Analysis of near-miss and maternal mortality at tertiary referral centre of rural India

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Abstract

Objective (1) To determine the incidence of near-miss, maternal death and mortality index; (2) to compare near-miss cases as per WHO criteria with that of maternal mortality; and (3) to study the causes of near-miss and maternal deaths.

Study design Retrospective cohort study.

Setting Shri Vasantnao Naik Govt. Medical College, Yavatmal, India.

Study population All cases of near-miss as per newer WHO criteria and maternal deaths.

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Methodology A cohort of emergency obstetric admission in the study setting during the study period was followed till 42 days after delivery, and cases fulfilled WHO set of severity markers for near-miss cases for severe acute maternal morbidity (SAMM) and mortality. All maternal deaths during the same period were analysed and compared with near-miss ones.

Results During the study period, there were 29,754 emergency obstetric admissions, 21,992 (73.91 %) total deliveries with 18,630 (84.71 %) vaginal deliveries and 3360 (15.28 %) caesarean deliveries. There were 161 near-miss cases and 66 maternal deaths occurred. The maternal near-miss incidence ratio was 7.56/1000 live births, while maternal mortality ratio was 2.99/1000 live births. Mortality index was 29.07, lower index indicative of better quality of health care. Maternal near-miss-to-mortality ratio was 3.43:1. Amongst near-miss cases, haemorrhage $n = 43$ (26.70 %), anaemia $n = 40$ (24.84 %), hepatitis $n = 27$ (16.77 %) and PIH $n = 19$ (11.80 %) were leading causes, while causes for maternal mortality were PIH $n = 18$ (27.27 %), haemorrhage $n = 13$ (19.79 %), sepsis $n = 12$ (18.18 %), anaemia $n = 11$ (16.16 %) and hepatitis $n = 11$ (16.66 %).

Conclusion Despite improvements in health care, haemorrhage, PIH, sepsis and anaemia remain the leading obstetric causes of near-miss and maternal mortality. All of them are preventable. The identification of maternal near-miss cases using new WHO set of severity markers of SAMM was concurrently associated with maternal death. Definite protocols and standards of management of SAMM should be established, especially in rural Indian settings.

Keywords Maternal death · SAMM · WHO index

Introduction

Despite the improvements in obstetric care over the few decades, maternal morbidity and mortality remains to be a challenge in the developing countries. Global MMR dropped by 45 % between 1990 and 2013. The millennium development goals to reduce maternal mortality by 75 % have not been met with. MDG 2014 report says that India is amongst 10 nations with highest MMR and still accounts for 17 % of total maternal deaths [1].

An estimated 289,000 maternal deaths occurred in 2013 around the world [1]. Out of that, 50,000 women died in India alone. Most of the burden of maternal deaths is carried by low-income countries, but maternal mortality is still a relevant public health problem amongst developing countries. Maternal mortality is ‘Just the tip of iceberg’ and has vast base to the iceberg, maternal morbidity which remains undescribed.

Over the last decade, the identification of cases of severe maternal morbidity has emerged as a promising complement or alternative to the investigation of maternal deaths. Analysis of well-defined near-miss cases may be a more sensitive measure of the standard of obstetric care. Hence, concept of severe acute maternal morbidity (SAMM) is apt for the present health-providing system [2, 3].

SAMM has been studied extensively in the recent past as a complement for maternal mortality and also to evaluate the quality of obstetric care in the particular institution. This concept is superior over maternal death in drawing attention to surviving women’s reproductive health and lives and is equally applicable for developing countries as well as developed countries. Maternal near-miss cases can directly inform on problems and obstacles that had to be overcome during the process of health care. Maternal near-miss audits have been considered as useful approaches to improve maternal health care [4].

The maternal near-miss mortality is defined by the WHO as a woman who nearly died but survived from complications that occurred during pregnancy, childbirth or within 42 days of termination of pregnancy.

In 2008, the WHO has developed a maternal near-miss definition and established standard criteria for identification of women presenting pregnancy-related life-threatening conditions (Table 1). WHO definition enables a common ground for the implementation of maternal near-miss assessments across countries and allows international comparisons to be carried out.

Materials and methods

This retrospective cohort study was conducted in the tertiary care referral centre of Shri Vasantrao Naik Government Medical College (SVNGMC) and Hospital of rural and tribal district of Yavatmal. SVNGMC is a tertiary referral teaching institute and caters local and tribal population of rural India. It is a referral hospital for both public and private hospitals in Yavatmal District and 3 nearby districts (2 in Maharashtra and 1 in Andhra Pradesh). Our hospital has 24-h emergency obstetric services, antenatal outpatient department which provides antenatal care for 4000 patients annually. The hospital has 24-h facility for blood bank. Intensive care unit with 24-h facility is available and has annual admission of 379 critical patients. Out of total obstetric patients admitted in the Department of Obstetrics and Gynaecology during study period January 2011–December 2013, those who met new WHO set of severity markers for near-miss cases for acute severe maternal morbidity were selected (Table 1). All maternal deaths during the same period were analysed and compared with near-miss ones.

Table 1 WHO set of severity markers (life-threatening conditions) used in maternal near-miss assessments

Clinical conditions	Less risk (SOFA category 1, 2)	Greater risk (SOFA category 3, 4)
Cardiovascular dysfunction	Shock Lactate > 5	pH < 7.1 Use of continuous vasoactive drugs Cardiac arrest Cardio-pulmonary resuscitation
Respiratory dysfunction	Acute cyanosis Respiratory rate >40 or <6 per min. Oxygen saturation <90 % for ≥60 min	Gasping PaO ₂ /FiO ₂ < 200 mmHg Intubation and ventilation not related to anaesthesia
Renal dysfunction	Oliguria non-responsive to fluids or diuretics	Creatinine ≥300 mmol/l or ≥3.5 mg/dl Dialysis for acute renal failure
Clotting/haematological dysfunction	Clotting failure Transfusion of ≥5 units of blood/red cells	Acute thrombocytopenia (<50,000 platelets)
Hepatic dysfunction	Jaundice in the presence of pre-eclampsia	Bilirubin >100 mmol/l or >6 mg/dl
Neurological dysfunction	Metabolic coma (loss of consciousness and the presence of glucose and ketoacids in urine) Status epilepticus/uncontrolled fits/total paralysis	Coma/loss of consciousness for 12 h or more
Uterine dysfunction	Hysterectomy due to infection or haemorrhage	

The classification is based on Sequential Organ Failure Assessment (SOFA) score

Data collection

For each eligible patient, medical records were reviewed. Their socio-demographic features, mode of delivery, diagnosis on admission, surgical intervention, ICU admission, duration of hospital stay and ultimate outcome were collected. All the maternal deaths during study period were analysed and compared with near-miss cases. Following indices were calculated.

Near-miss cases—Survivors of the WHO pregnancy-related life-threatening conditions as severity markers (Table 1) are classified as maternal near-miss cases.

Maternal near-miss incidence ratio—It refers to the number of maternal near-miss cases per 1000 live births.

Mortality index—It is the number of maternal deaths divided by the number of women with life-threatening conditions, expressed as a percentage.

Maternal near-miss-to-mortality ratio—It is the proportion between maternal near-miss cases and maternal deaths.

Maternal death—Maternal death is defined as the death of a woman while pregnant or within 42 days of termination of pregnancy and from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes. Data were expressed as percentage rate 100,000 live births.

Results

During the study period (January 2011–December 2013), there were 29,754 emergency obstetric admissions. There were 21,992 total deliveries including both vaginal and

caesarean births. Out of that, 18,630 patients delivered vaginally and 3360 underwent caesarean section. There were 22,092 live births. One hundred and sixty-one patients were near-miss cases as per WHO set of severity markers for acute maternal morbidity (Table 1), and 0.66 maternal deaths occurred during study period.

Table 2 shows the socio-demographic characteristics of women with near-miss cases and mortality.

Primiparas were significantly more in number in both near-miss and mortality group. In near-miss group, 68.32 % of patients ($n = 110$) were in third trimester, whereas 71.21 % patients ($n = 47$) were in post-natal period in maternal death group. The mean age of the patients was 21.75 years in maternal near-miss cases and 22.75 years in maternal death group. Amongst near-miss group, 18.63 % ($n = 30$) were unbooked, whereas 24.24 % ($n = 16$) are unbooked in maternal death group.

During the study period, there were a total of 161 near-miss cases, those who met new WHO set of severity markers for acute severe maternal morbidity. Maternal near-miss incidence ratio is 7.56 per 1000 live births. Maternal mortality ratio is 2.99 per 1000 live births, while maternal near-miss mortality ratio is 3.43:1, which means for every 3.4 women who survived life-threatening WHO severity markers listed in Table 1, one woman died. Mortality index was 29.07, lower index indicative of better quality of health care. A total of 43 patients (26.70 %) of near-miss cases required ICU admission and 6 patients (3.72 %) required emergency peripartum hysterectomy for the management of PPH. Table 3 shows, amongst near-miss cases, haemorrhage (26.70 %, $n = 43$) is the leading cause, followed by anaemia (24.84 %, $n = 40$), hepatitis

Table 2 Demographic profile of near-miss cases and maternal deaths

Characteristic	2011		2012		2013	
	Near-miss	Death	Near-miss	Death	Near-miss	Death
Age (years)						
Mean (SD)	24.38 (3.23)	22.95 (2.86)	24.17 (3.02)	23.71 (3.85)	23.63 (3.69)	24.12 (4.20)
Statistical significance	$t = 1.83$ $p = 0.07$		$t = 0.56$ $p = 0.58$		$t = 0.56$ $p = 0.58$	
Parity						
Primipara	12 (70.59)	12 (70.59)	7 (63.64)	7 (63.64)	13 (68.42)	13 (68.42)
Multipara	5 (29.41)	5 (29.41)	4 (36.36)	4 (36.36)	6 (31.58)	6 (31.58)
Gestational period						
Antenatal	39 (69.64)	4 (19.05)	34 (75.56)	6 (35.29)	39 (67.24)	10 (34.48)
Post-natal	17 (30.36)	17 (80.95)	11 (24.44)	11 (64.71)	19 (32.76)	19 (65.52)
Statistical significance	Fisher exact test $p = 0.00008$ OR = 9.75 (2.85–33.33)		Fisher exact test $p = 0.0062$ OR = 5.67 (1.70–18.91)		Chi-square = 8.43 $p = 0.0056$ OR = 3.9 (1.52–10.00)	
Status of antenatal registration						
Registered	47 (79.66)	15 (68.18)	41 (78.85)	18 (78.26)	43 (86.00)	17 (80.95)
Unregistered	12 (20.34)	7 (31.82)	11 (21.15)	5 (21.74)	7 (14.00)	4 (19.05)
Statistical significance	Chi-square = 1.17 $p = 0.38$ OR = 1.8 (0.6–5.5)		Chi-square = 0.0033 $p = 1.0$ OR = 1.03 (0.31–3.42)		Chi-square = 0.28 $p = 0.72$ OR = 1.44 (0.37–5.58)	

Total live births in 2011, 2012 and 2013 were 22,092

Table 3 Common direct and indirect causes of maternal near-miss and death

Diagnosis/cause	2011		2012		2013	
	Near-miss	Death	Near-miss	Death	Near-miss	Death
Haemorrhage	13 (21.31)	4 (19.05)	17 (30.36)	4 (16.67)	13 (24.07)	5 (18.52)
Anaemia	11 (18.03)	5 (23.81)	16 (28.57)	3 (12.50)	13 (24.07)	3 (11.11)
PIH	11 (18.03)	5 (23.81)	4 (7.14)	9 (37.50)	4 (7.41)	4 (14.81)
Hepatitis	9 (14.75)	3 (14.29)	7 (12.50)	4 (16.67)	11 (20.37)	4 (14.81)
Sepsis	7 (11.48)	3 (14.29)	5 (8.93)	2 (8.33)	6 (11.11)	7 (25.93)
Respiratory	7 (11.48)	1 (4.76)	6 (10.71)	1 (4.17)	5 (9.26)	2 (7.41)
Cardiac	3 (4.92)	0	1 (1.79)	1 (4.17)	2 (3.70)	2 (7.41)
Total	61 (100)	21 (100)	(100)	(100)	(100)	27 (100)

(16.77 %, $n = 27$) and hypertensive disorders of pregnancy (11.80 %, $n = 19$). Amongst the causes of maternal mortality, PIH in (27.27 %, $n = 19$) patients was the leading cause, followed by haemorrhage (19.79 %, $n = 11$), sepsis (18.18 %, $n = 12$), anaemia (16.66 %, $n = 11$) and hepatitis ($n = 11$, 16.66 %).

Table 4 shows mortality index of all WHO severity markers and comparison of maternal near-miss events and maternal deaths. Mortality index for cardiac dysfunction is

the highest, followed by neurological dysfunction and respiratory dysfunction.

Discussion

Women who survive life-threatening conditions arising from complications related to pregnancy and childbirth have many common aspects with those who die of such

Table 4 Comparison of near-miss events and primary causes and maternal deaths as per WHO markers of severity

WHO severity markers	2011	2012	2013	Near-miss/1000 live birth*	2011	2012	2013	Mortality index
Cardiovascular dysfunction	3	1	2	0.27	3	3	7	68.42 %
Respiratory dysfunction	7	6	5	0.81	2	2	4	30.76 %
Haematological/coagulation dysfunction	31	30	25	3.89	7	5	6	17.30 %
Renal dysfunction	4	4	3	0.49	0	0	2	15.38 %
Hepatic dysfunction	9	7	11	1.22	3	4	4	29.72 %
Neurological dysfunction	4	2	2	0.36	6	3	4	61.90 %
Uterine dysfunction	3	4	4	0.49	0	0	1	8.3 %
Total	61	54	52	7.56	21	17	28	2.99

complications. This similarity led to the development of near-miss concept in maternal health. Exploring the similarities, the difference and the relationship between women who died and those who survived provide more complete assessment of quality in maternal health care [7].

The WHO criteria for pregnancy-related life-threatening conditions were found to be highly associated with maternal deaths. Survivors of the WHO pregnancy-related life-threatening conditions can be accurately classified as maternal near-miss cases. The WHO criteria for pregnancy-related life-threatening conditions are part of strategy promoted by WHO for assessing and improving quality of maternal health care [8–10].

A study by Roopa et al. [11] in Manipal represents near-miss from developing countries. MMR was 313/100,000 live births, whereas maternal near-miss incidence ratio was 17.8/1000 live births. Amongst leading causes of near-miss were severe haemorrhage, hypertensive disorders of pregnancy and sepsis, which is similar to our study result. They had taken WHO 2009 criteria for inclusion criteria of near-miss cases.

In the study by Saima Aziz Siddiqui et al. from Pakistan, they used disease-specific criteria by Waterstone et al. Six specific disease groups were (1) severe haemorrhage, (2) eclampsia/severe pre-eclampsia with or without HELLP syndrome, (3) sepsis, (4) rupture uterus including peripartum hysterectomy or laparotomy, (5) severe anaemia Hb % <6 gm% and (6) miscellaneous group. The frequency of severe obstetric complications was 86.20/1000 deliveries, and haemorrhage was the leading cause, followed by hypertensive disorders [12].

In the study by Wanchai Wianwiset M.D., in Thailand, he used WHO criteria of 2009 for near-miss cases. They are set of orange dysfunction markers including (1) basic laboratory tests, (2) management-based markers and (3) clinical criteria. His study showed a near-miss rate of 57.7/1000 deliveries. Amongst the causes of near-miss cases, hypertension (44.7 %) and obstetric haemorrhage were the leading causes, whereas hypertension, embolism, haemorrhage and infection were the leading causes of maternal death [13].

SAMM study from Brazil was in ICU setting only, not representing all near-miss cases, while our case study included all the near-miss cases. That study did not use WHO criteria [14].

The maternal mortality ratio at our setup was 298/100,000 live births, which is similar to the study by Roopa P S, and it showed an MMR of 313/100,000 live births. The Brazilian study showed an MMR of 260/100,000 live births.

In other developing countries, the maternal mortality ratio was 423/10,000 live births and 324/1,000,000 live births [15, 16].

Haemorrhage and septicaemia are the leading causes of death, followed by hypertensive disorders of the pregnancy. As being rural and tribal region, there is a high prevalence of anaemia in our region. Delay in seeking help for any infection like PUO, decreased immunity because of anaemia and malnutrition may be the aggravating factors for septicaemia. Amongst the cases of maternal death during study period, 4 cases in 2011, 6 cases in 2012 and 9 cases in 2013 were brought to emergency OBGY department in serious condition and some of them in irreversible state of shock. In spite of 24-h blood bank facility, ICU facility and massive blood transfusion, these patients did not survive.

The near-miss-to-mortality ratio was 3.43:1, which means for every 3.4 women who survived life-threatening WHO severity markers listed in Table 1, one woman died. Mortality index was 29.07, lower index indicative of better quality of health care.

The study by Roopa showed a near-miss-to-mortality ratio of 5.6:1, whereas a study conducted at Pakistan showed a ratio of 76.97/1000 live births. A Study conducted in Nepal showed a ratio of 7.2:1. Progressively increasing ratio denotes improvement in obstetric care.

As mentioned above, 19 cases (28.78 %) were brought to our hospital in serious condition in the study period and had very less time to manage, which denotes delay in referral. Training of multipurpose health worker, ASHA, ANM working at sub-centre of PHC and rural hospital

regarding warning signs and symptoms of pregnant women and diagnosis of condition, identification of high-risk cases, and timely and fast referral of high-risk patient, institutional delivery can prevent near-miss event and reduce maternal mortality.

Conclusion

1. Maternal near-miss incidence ratio is 7.56 per 1000 live births. Maternal mortality ratio is 2.99 per 1000 live births, while maternal near-miss mortality ratio is 3.43:1.
2. Major determinants were *hypertensive disorders of pregnancy, followed by haemorrhage, anaemia and sepsis*. Although there is improvement in health care, haemorrhage and hypertensive disorders of pregnancy remain the leading causes of near-miss cases and maternal mortality. Sepsis, anaemia and viral infection are non-obstetric causes for maternal near-miss and mortality. All of them are preventable.
3. The identification of maternal near-miss cases using new WHO set of severity markers of pregnancy-related life-threatening conditions is valid, as these conditions are accurately associated with maternal death. Definite protocols and standards of management of SAMM should be established for the developing countries such as India, especially in the health care practices of rural India.
4. Maternal near-miss is a good proxy indicator to assess and monitor the activities aimed for prevention of maternal mortality.
5. Results for maternal near-miss in our study, which was conducted in India, are similar to those of other developing countries.

Recommendations

1. Incorporation of maternal near-miss as an indicator in MIS.
2. Strengthening antenatal services for prevention of PIH and anaemia.
3. Provisions for obstetric intensive care services and standardized management protocols for maternal morbidities, for example PIH and PPH.
4. Maternal care during first 24 h after birth and post-natal period.
5. Need for revising the ways of health education and counselling for ANC patients. at the time of registration visit and follow-up visits.

Compliance with ethical standards

Conflict of interest Dr. Archana Rathod, Dr. R. P. Chavan, Dr. S. P. Pajai, Dr. Vijay Bhagat, Dr. Prachi Thool and Dr. Atul Padmawar declare that they have no conflicts of interest.

Informed consent Informed consent was obtained from all patients for being included in the study.

Human and animal rights This article does not contain any studies with human or animal subjects.

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