Obstetrics; *Maternal Fetal Medicine and Perinatology*

A Cross-Sectional Study of Maternal Near Miss Events and Maternal Deaths Using the Operational Guidelines of the Government of India 2014

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ABSTRACT

OBJECTIVE: Maternal near miss (MNM) events share many pathological and circumstantial factors with maternal mortality. Compared with maternal mortality, near-miss events are more common; thus, MNM evaluation is used to assess the quality of obstetric care in a health facility.

STUDY DESIGN: This is a prospective, observational, cross-sectional study of critically ill women admitted to the intensive care unit, using the operational Guidelines of the Government of India 2014. Maternal deaths during this period were also reviewed. The MNM-to-mortality ratio, MNM incidence ratio, and maternal mortality index were determined, along with the identification of MNM and maternal mortality causes and risk factors. Data on demographics, obstetric history, underlying disorders leading to ICU admission, lifesaving interventions performed, and treatment delays were collected and analysed.

RESULTS: There were 7,669 deliveries and 7,222 live births. Sixty-six cases were diagnosed as MNM, and there were 17 maternal deaths. The incidence of MNM was 9.13 per 1,000 live births. The MNM-to-mortality ratio was 3.8:1. The maternal mortality ratio was 142 per 1,00,000 live births. The three leading complications in MNM were haemorrhage (50%), hypertensive disorders of pregnancy (31.8%), and sepsis (10.6%). Level 1 delay was present in 57.5% of cases, followed by level 3 delay in 51.5% of MNM cases.

CONCLUSIONS: Haemorrhage and hypertensive disorders of pregnancy remain the leading cause of MNM and mortality.

Keywords: Haemorrhage; Hypertension; Maternal death; Maternal mortality; Near miss

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Introduction

A Maternal Death/Mortality is defined as "the death of a woman while pregnant or within 42 days of termination of pregnancy from any cause related to or aggravated by pregnancy or its management (excluding accidental or incidental causes), irrespective of the duration and site of the pregnancy" (1). A maternal near-miss case is defined as "a woman who nearly died but survived a complication that occurred during pregnancy, childbirth or within 42 days of termination of pregnancy" (2,3). In practical terms, women are considered near-miss cases when they survive life-threatening conditions (i.e., organ dysfunction). Terms like severe acute maternal morbidity (SAMM), severe maternal outcomes (SMO), and women with life-threatening maternal conditions (WLMC) are also used for this purpose.

India's Maternal Mortality Ratio (MMR), per the Sample Registration System (2018-2020), is 103 per 100,000 live births. The Sustainable Development Goals set by the UN target reducing global MMR to below 70 per 100,000 live births by 2030 (4).

Worldwide, maternal mortality audits are the most widely used method for assessing the quality of maternal health care services. Maternal mortality cases form only the tip of the iceberg, whose large base is formed by MNM cases. As per PAHO/WHO, for every woman who dies from maternal complications in the Americas, there are 20 others who suffer a

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life-threatening complication and narrowly escape death (5). Hence, the concept of MNM was introduced and is now being widely used as a tool for monitoring the health providing system and planning interventions to prevent maternal mortality. Many tools have been developed worldwide to study the MNM cases. However, the routine use of MNM as an indicator is limited due to a lack of uniform criteria for case identification. In 2011, the WHO developed clinical, laboratory, and management criteria for the identification of these cases (6). In December 2014, the Operational Guidelines of Maternal Near Miss were released by the Government of India (GOI), which are largely based on the WHO criteria for MNM. It consists of parameters grouped into clinical, laboratory, and management-based criteria, mainly focusing on the presence of direct causes of death and organ dysfunctions such as cardiac, respiratory, renal, coagulation/haematological, hepatic, neurologic, and uterine dysfunctions (7).

Investigating near-miss events has several advantages, as they are more common than maternal deaths and share the same major causes. Additionally, the MNM reviews provide valuable information on factors that could have led to maternal death. Moreover, investigating MNM may be less threatening to care providers.

Material and Method

A prospective, observational, cross-sectional study was conducted in accordance with the 'Declaration of Helsinki' over 2 years, from August 2022 to July 2024, in the Department of Obstetrics and Gynaecology at a tertiary care centre in North India. It is a 550-bed rural hospital that receives referrals from three districts of Haryana and serves a population of approximately 28,00,000 (2011 census). The hospital provides free reproductive and child health services and comprehensive emergency obstetric care, including ambulance services. Furthermore, there is an Intensive Care Unit (ICU) with 24-hour medical supervision and mechanical ventilation facilities. Institutional Ethical Committee clearance (BPSGMCW/RC855/IEC/22 dated 18th November 2022) was obtained before commencing the study. Additionally, informed consent was taken from each patient enrolled in the study.

Whenever any pregnant woman presented to the health facility in a critical condition, the operational guidelines of MNM of GOI 2014 (7) were followed to identify all MNM cases which includes the following criteria (minimum three from each category) must be met with: 1) Clinical findings (either symptoms or signs), 2) Investigations 3) Interventions done or any single criteria which signifies cardio respiratory collapse (indicated by a red heart symbol). Maternal deaths during this period were also noted. The total number of live births over 2 years was recorded at the end of the study and used to calculate the MNM incidence rate and the institutional MMR. Cases were identified daily by a trained resident doctor during visits to the labour room, ICUs, and wards. Data were obtained from hospital files, and Annexure 1 of the operational guidelines was completed at discharge. Annexure 1 (MNM-R) contains the demographic characteristics of the patient, booking status, literacy, socio- economic status, gestational age, parity, referred or self-referred and source of referral, mode of delivery, as well as examination, investigations done and disease responsible for critical illness, nature of obstetric complications, presence of organ and/or system dysfunction, duration of hospital stays, requirement of blood products, surgical interventions done to save the life of mother and other relevant information were collected. Levels of delay were identified as levels 1, 2, and 3, as described by the WHO. The level 1 delay refers to the delay in deciding to seek care, the level 2 delay to the delay in reaching appropriate care, and the level 3 delay to the delay in receiving care at a health facility. All the data was recorded in an Excel spreadsheet and was analysed using IBM SPSS Statistics, version 20. Continuous data were analysed with Student's t-test, and categorical data with the Chi-Square test/Fisher's exact test. A p-value <0.05 was considered significant.

The current study aimed to determine the frequency of MNM and to analyse the nature of MNM events. The trends in MNM events and maternal deaths over two years were studied to identify gaps in patient care and infrastructure. This was also an assessment of the 'Operational Guidelines of MNM of GOI 2014', as there are only a few studies in the literature.

The following indices were calculated:

1. MNM incidence ratio per 1000 live births.
2. MNM to mortality ratio
3. Mortality index- (MD/MD+MNM) × 100
4. Maternal mortality ratio (MMR)

Results

Over 2 years, from August 2022 to July 2024, there were 11,946 ANC cases and 7,222 live births. Annexure 1 (shows the criteria that were used for identification of MNM cases). Sixty-six cases were diagnosed as MNM, and 17 maternal deaths occurred during this study period. The MNM incidence ratio (number of MNM cases per 1000 live births) was 9.1 per 1000 live births, and the MNM-to-mortality ratio was (3.8:1). The maternal mortality ratio was 142 per 100,000 live births, and the maternal mortality index was 20.7%.

Table I shows the demographic details of these 66 MNM and 17 maternal mortality cases. The mean age of patients in the MNM group was 26.3±6.65, which was comparable to that of patients in the maternal mortality group (26.64±6.22; p=0.938). Multipara cases were more common in both the groups, i.e., 60.6% (n=40) in the MNM group and 64.7% (n=11) in the maternal mortality group (p=0.757). Of these 66 MNM women, 7.5% (n=5) were grand multipara (parity ≥ 5) and 19.6% (13) had parity ≥ 4. Among 67 MNM cases, 59% (n=39) were unbooked and did not receive any antenatal care

Table I: *Demographic characteristics of Maternal near-miss cases*

	MNM n (%)	MM n (%)	MM n (%)	p
Age in years (Mean±SD)	26.3±6.65	26.64± 6.22	26.64± 6.22	0.938
Gestational age in weeks (Mean±SD)	36.03±5.16	34.25±6.94	34.25±6.94	0.311
Primigravida	26 (39.3)	26 (39.3)	6 (35.2)	0.757
Multigravida	40 (60.6)	40 (60.6)	11(64.7)	
Booked	27(40.9)	27(40.9)	9 (53)	0.375
Unbooked	39 (59)	39 (59)	8 (47)	
Socioeconomic status- below poverty line	26 (39.3)	26 (39.3)	11 (64.7)	0.061
Socioeconomic status- not below poverty line	40 (60.6)	40 (60.6)	6 (35.2)	
Referred	44 (66.6)	44 (66.6)	14 (82.3)	0.209
Not referred	22 (33.3)	22 (33.3)	3 (17.6)	
Illiterate	16 (24.2)	16 (24.2)	8 (47)	0.342
Primary education	17 (25.7)	17 (25.7)	3 (17.6)	
Secondary education and above	33 (50)	33 (50)	6 (35.2)	

**p value calculated using Chi Square, Fischer Exact test and Student's t test. p-value <0.05 was considered significant*

during pregnancy (p=0.375). Among maternal mortality cases, 53% (n=9) were unbooked and did not receive any antenatal care during pregnancy (p=0.375). The majority of women, i.e., 66.6% (n=44) in the MNM group and 82.3% (n=14) in the maternal mortality group, were referred from either a public or a private hospital, while 33.3% (n=22) were brought directly to the institute. Of the referred patients, transportation was provided to 90.9% (n=40). A large proportion of patients were below the poverty line: 60.6% (40) and 64.7% (n=11) in the MNM and maternal mortality groups, respectively (p=0.061). Of these 66 MNM cases, 24.2% (n=16) were illiterate, 25.7% (n=17) studied till primary level, 43.9% (n=29) had secondary level education, and only 6.66% (n=4) were educated up to senior secondary or above junior college level. Among the maternal mortality cases, 47% (n=8) were illiterate, and 17.6% (n=3) had only primary education (p=0.180). Most of the women in the MNM group were antenatal (74.24% (49)) at the time of admission, and 18.18% (n=12) were postnatal. On the other hand, in the maternal mortality group, 70.5% (n=12) were antenatal and 29.4% (n=5) were postnatal at the time of admission.

Table II summarises the causes of MNM and maternal mortality. The three primary obstetric complications that were most commonly responsible for MNM were haemorrhage (50%), hypertensive disorders of pregnancy (31.8%), and sepsis (10.6%). These are also the three major causes of mortality accounting for 76.4% (n=13) cases of maternal mortality. Haemorrhage contributed to 50% (n=33) of MNM cases; PPH was the leading cause of haemorrhage and was responsible for 29.4% (n=15) of MNM cases. Though more than one risk factor contributing to near miss events was identified in 39.3% (n=26) of the cases, the primary cause of death was identified as postpartum haemorrhage in 29.4% (n=5). hypertensive disorders of pregnancy in another 29.4% (n=5) and sepsis in 17.6% (n=3) cases. Of 17 cases of PPH, 16.6% (n=11) had multiple risk factors (≥2), which led to PPH. In 3% of cases, preeclampsia, anaemia, and thrombocytopenia were contributing factors for PPH, while in 4.5% of cases, placenta previa with severe anaemia led to PPH. Of these, severe anaemia was found to be the associated risk factor in 28.7% (n=19) cases.

The obstetric outcome was also studied, and it was found that 63.6% (n=42) had cesarean delivery, 22.7% (n=15) had vaginal delivery, 4.54% (n=3) underwent hysterectomy, and 1.5% (n=1) had suction and evacuation for abortion. In 4.54% (n=3) cases, laparotomy was done for uterine rupture, and 1.5% (n=1) patient underwent laparotomy for ectopic pregnancy. Out of 92.4% (n=61) women who delivered beyond 28 weeks, 19.6% (n=13) had stillbirth.

Table II: *Causes of Maternal near miss (MNM) and Maternal mortality (MM)*

Causes	MNM n (%)	MM n (%)	p
Hemorrhage	33 (50)	5 (29.4)	0.129
Hypertensive Disorders	21 (31.8)	5 (29.4)	0.849
Sepsis	7 (10.6)	3 (17.6)	0.420
Severe Anaemia	1 (1.5)	-	
Renal Dysfunction	2 (3.03)	-	
Status Epilepticus	2 (3.03)	-	
Hepatic Failure	-	1 (5.8)	
Viral Pneumonia	-	1 (5.8)	
Ventricular Tachycardia	-	1 (5.8)	
Pulmonary Embolism	-	1 (5.8)	

Table III summarises the lifesaving interventions that were used in MNM cases. In the current study, 96.9% (n=64) of patients required ICU care, 84.8% (n=56) required ventilatory support, 54.5% (n=36) required cardiotonics or vasopressors, and 31.8% (n=21) required massive blood transfusion (≥5 units PCV or whole blood). Hysterectomy was done in 13.6% (n=9) and internal iliac artery ligation in 12.1% (n=8) cases. Amongst the nine patients who required hysterectomy, three patients had placenta accreta, one had uterine rupture, and five had atonic PPH.

Delay in seeking help (level 1 delay) was identified as one of the major causes of delay i.e., in 44 cases, lack of transport facility (level 2 delay) was seen in 20 cases, while unavailability of treatment at lower-level health care or referral facility prior to admission to the current institute (level 3 delay) was identified in 41 MNM cases. Furthermore, more than one cause of delay (level 1 and level 3) was identified in 45.4% (n=30) of patients.

Discussion

Reducing maternal mortality is one of the Millennium Development Goals, and it remains a major challenge in developing countries. Maternal death audits form the mainstay of evaluation of maternal health services in developing countries, and they have overshadowed severe obstetric morbidity. A clinical audit of MNM cases is thus a useful approach for investigating and monitoring the quality of a health care system.

In 2011, the WHO proposed criteria for identifying MNM, including clinical signs, laboratory tests, and management parameters. In the present study, the GOI's MNM operational guidelines were used to identify and evaluate obstetric near-miss cases. Since there are very few studies that have used these GOI guidelines to evaluate maternal near-miss patients, the criteria were selected. Table IV compares various indices across studies that used the GOI MNM operational guidelines as MNM selection criteria.

MNM Incidence ratio: The MNM incidence ratio in the present study was 9.13 per 1,000 live births (LB). Similarly, the MNM incidence ratios of various other studies done in previous years from 2014 to 2020 were 8.46/ 1000 LB, 9.27/1000 LB, and 10.24/1000 LB, as reported by Tallapureddy et al. in 2017, Reena et al. in 2018, and Sarkar et al. in 2020, respectively (8-10). Studies conducted in recent years, using the GOI's MNM operational guidelines as selec-

Table III: *Lifesaving interventions*

Lifesaving Interventions	MNM n (%)	MM n (%)
ICU Admission	64 (96.9)	16 (94.1)
Mechanical Ventilation	56 (84.84)	17(100)
Vasopressors	36 (54.5)	6(35.2)
Blood Transfusion	21 (31.81)	14(82.3)
Stepwise Devascularisation	14 (21.21)	2(11.7)
Balloon Tamponade	5 (7.5)	2(11.7)
Hysterectomy	9 (13.6)	
Internal Iliac Artery Ligation	8 (12.8)	
Laparotomy	5 (7.5)	
Manual Reposition Of Inverted Uterus	2 (3.03)	
Repair Of Genital Injuries	3 (4.5)	
Dialysis	1 (1.5)	
Colpotomy & Pelvic Abscess Drainage	1 (1.5)	
Colostomy	1 (1.5)	
PCNL& Liver Abscess Drainage	1 (1.5)	

Table IV: *Comparison of various indices among studies which have used the MNM operational guidelines of the GOI as MNM selection criteria.*

Study	Year	MNM incidence ratio (MNM IR = MNM/ LB) ×1000	MNM mortality ratio (MNM/ MD)	Mortality index (MD/MD+MNM) ×100	Most common cause of MNM
Purandare et al. (11)	2014	9.623/1000 LB	-	-	Hemorrhage (44.2%)
Jain U. (12)	2019	14.34/1000 LB	-	-	Hypertensive disorders (30.18%)
Kumari et al. (13)	2020	8/1000 LB	1.9:1	0.34	Haemorrhage (53.8%)
Ingole et al.(14)	2021	9.02/1000 LB	17.5:1	5.7	Hypertensive disorders (42.22%)
Chonla et al. (15)	2023	3.25/1000 LB	0.38:1	71.95	Haemorrhage (52.2%)
Kulkarni et al. (16)	2023	11/1000 LB	1.2:1	-	Haemorrhage (36.4%)
Current study	2025	9.1/1000 LB	3.8:1	20.7	Haemorrhage (50%)

tion criteria, have reported MNM incidence ratios ranging from 3.25 to 14.34/1000 live births (11-16). In 2013, a study using WHO criteria to select near-miss cases found an incidence rate of 17.8 per 1,000 live births (17). Other studies conducted in developing countries show the same trend, with the ratio ranging from 15 to 40/1000 live births (2,18). The lower MNM incidence rate in the current study, compared with other studies, may be attributed to the selection criteria used to include near-miss cases. The MNM operational guidelines of GOI 2014 are a stricter criterion compared to the WHO maternal near-miss criteria, since there were 9 more women during the study period who had severe acute maternal morbidity requiring ICU admission and were MNM cases as per WHO criteria, but were excluded from the current study because they did not comply with the criteria used in the present study.

Near miss-to-mortality ratio: The near-miss-to-mortality ratio (3.8:1) in the present study indicates that for every 4 near-miss events, 1 maternal death occurred. The findings of the current study were consistent with those of other similar studies by Gupta et al. (2015), Rathod et al. (2016), and Mansuri et al. (2019), which reported near-miss-to-mortality ratios of 3.37:1, 3.43:1, and 3.13:1, respectively (19-21). This near-miss event to mortality ratio is much lower than 117-223:1 as reported from studies conducted in high-income countries (19). However, it is comparable to other studies done in India, such as PS Roopa et al. (2013), who reported a ratio of 5.6:1; Taly et al., who found a ratio of 6:1; and Shrestha et al. (2010), who reported a ratio of 7.2:1 (17,22,23). This low ratio in the present study could be attributed to the facility being a rural tertiary care referral centre, and most cases were unbooked and referred from other hospitals in a critical condition. Furthermore, these differences may be due to the use of WHO criteria for classifying near-miss events, which has led to a higher number of MNM cases in these studies and, consequently, a higher near-miss-to-mortality ratio.

Maternal Mortality Ratio: The maternal mortality ratio in the present study was 142 per 100,000 live births. Other studies conducted in India by PS Roopa et al. (2013) and Bansal et al. (2016) reported MMR of 313/100,000 LB and 580/100,000 LB, respectively (17,24). The maternal mortality ratio (MMR) of India has declined from 384 in 2000 to 103 in 2020, i.e., by 6.36%, which is three times the global rate of decline (25). Various schemes, such as Pradhan Mantri Surakshit Matritva Abhiyan (PMSMA), Surakshit Matritva Ashwasan (SUMAN), Janani Sishu Suraksha Karyakaram (JSSK), and LaQshya (Quality Improvement Initiatives), implemented by the Government of India, have played a pivotal role in reducing the MMR. Although there has been a significant reduction in MMR since 2000, there is still a long way to go to achieve Sustainable Development Goal (SDG) Target 3.1, which aims to reduce MMR to less than 70 per 100,000 live births by 2030.

Maternal Mortality Index: The maternal mortality index in the present study was 20.7%, indicating that 20 women die because of severe acute maternal morbidity for every 100 cases of MNM and mortality together. Sepsis had the highest mortality index (30%), followed by hypertensive disorders of pregnancy (19.2%) and haemorrhage (13.1%). Another study done in 2021 reported the highest mortality index in the sepsis group (14.28%) (14).

Causes of Maternal Near Miss: In the present study, direct obstetric complications, i.e., haemorrhage, hypertensive disorders of pregnancy, sepsis, and labour-related complications, accounted for 92.4% (n=61) of cases of maternal near miss events. The findings of our study are consistent with the results of other studies conducted in India, where haemorrhage followed by hypertension and sepsis are the leading causes of MNM. Various other studies conducted in India have reported similar results (12-16). Therefore, the obstetric causes responsible for MNM and mortality remain the same (8,11,13, 15,16,25).

Life-threatening obstetric haemorrhage (50%) was the major cause of MNM and maternal mortality in the current study and other studies conducted in developing countries. PPH was the leading cause of haemorrhage and was responsible for 29.4% (15) of MNM cases. There were 48 cases of severe PPH during the study period, but only 31.2% (n=15) of these became near misses. Thus, it is an evidence and experience-based fact that timely management of PPH with the use of uterotonics, balloon tamponade, emergency blood transfusion, stepwise devascularization, and immediate repair of genital injuries in traumatic PPH has saved 68.7% (n=33) of cases of PPH in the present study from developing critical illness and becoming MNM. This highlights the importance of holding regular maternal mortality meetings to update existing protocols and SOPs. Changes in blood transfusion strategies after such meetings in our facility have proven to be a saviour to 3 patients of PPH who were transfused uncross-matched O-negative blood in a state of very severe PPH and hence saved from death.

Hypertensive disorders were the second leading cause of MNM events and were responsible for 31.8% cases. Improving antenatal care by measuring blood pressure and urine albumin at each visit, emphasising the importance of regular follow-up, encouraging twice-a-week ANC visits in the third trimester after 34 weeks, and timely management of severe preeclampsia with magnesium sulfate can improve the prognosis and prevent life-threatening complications.

Sepsis, however, was the cause of MNM in 10.6% cases but had the highest maternal mortality index, which is an indicator of improvement in clean delivery practices, as well as judicious use of antibiotics to prevent antibiotic resistance, which has become a serious concern worldwide.

Severe anaemia is a major health problem in India. In the

present study, 63.3% (n=42) of patients were anaemic at admission (haemoglobin <11gm/dl) and 28.7% (n=19) had severe anaemia (Haemoglobin <7gm/dl). It is thus required to reinforce existing nutritional programmes, ensure adequate supplementation, and ensure early detection and timely management of anaemia.

Levels of Delay: In the current study, delay in seeking help (Level 1) was identified as the primary cause (66.6%). This is comparable to a study conducted in Maharashtra in 2023, where 52.6% reported this delay; however, this is much higher than a study conducted in Kerala in 2018, where only 12% of cases reported level 1 delay (9,16). This can be explained by Kerala's high literacy rate, which leads women to seek healthcare earlier. Hence, early registration of antenatal patients, educating them about high-risk factors, and counselling for behavioural change can prove beneficial. A major proportion of patients (62.1%) also faced problems due to the unavailability of treatment at a lower-level health care facility (Level 3). A similar proportion of patients experiencing level 3 delay was reported by Kulkarni et al. (69.7%) in a 2023 study (16). At the referral facility, 59% (n=39) were referred due to infrastructural issues because of the non-availability of obstetric HDU or ICU facility, 56% (n=37) were referred due to lack of blood products, while 43.9% (n=29) women reported lack of obstetricians, medications, and equipment as the reason for referral.

To overcome the level 1 delay, educating pregnant women about the high-risk factors at the first visit by organising maternal education classes may be done. Staff at primary and secondary health centres may be trained through frequent drills to handle obstetric emergencies, ensuring that sick patients are resuscitated and referred only after stabilisation.

The underlying diseases causing MNM are the same as those causing maternal death. Therefore, studying the circumstances and evaluating the risk factors surrounding a woman with near-miss events acts as a surrogate for analysis of maternal mortality, and hence, in building a stronger health care system.

Strength of the study: The current study is one of the few to have evaluated the MNM using the GOI's Operational Guidelines. Consequently, it will provide valuable & meaningful information on the quality of obstetric care and help identify critical health system gaps relevant to similar resource-limited settings.

Limitations of the study: This study involves only patients from a single tertiary care hospital, and extrapolating its findings to the entire population of this area may be erroneous. A further study may be warranted to evaluate the root causes of health care gaps at the community level. Besides, continuous psychosocial follow-up of those who survived is also necessary, as their future health and quality of life may be impaired due to the near-miss events.

Declarations

Authors' contributions: PL: Contributed to the conceptualisation and methodology of the study and drafted the original manuscript. VS: Was responsible for manuscript review and editing. JK: Contributed to the investigation and data curation. S: Performed the formal analysis. SS: Provided supervision throughout the study.

Ethics: Institutional Ethical Committee clearance (BPS-GMCW/RC855/IEC/22 dated 18th November 2022) was obtained before commencing the study. Additionally, informed consent was taken from each patient enrolled in the study.

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