbidity consistent with the WHO criteria for near miss, including those seen in the labour ward and those admitted to the intensive care unit with severe obstetric conditions, were included in the study. In addition, all MDs that occurred during the study period were also prospectively included. Those women who met the WHO criteria but had not yet been discharged by the end of the study period were not included in the study, because the final outcomes of discharge or death were not available.

Indicators that were used in addition to SMO included severe maternal complications, such as pre-eclampsia with severe features, eclampsia, postpartum haemorrhage, sepsis or severe systemic infection, ruptured uterus and severe complications of abortion. Critical interventions included admission to intensive care units, interventional radiology, laparotomy and use of blood products. Life-threatening conditions were classified as cardiovascular dysfunction, respiratory dysfunction, renal dysfunction, coagulation/haematological dysfunction, hepatic dysfunction, neurological dysfunction and uterine dysfunction.

Statistical methods

Data were entered into an Excel (Microsoft, USA) spreadsheet and analysed using SPSS version 26 (IBM Corp, USA). The primary outcome variable was MNM or MD. Independent variables considered demographic (age, marital status, educational level, employment status), reproductive (parity, gestational age at delivery, mode of delivery), clinical (named complication of pregnancy, HIV status, organ dysfunctions) and process (month of admission, delivery/termination before admission, delivery/laparotomy within 3 hours of admission) characteristics, as highlighted in the literature. Prescribed mathematical equations were used to estimate rates and ratios for MNM and death indicators. For example, MNM ratio (MNMR) was estimated as the number of MNMs per 1 000 live births. The case fatality ratio for a named MNM event was calculated as the proportion of fatal cases among the reported cases of that event. The SMO ratio (SMOR), MMR, MNM/MD ratio and stillbirth rate were also estimated.

Statistical outputs of categorical variables were generated using frequency and percentages, while medians and interquartile ranges (IQRs) were used for continuous variables. Proportions were compared using Pearsons's χ^2 test and medial comparisons using the Mann-Whitney U-test. Binary logistic regression analysis with all significant independent variables was computed to identify the predictors of MNM and MD. The odds ratio (OR) with corresponding 95% confidence interval (CI) for the predictors was reported. All observations with a p-value <0.05 were read as significant.

Results

There were a total of 1 706 live births, 228 MNM cases and 24 MD cases in the institution. The total number of patients with SMOs admitted at NMAH during the study period was 252. Of these, 228 (90.5%; 95% CI 86.4 - 93.6) were MNM cases, and 24 (9.5%; 95% CI 6.4% - 13.6%) were MDs. The SMOR was 147.7 per 1 000 live births. The majority (n=172; 68.3%; 95% CI 62.3 - 73.8) of the participants were between 19 and 34 years old, with a median (IQR) age of 23 years (19 - 29 years). As illustrated in Table 1, most participants were single (n=210; 83.3%; 95% CI 78.4 - 87.5), attended school to senior secondary level (n=138; 54.8%; 95% CI 48.6 - 60.8) and were unemployed (n=144; 57.1%; 95% CI 51.0 - 63.1). The age of participants who died was statistically significantly higher (p=0.01) than that of those who survived. A statistically significant difference was also observed across categories of all other demographic characteristics for the near-miss cases and MDs (p<0.05). Among the MDs, the majority were in the 19 - 34-year age group, single, had not attended school and were unemployed. Of the near-miss cases, the majority were also in the 19 - 34-year age group, single and unemployed, but most had attended school up to high school, as illustrated in Table 1.

The institutional SMOR, MNMR, maternal mortality ratio (MMR), MNM/MD ratio, mortality index (MI) and stillbirth rate are shown in Table 2.

The three leading causes of MNM were eclampsia (47.8%; 95% CI 41.4 - 54.3), abruptio placentae (19.7%; 95% CI 15.0 - 25.3) and postpartum haemorrhage (8.3%; 95% CI 5.3 - 12.4). The median (IQR) age was 20 (14 - 37) years for eclampsia, 22 (16 - 45) years for abruptio placentae and 29 (18 - 41) years for postpartum haemorrhage. The three leading causes of MD were eclampsia (29.2%; 95% CI 14.1 - 48.9), followed by puerperal sepsis (25%; 95% CI 11.2 - 44.5) and postpartum haemorrhage (12.5%; 95% CI 3.6 - 29.7). The median (IQR) age was 23 (16 - 35) years for eclampsia, 29 (25 - 38) years for puerperal sepsis, and 37 (24 - 37) years for postpartum haemorrhage.

The case fatality rate for each of the leading life-threatening conditions is shown in Table 3. Of the common life-threatening conditions, the case fatality rate was highest for puerperal sepsis (33.3%; 95% CI 16.3 - 56.3), followed by postpartum haemorrhage (13.6%; 95% CI 4.7 - 33.3), eclampsia (6%; 95% CI 3.0 - 11.9) and abruptio placentae (4.3%; 95% CI 1.2 - 14.3), although a case fatality rate of 100% was registered for two cases of severe liver disease, one case of cardiac disease and one case of cerebrovascular accident.

Overall, 25 (9.9%; 95% CI 6.7 - 14.1) patients with life-threatening conditions were admitted to the intensive care unit. Of these,

Table 1. Sociodemographic characteristics of the sample population (*N*=252)

Characteristic	Category	All, *N*=252, *n* (%)	MNM, *n*=228 *n* (%)	MD, *n*=24, *n* (%)	χ^2 *p*-value
Age, years	≤18	49 (19.4)	47 (20.6)	2 (8.3)	0.02
	19 - 34	172 (68.3)	157 (68.9)	1 5(62.5)	
	>34	31 (12.3)	24 (10.5)	7 (29.2)	
	Median (Q1 - Q3)	23 (19 - 29)	25.5 (23 - 35)	23 (19 - 29)	0.01*
Marital status	Single	210 (83.3)	196 (86.0)	14 (58.3)	<0.0001
	Married	33 (13.1)	27 (11.8)	6 (25.0)	
	Widowed	1 (0.4)	1 (0.4)	0 (0.0)	
	Not recorded	8 (3.2)	4 (1.7)	4 (16.7)	
Highest level of education	Junior primary school	1 (0.4)	1 (0.4)	0 (0.0)	<0.0001
	Senior primary school	14 (5.6)	13 (5.7)	1 (4.2)	
	Junior secondary school	32 (12.7)	32 (14.0)	0 (0.0)	
	Senior secondary school	138 (54.8)	132 (57.9)	6 (25.0)	
	Above matric	9 (3.6)	9 (3.9)	0 (0.0)	
	No schooling	39 (15.5)	28 (12.3)	11 (45.8)	
	Not recorded	19 (7.5)	13 (5.7)	6 (25.0)	
Employment status	Working	17 (6.7)	16 (7.0)	1 (4.2)	<0.0001
	Unemployed	144 (57.1)	129 (56.6)	15 (62.5)	
	Scholar	77 (30.6)	75 (32.9)	2 (8.3)	
	Not recorded	14 (5.6)	8 (3.5)	6 (25.0)	

MNM = maternal near miss; MD = maternal death; Q1 - Q3 = 25th - 75th percentile.
*Mann-Whitney U-test.

14 (56%; 95% CI 36.8 - 73.9) were MNM patients, and 11 (44%; 95% CI 26.1 - 63.2) were patients who subsequently died.

Of all patients, 75 were HIV-positive. In the near-miss patients, 60 (26.3%; 95% CI 20.9 - 32.3) were HIV-positive, while the majority were HIV-negative. Of the patients who subsequently died, 15 (62.5%; 95% CI 42.6 - 79.6) were HIV-positive. Only one patient in each group had unknown or untraceable HIV results (Table 4).

All the 24 patients who subsequently died were referred from other levels of care, the vast majority of whom (95.8%; 95% CI 82.1 - 99.5, *n*=23) were from district hospitals.

The predictors of MD and MNM are shown in Table 5 and Table 6. The predictors of MNM were being in the 19- 34-year age group, being single, having at least high school education and being unemployed. Reproductive predictors included being primiparous, attending the antenatal clinic <4 times and being in the third trimester. Clinical predictors include being diagnosed with eclampsia. All the predictors for MNM were statistically significant.

The unadjusted predictors of MDs were being in the 19 - 34-year age group, and being single, illiterate (no schooling) or unemployed. Reproductive predictors were being para 2 - 4, being in the third trimester and delivery via caesarean section. Clinical predictors were eclampsia diagnosis, having HIV/AIDS, having ≥2 contributory predictors such as anaemia and HIV, and having ≥2 organ dysfunctions. Process predictors included being admitted in January, being undelivered or not having termination of pregnancy before admission, and not being delivered or having laparotomy within 3 hours of admission.

On multivariate logistic regression, having ≥1 organ dysfunction was an independent predictor of MD. Patients with just one organ dysfunction were 9.2 times more likely to die (odds ratio (OR)=9.2; *p*<0.008) compared with patients without any organ dysfunction. The likelihood of dying was even higher with >1 organ dysfunction. Patients with ≥2 organ dysfunctions were 138.9 times more likely to die than patients without any organ dysfunction (OR=138.9; *p*<0.0001) (Table 7).

Table 2. Maternal near miss and death rates and ratios

Indicator	
Maternal near-miss participants, *n*	228
Maternal deaths, *n*	24
Women with life-threatening conditions	252
Total deliveries, *n*	1 885
Live births, *n*	1 706
SMOR, per 1 000 live births	147.7
MNMR, per 1 000 live births	133.6
MMR, per 100 000 live births	1 406.8
MNM/MD ratio	9.5:1
MI, %	9.5
Stillbirth rate	95.0

SMOR = severe maternal outcome ratio; MNMR = maternal near miss ratio; MMR = maternal mortality ratio; MNM = maternal near miss; MD = maternal death; MI = mortality index.
Women with life-threatening conditions = MNM + MD; SMOR = MNM + MD/1 000 live births; MNMR = MNM participants/1 000 live births; MMR = MD/live births ×100 000; MI = MD/MNM + MD ×100%; stillbirth rate = total stillborn (179)/total infants delivered × 1 000.

Discussion

As a rural tertiary hospital with a large catchment area, most obstetric patients with complications within the region end up at NMAH. This prospective cross-sectional study set out to identify the magnitude of the problem and associated factors in the institution. In this study, we adapted the WHO MNM audit tool, and only modified it to accommodate MDs and other demographic information.

The facility-based MNMR was found to be 133.6 per 1 000 live births. This is far higher than the weighted pooled global MNMR of 18.67 per 1 000 live births, 31.88 per 1 000 live births in Africa, 16.92 per 1 000 live births in Asia and 3.10 per 1 000 live births in Europe, as reported in a systematic review and meta-analysis.[11] However, the high maternal near-miss ratio in this study compares favourably with

Table 3. Underlying causes

Underlying cause	Near miss, *n*=228, *n* (%)	Maternal death, *n*=24, *n* (%)	Case fatality rate (%)
Eclampsia	109 (47.8)	7 (29.2)	6.0
Abruptio placentae	45 (19.7)	2 (8.3)	4.3
Postpartum haemorrhage	19 (8.3)	3 (12.5)	13.6
Pre-eclampsia	18 (7.9)	1 (4.2)	5.3
Puerperal sepsis	12 (5.3)	6 (25.0)	33.3
Ruptured uterus	10 (4.4)	0 (0.0)	0.0
Post-abortal sepsis	4 (1.8)	0 (0.0)	0.0
Abdominal pregnancy	3 (1.3)	0 (0.0)	0.0
Placenta accreta	2 (0.9)	0 (0.0)	0.0
Placenta praevia	2 (0.9)	0 (0.0)	0.0
Liver disease	0 (0.0)	2 (8.3)	100.0
Pyelonephritis	2 (0.9)	0 (0.0)	0.0
Cardiac	0 (0.0)	1 (4.2)	100.0
Cerebrovascular accident	0 (0.0)	1 (4.2)	100.0
First-trimester haemorrhage	1 (0.4)	0 (0.0)	0.0
Acute respiratory distress syndrome	0 (0.0)	1 (4.2)	100.0
Bladder injury	1 (0.4)	0 (0.0)	0.0

Table 4. Patient HIV status

Category	MNM, *n*=228, *n* (%)	MD, *n*=24, *n* (%)
Positive	60 (26.3)	15 (62.5)
Negative	167 (73.2)	8 (33.3)
Unknown	1 (0.4)	1 (0.4)

MNM = maternal near miss; MD = maternal death.

near-miss ratios reported from referral hospitals in some African countries such as Ethiopia, with a ratio of 208 per 1 000 births,[12] but poorly with the MNMR of 23.6 per 1 000 live births reported from Tanzania.[13]

When compared with local studies in SA, this MNMR was also much higher than that found in Cape Town, where the MNMR was found to be 5.83 per 1 000 live births,[14] and in Pretoria, where the MNMR was found to be 4.3 per 1 000 live births.[15] However, these differences could partly be attributed to the fact that the present study was facility-based, whereas these other studies were urban community-based and included secondary and tertiary level hospitals within their metros, which gave them larger denominators. The other possible explanation is that healthcare services in the metropolitan areas of Cape Town and Pretoria are far more advanced than the services in the poverty-stricken rural areas of the Eastern Cape Province, in which NMAH is situated.

The institutional MMR was 1 406.8 per 100 000 live births. This is a very high MMR and compares poorly with reports from other parts of SA, where the institutional MMR was found to be 71.4 per 100 000 live births in Pretoria metro,[15] and 67.6 per 100 000 live births in the Cape Town metro.[14] This is likely because Pretoria and Cape Town metros have some of the best healthcare services in SA, and do not compare with the type of services available in the poorer areas of the country such as rural Eastern Cape Province. As a matter of fact, the institutional MMRs in these two reports are better than the estimated national average, which is 135 per 100 000 live births.[16]

The institutional MMRs reported from other sub-Saharan African countries are variable, and range from 110 per 100 000 to highs of 2 875 per 100 000 live births.[13,17,18] In most of these countries, the institutional MMRs are much higher in referral hospitals than the estimated national MMRs because patients are often referred in very critical condition, and many die shortly before or after admission.[19]

The SMOR in this study was 147.7 per 1 000 live births, and this compares with the SMOR of 270 per 1 000 live births reported [19] in Nigeria. The comparative SMOR reported for local studies was 5.1 - 6.5 per 1 000 live births.[14,15] The SMOR indicates the burden of life-threatening conditions among pregnant women in a particular area. The high SMOR at NMAH is therefore a reflection of this burden in a wide rural area serviced by just one referral centre. However, because only the total number of live births from our institution and not from the entire catchment area were included in this study, this may have affected the denominator of live births, making the SMOR and MMR higher.

The maternal mortality index (MMI), which is the number of MDs divided by the number of near-miss cases expressed as a percentage, was 9.5%. This compares favourably with the MMI of 14.0% reported from the Pretoria metro by Soma-Pillay *et al.*,[15] and 10.4% reported from the Cape Town metro.[14] This also compares favourably with MMIs reported from other sub-Saharan countries, which range between 10.6% and 40.8%.[13,17-20] In general, the higher the MMI, the lower the quality of obstetric care given. The MMI for reports from SA and other sub-Saharan African countries compares poorly with MMIs reported from high-income countries, such as 1.9% in the Netherlands,[21] and 0% in Australia.[22]

The three leading causes for life-threatening conditions, MNM and MD found in this study were pre-eclampsia with its complications, obstetric haemorrhage and puerperal sepsis. These three conditions are also the leading causes of direct MDs nationally for the triennium 2014 - 2016. This has been the trend for previous Saving Mothers reports published since 2010. [30]

Eclampsia was responsible for 47.8% of the near-miss cases, and 29.2% of MDs. Abruptio placentae, which is often associated with pre-eclampsia or eclampsia, was the leading cause of obstetric haemorrhage, and responsible for 19.7% of near-miss cases, and 8.3% of MDs. Postpartum haemorrhage accounted for 8.3% of the MNM cases, and 12.5% of MDs. Puerperal sepsis accounted for 5.3% of near-miss cases, and 25% of MDs.

The three leading causes of MNM and MD identified in this study are also the leading causes in reports from Pretoria and Cape Town metros[14,15] and several other sub-Saharan African countries,[12,13,17,19,20,23] although the proportions vary from report to report.

Table 5. Predictors of maternal deaths

Variable	Category	χ^2 value (df)	*p*-value
Demographic			
Age, years	19 - 34	10.8 (2)	0.005
Marital status	Single	7 (2)	0.03
Level of education	No schooling	8.3 (3)	0.04
Employment status	Unemployed	15 (10.4)	<0.0001
Reproductive			
Parity	Para 2 - 4	9.1 (2)	0.01
Gestational age at delivery	Third trimester	0.5 (2)	<0.0001
Mode of delivery	Caesarean section	16.3 (3)	0.001
Clinical			
Diagnosis	Eclampsia	15.8 (8)	0.04
HIV	HIV/AIDS	12.3 (2)	0.002
Contributory predictors	≥2	7.8 (2)	0.021
Organ dysfunctions	≥2	10.8 (2)	0.005
Process			
Month of admission	January	15 (5)	0.01
Delivery/termination before admission	No	6.8 (2)	0.03
Delivery/laparotomy within 3 hours of admission	No	18.3 (3)	<0.0001

Table 6. Predictors of maternal near miss

Variable	Category	χ^2 value (df)	*p*-value
Age, years	19 - 34	133 (2)	<0.0001
Marital status	Single	459.1 (3)	<0.0001
Level of education	Senior secondary school	375.4 (6)	<0.0001
Employment status	Unemployed	168.2 (3)	<0.0001
Parity	Primipara	81.8 (2)	<0.0001
Number of ANC visits	<4	146.4 (3)	<0.0001
Gestational age at delivery	Third trimester	278.1 (2)	<0.0001
Diagnosis	Eclampsia	620.1 (12)	<0.0001

ANC = antenatal clinic.

Table 7. Independent predictors of maternal deaths

Independent predictor	β-coefficient	Wald	OR (95% CI)	*p*-value
Organ dysfunction, *n*	37.4	-	-	<0.0001
1 dysfunction	2.2	7.1	9.2 (1.8 - 46.8)	0.008
≥2 dysfunctions	4.9	33.2	138.9 (25.9 - 743.0)	<0.0001
Constant	–4.4	38.2	0.01	<0.0001

OR = odds ratio; CI = confidence interval.
Nagelkerke R square = 45.0%; model fit $\chi^2 = 52.6$, $p<0.0001$; predicted value = 94.2%.

The overall case fatality rate in this study was 9.5%, and this compares with the case fatality rate of 14% reported from Pretoria metro[15] and 10.8% from Cape Town metro.[14] This also compares with the variable overall case fatality rate reported from sub-Saharan African countries, such as 10.8% from Zimbabwe[17] and 12.8% from Tanzania.[13]

The case fatality rate in this study for hypertensive disorders was 5.9% (6% for eclampsia and 5.3% for severe pre-eclampsia), and this compares with a case fatality rate in other local studies[14,15] and studies from other sub-Saharan African countries.[13,17,20,23]

In this study, the case fatality rate for puerperal sepsis was 33.3%, which is the highest of all the causes of life-threatening conditions. Of patients who died because of puerperal sepsis, 78% were delivered by caesarean section, and 83% were HIV-positive, indicating that HIV is still a significant contributing factor in MDs, especially following caesarean section. Caesarean delivery is a known important risk factor for puerperal sepsis,[24] and HIV-positive status has been known to increase the chances of dying from puerperal sepsis up to eight-fold.[25-27] HIV is still a significant factor contributing to puerperal sepsis, even though all pregnant women now receive highly active antiretroviral treatment (HAART) from the time of diagnosis. This could be related to late antenatal booking and poor attendance.

Except for four self-referrals, the vast bulk of patients with life-threatening conditions were referred from district hospitals and a few health centres. Prompt decision to refer depends on the skill of healthcare personnel in the referring facilities to screen patients adequately for life-threatening conditions.[28]

In univariate analysis, age between 19 and 34, being single, having no schooling, being unemployed, having a parity of ≥2 and being in the third trimester at the time of the obstetric emergency were

all significant predictors of maternal mortality. Other significant predictors of maternal mortality found in this study include having a caesarean section, being eclamptic, having HIV infection, having <4 antenatal visits and having ≥1 organ dysfunctions. Wandabwa *et al.*[25] in 2011 reported similar findings in a tertiary referral hospital in Uganda. Poor antenatal care attendance exposes patients who develop obstetric complications to delays in presentation and early identification of life-threatening conditions. Having ≥1organ dysfunction is an indication of the severity of the obstetric complication, and was found to be a strong independent predictor of maternal mortality. This is not surprising because most life-threatening emergency obstetric referrals fall into this category.

Conclusion

Despite the very high MNMR and MM ratio, the overall MMI was lower than that found in other local studies in SA. MMI is a direct reflection of the institutional quality of care.

It can prove impossible to reduce maternal morbidity and mortality when an effective referral system is not in place for complicated cases. This requires skill in the referring staff, tools for diagnosis and availability of a health institution with specialist levels of care.[29] In this case, NMAH being the only such centre for a large rural population, where access is a real problem, complicates matters.

The study of near-miss cases offers the opportunity to do institutional assessments and to identify gaps in quality of care that can be improved upon. One of the limitations of our study was not being able to collect data on all live births from all hospitals that refer to NMAH. A longer study that includes data from the individual referring centres may offer even more insight, and is recommended.

Data availability. All the data analysed during the study are available from the corresponding author upon reasonable request.

Declaration. This research was a mini-dissertation submitted in partial fulfillment of the requirements for the degree of master of medicine (MMed) in Obstetrics and Gynaecology at Walter Sisulu University.

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