



Incidence & factors influencing maternal near miss events in tertiary hospitals of Maharashtra, India

Ragini Kulkarni¹, Sanjay Chauhan², Juzar Fidvi⁶, Arun Nayak⁵, Anil Humane⁶, Rahul Mayekar⁵, Shahina Begum³, Anushree Patil⁴ & Niranjan Mayadeo⁵

Department of ¹Operational Research, ²Operational & Clinical Research, ³Biostatistics, ⁴Clinical Research, National Institute for Research in Reproductive and Child Health, Indian Council of Medical Research, ⁵Department of Obstetrics & Gynaecology, Lokmanya Tilak Municipal General Hospital & Medical College, Mumbai & ⁶Department of Obstetrics & Gynaecology, Government Medical College & Hospital, Nagpur, Maharashtra, India

Received September 30, 2021

Background & objectives: Government of India (GoI) released operational guidelines for maternal near miss-review (MNM-R) in 2014 for use by programme managers of public health system to assist them for conducting MNM-R. The objective of the present study was to review the incidence and factors influencing MNM events in two tertiary hospitals of Maharashtra, India, as per the operational guidelines of the GoI released in 2014 and identify delays based on three-delay model to prevent such events in future.

Methods: This prospective observational study was conducted in two tertiary hospitals of Maharashtra, from July 2018 to November 2020. All women during pregnancy, childbirth or postpartum upto 42 days meeting the eligibility criteria of MNM as per the 2014 GoI guidelines were included as cases (n=228), interviewed and discussed during the monthly MNM meetings at these hospitals.

Results: The incidence of MNM was 11/1000 live births; the ratio of MNM to maternal deaths was 1.2:1. Leading causes of MNM were haemorrhage (36.4%) and hypertensive disorders of pregnancy (30.3%). Haemorrhage was maximum (70.6%) in abortion and ectopic pregnancies. Majority of the women (80.2%) were anaemic, of whom 32.4 per cent had severe anaemia. Eighty six per cent of women included in the study had MNM events at the time of admission and 81 per cent were referred from lower facilities. Level one and two delays were reported by 52.6 and 32.5 per cent of women, respectively. Level three delay at referral centres and at tertiary hospitals was reported by 69.7 and 48.2 per cent of women, respectively.

Interpretation & conclusions: The findings of this study suggest that MNM-R should be undertaken at all tertiary hospitals in India as per GoI guidelines to identify gaps based on three-delay model. These hospitals should implement interventions as per the identified gaps with emphasis on strengthening the infrastructure, facilities and manpower at the first-referral units.

Key words Causes - delays - India - Maharashtra - MNM-review - maternal near miss events

Maternal Near Miss (MNM) is defined by the World Health Organization (WHO) as, 'A woman who nearly died but survived a complication that occurred during pregnancy, childbirth or within 42 days of termination of pregnancy'¹. MNM reviews are proxy models of maternal death and are less threatening to the service providers as the woman survives and she can be interviewed to understand the factors which saved her from this event.

In India, over the past few years, the maternal mortality ratio (MMR) has been declining steadily [130/100,000 live births (LB), 122/100,000 LB and 113/100,000 LB for the years 2014-2016, 2015-2017 and 2016-2018, respectively]². Maternal death review (MDR) as per the guidelines of Government of India (GoI) is being conducted at all the facilities in India³. However, a major disadvantage of MDR is that the service providers and other stakeholders perceive it as a blame game and fear punitive actions against them³. MNM-review (MNM-R) has many advantages over MDR. Several studies on MNM have been conducted in India⁴⁻¹⁹ and other low- and middle-income countries over the past decade²⁰⁻²⁴; however, there is a lack of uniformity in using the criteria for MNM across these studies. A study conducted as a pilot study across six medical colleges in India indicated that MNM reporting is not considered threatening and it can yield information critical to improving quality of care²⁵.

Subsequently, GoI released operational guidelines for MNM-review (MNM-R) in December 2014³. These guidelines are designed for use by programme managers at different levels of public health system to assist them for conducting systematic MNM-R for improving quality of care and thus reduce maternal morbidity and mortality³. The guidelines need to be implemented initially at tertiary level facilities and then at the lower level facilities. To the best of our knowledge, there are no published studies on MNM in which criteria for classification of MNM as per operational guidelines of GoI have been used. With this background, the present study was conducted with the objective to review the incidence and factors influencing MNM cases in two tertiary hospitals of Maharashtra, to identify delays based on the three-delay model and suggest recommendations to prevent such cases in future.

Material & Methods

This prospective observational study was conducted by the department of Operational Research,

ICMR-National Institute for Research in Reproductive and Child Health (NIRRCH), Mumbai, to review MNM cases as per the Operational Guidelines of GoI at two selected tertiary hospitals, Lokmanya Tilak Municipal General Hospital (LTMGH) and Lokmanya Tilak Municipal Medical College (LTMMC), run by Municipal Corporation of Greater Mumbai, and Government Medical College and Hospital (GMCH), Nagpur, under State government of Maharashtra between July 26, 2018 to November 25, 2020. LTMGH and LTMMC are strategically located at the entrance of Mumbai, with easy access by all means of transport, *i.e.* highways, railways, *etc.* These hospitals receive referrals from Mumbai as well as other districts in its vicinity (Thane, Raigad, Sindhudurg, *etc.*). GMCH is located in south Nagpur and receives referrals not only from Nagpur but other adjoining districts (Akola, Amravati, Chandrapur, *etc.*) in Maharashtra and also from districts in Madhya Pradesh and Chhattisgarh.

The study was approved by the Ethics Committee for Clinical Studies, ICMR- NIRRCH, Mumbai, and the respective Institutional Ethics Committees of LTMGH and LTMMC and GMCH prior to initiation.

Sensitization meetings were held at LTMGH and LTMMC, Mumbai, and GMCH, Nagpur. Staff from the department of Obstetrics and Gynaecology, Medicine, Intensive Care Unit (ICU), Anaesthesia and Surgery participated in these meetings. MNM committee was constituted at both the selected tertiary hospitals with affiliated and non-affiliated members of the selected hospitals (gynaecologists and obstetricians, medico-legal and social science experts, laypersons, government officials, physicians, surgeons and anaesthetists). Intensive training was given to the staff responsible for data collection; they were provided with an overview of MNM guidelines and were sensitized for identifying of MNM women.

Inclusion & exclusion criteria: Trained staff (Research Assistants) at the selected hospitals screened all women during pregnancy, childbirth and postpartum up to 42 days with potentially life threatening complications under guidance of obstetricians for inclusion of women in the study. They visited all the wards, ICUs and other departments to screen such women, which were further categorized into women with life-threatening complications and women without life-threatening complications. Of these, women with life-threatening complications and maternal deaths were

noted and women who survived were identified as MNM cases as per the criteria stated in the operational guidelines of GoI for classification of MNM cases. Those meeting either minimum one criteria from each category – clinical findings (either symptoms or signs), investigations and interventions; or single criteria that signified cardiorespiratory collapse were included. The clinical findings, investigations and interventions were put under three broad categories – pregnancy-specific obstetric and medical disorders, pre-existing disorders aggravated during pregnancy and accidental/incidental disorders of pregnancy. These categories were further segregated under adverse events such as haemorrhage, sepsis, hypertension, *etc.* Admitted pregnant/postpartum women not meeting criteria of MNM were excluded from the study.

MNM characteristics: After identification of the MNM women, written informed consent was obtained from the women in local language before conducting the interview. Interviews were conducted on a day before discharge when they were stable and their relatives provided details, if needed. The information was filled in a structured semi-quantitative facility based MNM form. Additional information related to sociodemographic characteristics of the women such as occupation, family income, age at marriage and first pregnancy was also obtained. Information related to factors present for delay (personal factors, transport facilities from home to healthcare facility and between healthcare facilities in referred cases) was obtained by the research team from the study participant or her relatives.

All MNM cases identified were discussed in detail during the MNM meeting conducted every month at both the hospitals for a period of one year. Criteria for MNM cases, sociodemographic factors and delays occurring on the basis of three-delay model – level one (delay in decision to seek care), level two (delay in reaching care) and level three (delay in receiving adequate healthcare) – were reviewed in detail during these meetings. Recommendations for adopting corrective measures based on the gaps identified as per the three-delay model for reducing these MNM cases were also provided during these meetings. Supervision and monitoring of the project activities was done by investigators from ICMR-NIRRH, Mumbai.

Statistical analysis: Data entry and analysis was done in SPSS version 19.0 (IBM Corp., Armonk, NY, USA). For categorical variables, percentage and, for

quantitative variables, mean and SD were calculated. Chi-square test was used to study the association between two categorical variables.

Results

Five hundred and seven women admitted during pregnancy, childbirth or postpartum up to 42 days with potentially life threatening complications were screened for inclusion in this study. Of these, there were 91 women without life-threatening complications and 416 women with life-threatening complications. Out of 416 women, 228 women survived and were identified as MNM and there were 188 maternal deaths.

The incidence of MNM was 11 per 1000 live births (LB). There were 1.2 MNM for every maternal death. The mortality index was 45.2 per cent (Table I). The mean age of study participants was 26±4.2 yr and the mean age at marriage and first pregnancy was 21±3.2 and 23±3.2 yr, respectively. Age at marriage was reported as <18 yr by four (1.7%) women. The details of sociodemographic characteristics of the study participants are given in Table II. Almost half of these were from urban areas; 55.7 per cent had 6-12 yr of schooling and 69.3 per cent had below poverty line status.

Majority of the participants, 200 (87.8%), had received antenatal care (ANC) during pregnancy. During their ANC visits, pallor was checked, urine was tested, abdominal examination was done and blood pressure was recorded among majority (n=197, 98.5%) of the women. Haemoglobin was tested among 190 (95%) women. Majority of the service providers were nurses 185 (92.5%) followed by medical officers 174 (87%), specialists at public hospitals 143 (71.5%) and private doctors 59 (29.5%). The mean (±SD) number of ANC visits was 5.6 (±2.2). Majority, 173 (86.5%), were informed regarding the issues in their current pregnancy by the service providers.

Among the women with MNM (n=228), only 45 (19.7%) had normal haemoglobin levels, while 183 (80.2%) were anaemic. Severe anaemia was noted among 74 (32.4%) women, of these 29 had haemoglobin levels below 5 g/dl. Majority of the participants, 196 (86%), were MNM at the time of admission, while 32 (14%) became MNM after admission, or during their hospital stay. Only 43 (19%) of the total MNM cases had come on their own to seek services, while majority 185 (81%) were referred from lower facilities to these tertiary

Table I. Medical College and Hospital (MCH) services data and near-miss indicators from both the selected tertiary hospitals during February 2019-January 2020

MCH services data and near-miss indicators	Tertiary hospital		Total
	LTMGH, Sion	GMC, Nagpur	
Number of deliveries	9141	12,192	21,333
Number of live births	8923	11,888	20,811
Number of abortions	591	240	831
Number of maternal deaths	52	136	188
Number of MNM cases	89	139	228
MNM ratio (per 1000 live births) (95% CI)	10 (7.9-12.1)	11.7 (9.8-13.6)	11 (9.6-12.4)
MMR (per 100,000 live births)	583	1144	903
Maternal deaths: MNM	1:1.7	1:1	1:1.2
Mortality index (%)	36.9	49.5	45.2

MNM, maternal near miss; LTMGH, Lokmanya Tilak Municipal General Hospital; GMC, Government Medical College; CI, confidence interval; MMR, maternal mortality ratio

care hospitals. It was also found that more referred cases were admitted as MNM as compared to those women who sought services on their own, and this association was found to be significant ($P=0.001$). It was observed that out of the referred women, 25 (13.5%) were not provided with completed referral slips, and 40 (21.7%) were not provided transportation. Majority, 120 (64.8%), of the study participants visited public facilities before visiting tertiary hospital, 40 (21.6%) visited private facilities, while 25 (13.5%) visited both the facilities.

Out of the 228 MNM cases, any single criterion which signifies cardiorespiratory collapse was present in 87.7 per cent ($n=200$) of women, while all the three criteria were present in the remaining 12.3 per cent ($n=28$). Among the total MNM cases, 194 women had delivered and most of the deliveries (72; 91.2%) were conducted at public facilities while 13 (6.7%) were conducted at private health facilities. Furthermore, only four (2.1%) were home deliveries. A large number of women, 141 (72.7%), underwent caesarean, while 53 (27.3%) had vaginal deliveries. Of the 194 deliveries, 81.4 per cent were live births and 18.6 per cent were stillbirths. Majority of the deliveries were conducted by resident doctors (93.2%) and specialists (88.6%), followed by nurses (63.9%) and traditional birth attendants (2%).

The total number of MNM adverse events were noted in 228 among 265 women. Hence, the number of adverse events per woman was 1.1. The distribution of MNM cases according to adverse events is given in Table III. Events of haemorrhage were maximum at 36.4 per

cent ($n=83$) followed by hypertension at 30.3 per cent ($n=69$); sepsis and cardiac dysfunctions were reported in 9.2 per cent ($n=21$) each. Haemorrhagic events were maximum ($n=22$, 70.6%) among abortion and ectopic cases ($n=31$). The interventions provided for women at the tertiary hospitals indicated that transfusion of more than five units of blood was given in 118 women (51.8%) out of the total 228 participants. ICU admission 139 (61%) and resuscitation procedure 61 (26.8%) were the most common interventions followed by laparotomy 42 (18.4%) and use of cardiotonics in 25 (11%) participants. Out of the 228 participants, 208 (91.2%) women reported a delay at various levels (Table IV). At the level one delay, delay in seeking help was found to be maximum (55.8%). At the level three delay at the referral facilities, the leading factor was non-utilization of available medications, instruments and equipment (55.2%), while at the tertiary hospitals, it was due to a lack of blood and blood products (41.3%). Recommendations were given by the MNM committee at both the hospitals on the basis of the gaps identified as per the three-delay model.

Discussion

This is the first of its kind study in which MNM women were identified as per the criteria in GoI guidelines. In the present study, the incidence of MNM was 11/1000 LB; the ratio of MNM to maternal deaths was 1.2:1. This is low as compared to other Indian studies (2:1-21.8:1)^{4-8,10,12,15,16,19} and studies conducted in LMICs (4.6:1-26:1)²⁰⁻²⁴. The MNM-to-MD ratio was reported as 1.7:1 in one study¹¹, conducted in Odisha State which is almost similar to the present study (1.21:1). However,

Table II. Sociodemographic characteristics of the study participants

Characteristics	Total (n=228), n (%)
Current age (yr)	
<20	4 (1.8)
20-24	91 (39.9)
25-30	98 (43)
>30	35 (15.4)
Marital status	
Married	226 (99.1)
Unmarried	2 (0.9)
Place of residence	
Urban	119 (52.2)
Rural	69 (30.3)
Slum	38 (16.7)
Tribal	2 (0.9)
Education	
Illiterate	16 (7)
Literate up to 5 th class	26 (11.4)
6 th to 12 th class	127 (55.7)
Beyond 12 th class	59 (25.9)
Occupation	
Government	5 (2.2)
Private	44 (19.3)
Business	15 (6.6)
Others	164 (71.9)
Age at marriage (yr)	
<20	56 (24.6)
20-24	139 (61)
25-30	28 (12.3)
>30	3 (1.3)
NA (unmarried)	2 (0.9)
Age at first pregnancy (yr)	
>21	44 (19.3)
21-24	125 (54.8)
25-30	50 (21.9)
>30	9 (3.9)
BPL status	
BPL certificate/self-certificate	158 (69.3)
Not BPL	70 (30.7)

BPL, below poverty line; Na, not available

the maximum ratio reported among Indian studies was 21.8:1⁷. The WHO criteria were used in both these studies^{7,11}; however, the wide difference was probably due to the varying number of MNM cases and MMR in

these two studies. In the present study, the criteria used to identify MNM cases were as per the guidelines of GoI which mention that either minimum one criteria from each category – clinical findings (either symptoms or signs), investigations and interventions must be met; or single criteria that signified cardiorespiratory collapse should be present which is quite stringent. Other studies have employed varied criteria such as WHO¹, Filippi¹⁷, five scoring system¹⁸ and modified Mantel's criteria¹⁹. The criteria defined by Filippi mention only disease-specific criteria for the identification of MNM¹⁷ while modified Mantel's criteria¹⁹ are similar to WHO criteria with some modifications.

As per WHO, there are essentially three methods for identifying criteria of MNM, clinical criteria related to a specific disease entity, management-based criteria and organ system dysfunction-based criteria¹. Hence, there is possibility of more MNM cases being identified as only of one out of the above three criteria is to be met as compared to the GoI guidelines which mention that at least one of the three categories or cardiorespiratory collapse should be present. However, MNM cases may not be missed as per the GoI guidelines³, as cases with potentially life threatening complications are to be screened for MNM and the cases not included would be of women without potentially life threatening complications and hence would not be MNM. Furthermore, in case of WHO criteria, there may be inter-study variation in reporting due to the difference in physical and human resources available and the criteria for admission to ICU used in these facilities¹. The advantage of using GoI guidelines in various settings in India can ensure uniformity in identification of MNM cases and implementation of corrective measures.

The audit of MNM cases is an approach used in several high income settings. The UK has a well established programme of confidential enquiries into maternal deaths and a national system for research on MNM-the UK Obstetric Surveillance System (UKOSS) which studies the incidence, risk factors, care and outcomes of the most severe pregnancy complications and enables the lessons learnt so that improvement in future care can be identified more quickly²⁶. This results in rapid inclusion of recommendations into national guidance. The majority of recommendations which Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries Across the UK (MBRRACE-UK) assessors have identified to improve care are drawn directly from existing guidance or

Table III. Distribution of Maternal Near Miss cases according to adverse events as per Maternal Near Miss Guidelines of the Government of India (n=228)

Adverse event as per criteria*	n (%)
Pregnancy-specific obstetric and medical disorders (n=195)	
Number of women (n=178)	
Haemorrhage	83 (36.4)
Hypertension	69 (30.3)
Sepsis	21 (9.2)
Cardiac dysfunctions (cardiomyopathy - antepartum/postpartum)	21 (9.2)
Postpartum collapse	1 (0.4)
Pre-existing disorders aggravated during pregnancy (n=56)	
Number of women (n=55)	
Anaemia	32 (14)
Liver dysfunction	9 (3.9)
Cardiac dysfunctions (rheumatic heart disease, congenital heart disease)	5 (2.2)
Renal dysfunction	6 (2.6)
Other organ dysfunction (respiratory, hepatic, neurological each one)	3 (1.3)
Diabetic ketoacidosis	1 (0.4)
Incidental and accidental causes in pregnancy (n=14)	
Number of women (n=14)	
Infections	12 (5.3)
Accidents	2 (0.8)
Total	265*

*Multiple adverse events in one woman

reports and denote areas where implementation of existing guidance needs strengthening²⁷.

Majority (87.8%) of the women in the present study received ANC, still they were MNM cases. Hence, improving quality of care during ANC is important including monitoring patient vital signs and blood pressure, as well as checking haemoglobin and the albumin levels of urine for reducing anaemia and hypertensive disorders of pregnancy. In the present study, majority (86%) cases were MNM at the time of admission and 81 per cent of the MNM cases were referred from lower facilities to the tertiary care hospitals. Similar findings were reported in studies by Reena and Radha¹², and Kumar and Tewari¹⁷, in which referral to tertiary care facilities was reported as 84 and 80.2 per cent, respectively.

In the present study, the leading causes of MNM were haemorrhage (36.4%) and hypertensive disorders of pregnancy (30.3%). Haemorrhage was reported as a leading cause in other Indian studies (40.7, 43.9 and 42.5%)^{6,9,18} which is slightly more as compared to the present study. In a study conducted in Brazil²⁰,

it was reported to be 40.5 per cent. In the present study, as haemorrhage was the leading cause of MNM in cases of abortions and ectopic pregnancy, safe abortion practices and early ultrasound confirmation of intrauterine pregnancy need to be strengthened. Studies indicate that interventions aiming at improving quality of care without strengthening the health systems and improving community awareness may have minimal success^{28,29}. Active management of third stage of labour must be a routine in all maternities and preventing and treating anaemia in pregnancy can also prevent and reduce MMR and NMM.

Hypertensive disorders of pregnancy were reported to be 30.3 per cent in the present study. Similar findings were reported by some Indian studies (23.5-33.1%)^{5,8,18}. but lower as compared to some other Indian studies (40.6-61.2%)^{1,7,9,10,17,19}. In the study from Brazil²⁰, it was reported to be 45.3 per cent.

In the present study, majority of participants (91.2%) reported delay at various levels. Level one and two delays were reported by 52.6 and 32.5 per cent of women, respectively. Level three delay at referral

Table IV. Distribution of Maternal Near Miss cases according to the type of delay

Type of delay*	Total (n=208), n (%)
Delay 1 (n=120)	
Delay in women seeking help	116 (55.8)
Refusal of treatment or facility	15 (7.2)
Refusal of admission in facility	9 (4.3)
Total	140*
Delay 2 (n=74)	
Lack of transport from home to healthcare facility	62 (29.8)
Lack of transport between healthcare facilities	35 (16.8)
Total	97*
Delay 3 with referral (n=159)	
Lack of communication network	35 (16.8)
Infrastructural issues in referral facility	19 (9.1)
Lack of medications, instruments, equipment or consumables in referral facility	76 (36.5)
Non-utilization of available medications, instruments, equipment and consumables in referral facility	115 (55.2)
Lack of blood/blood products in referral facility	44 (21.2)
Total	289*
Delay 3 at present facility (n=110)	
Infrastructural issues in present facility	10 (4.8)
Lack of medications, instruments, equipment or consumables in present facility	66 (31.7)
Non-utilization of available medications, instruments, equipment and consumables in present facility	5 (2.4)
Lack of blood/blood products in present facility	86 (41.3)
Total	167*

*Multiple responses from each woman. No delay was noted in 20 cases and all three delays were noted in 31 cases

centres and at tertiary hospitals was reported by 69.7 and 48.2 per cent of women, respectively. These data were obtained as per the responses provided by the women during the interviews. At the level one, delay in seeking help was reported by 55.8 per cent of women. This finding is similar to a study conducted at six tertiary hospitals of India (60.6%)²⁵. In another study¹², it was reported as 6.3 per cent which is quite low as compared to the present study. This may be due to the educational status of women in this study¹² conducted in Kerala, in which 90.6 per cent of women were educated up to higher secondary level as compared to 55.7 per cent in the present study. Delay at level two was reported by 32.5 per cent of participants in the present study which is similar to that reported by Kulkarni *et al*¹⁰ and Purandare *et al*²⁵, as 20.8 and 30.3 per cent, respectively. Level three delay at the referral centres in present study (69.2%) is almost same as reported in a study in Mumbai (68.2%)¹⁰. Of the delay three, lack of blood and blood products was reported to be maximum in the present study, 41.3 per

cent, which is higher as compared to that reported in the study reported by Purandare *et al*²⁵ (7.6%). The high percentage of delay three at referral and tertiary hospitals is one of the contributory factors for the high mortality index observed in the present study (45.2%) as compared to other Indian studies (4.3%-36.5%)⁴⁻¹⁹. This indicates the low quality of care in the selected referral and tertiary hospitals which needs to be improved.

For reduction of MNM events in our country, interventions should be undertaken to address all the three delays and at all levels of the public health system. For reducing delay one, patient and family education with focus on identification of danger signals during pregnancy and seeking care early is essential. Transport facilities need to be improved to reduce level two delay. For referral of patients from referral facilities to tertiary hospitals, it was recommended that the referral facilities should provide transport and an accompanying health personnel should be sent along with adequately filled referral slip.

For reducing level three delays at referral facilities, it is essential to strengthen them for dealing with basic obstetric emergencies such as haemorrhage and shock. Facilities and infrastructure at the level of tertiary hospitals also need improvement. Availability of blood and blood products and essential medicines was an important gap identified to be addressed by both the referral and the tertiary hospitals.

MNM-R should be undertaken at all tertiary hospitals in India as per the Operational Guidelines of GoI to reduce MNM cases and MMR. A multicentric study across different regions of the country may be undertaken to bring out different causes, factors and delays which could be addressed to reduce MNM and MMR at regional level. A review documented studies reporting impact of the MNM case review cycle from different regions worldwide mentioned that this approach may be effective in reducing maternal mortality and in improving quality of maternal and newborn healthcare at facility level²⁸⁻³⁰. There are hardly any studies on this aspect conducted in India; hence, such studies if undertaken will be valuable.

To the best of our knowledge, this is a first of its kind study in India which was conducted at tertiary hospitals as per the Operational Guidelines of GoI. However, the limitation of this study was lack of generalizability of its findings, as it was conducted at only two tertiary hospitals in Maharashtra.

Overall, leading causes of MNM in this study were haemorrhage (36.4%) and hypertensive disorders of pregnancy (30.3%). Haemorrhage was maximum (70.6%) in abortion and ectopic cases. Majority (81%) of the MNM cases were referred from lower facilities. MNM-R should be undertaken at all tertiary hospitals in India as per the GoI guidelines to identify gaps based on the three-delay model. These hospitals should implement interventions as per the identified gaps with emphasis on strengthening the infrastructure, facilities and manpower at the first-referral units as level three delay at referral centres was maximum among the MNM women.

Financial support & sponsorship: The study is funded by Indian Council of Medical Research, New Delhi.

Conflicts of Interest: None.

References

- World Health Organization. *Evaluating the quality of care for severe pregnancy complications the WHO near-miss approach for maternal health*. Available from: <https://www.who.int/reproductivehealth/publications/monitoring/9789241502221/en/>, accessed on October 31, 2019.
- Office of the Registrar General & Census Commissioner, India. Ministry of Home Affairs, Government of India. *Special bulletin on maternal mortality in India 2016-18, sample registration system* Available from: <https://censusindia.gov.in/census.website/data/SRSMMB>, accessed on December 23, 2022.
- Ministry of Health and Family Welfare, Government of India. *Operational Guidelines for Maternal Near Miss Review*. Available from: http://www.nrhmorissa.gov.in/writereaddata/Upload/Documents/Maternal_Near_Miss_Operational_Guidelines.pdf, accessed on December 23, 2020.
- Venkatesh S, Chinmayi, Ramkumar V, Sheela CN, Thomas A. Implementation of WHO near-miss approach for maternal health at a tertiary care hospital: An audit. *J Obstet Gynaecol India* 2016; 66 : 259-62.
- Bakshi RK, Aggarwal P, Roy D, Nautiyal R, Kakkar R. Indicators of maternal "near-miss" morbidity at different levels of health care in North India: A pilot study. *Bangladesh J Med Sci* 2015; 14 : 254-7.
- Sangeeta G, Leena W, Taru G, Sushma K, Nupur G, Amrita P. Evaluation of severe maternal outcomes to assess quality of maternal health care at a tertiary center. *J Obstet Gynaecol India* 2015; 65 : 23-7.
- Sujata P, Sahoo J, Rajkumari P, Sahoo G. Evaluation of obstetric near miss and maternal deaths in a tertiary care teaching hospital. *Int J Recent Sci Res* 2016; 7 : 9001-5.
- Abha S, Chandrashekhar S, Sonal D. Maternal near miss: A valuable contribution in maternal care. *J Obstet Gynaecol India* 2016; 66 : 217-22.
- Patankar A, Uikey P, Rawlani N. Severe acute maternal morbidity (near miss) in a tertiary care center in Maharashtra: A prospective study. *Int J Sci Stud* 2016; 4 : 134-40.
- Kulkarni R, Chauhan S, Daver R, Nandanwar Y, Patil A, Bhosale A. Prospective observational study of near-miss obstetric events at two tertiary hospitals in Mumbai, Maharashtra, India. *Int J Gynaecol Obstet* 2016; 132 : 170-3.
- Behera R, Behera AA. Study on maternal mortality and miss case. *J Evid Based Med Healthc* 2017; 4 : 5720-4.
- Reena RP, Radha KR. Factors associated with maternal near miss: A study from Kerala. *Indian J Public Health* 2018; 62 : 58-60.
- Roopa PS, Verma S, Rai L, Kumar P, Pai MV, Shetty J. "Near miss" obstetric events and maternal deaths in a tertiary care hospital: An audit. *J Pregnancy* 2013; 2013 : 393758.
- Alluvala SA, Aziz N, Tumkur A, Boorugu HK. One-year follow-up of women with severe acute maternal morbidity (SAMM): A cohort study. *J Obstet Gynaecol India* 2019; 69 : 211-7.
- Pandit R, Jain V, Bagga R, Sikka P, Jain K. Applicability of WHO Maternal Severity Score (MSS) and Maternal Severity Index (MSI) Model to predict the maternal outcome in near miss obstetric patients: A prospective observational study. *Arch Gynecol Obstet* 2019; 300 : 49-57.
- Parmar NT, Parmar AG, Mazumdar VS. Incidence of maternal "near-miss" events in a tertiary care hospital of central Gujarat, India. *J Obstet Gynaecol India* 2016; 66 : 315-20.

17. Kumar R, Tewari A. "Near-Miss obstetric events" and its clinico-social correlates in a secondary referral unit of Burdwan District in West Bengal. *Indian J Public Health* 2018; 62 : 235-8.
18. Kamal S, Roy P, Singh S, Minz J. A study of maternal near miss cases at tertiary medical college of Jharkhand India. *Int J Reprod Contracept Obstet Gynecol* 2017; 6 : 2375-80.
19. Chaudhuri S, Nath S. Life-threatening complications in pregnancy in a teaching hospital in Kolkata, India. *J Obstet Gynaecol India* 2019; 69 : 115-22.
20. Cecatti JG, Costa ML, Haddad SM, Parpinelli MA, Souza JP, Sousa MH, *et al.* Network for Surveillance of Severe Maternal Morbidity: A powerful national collaboration generating data on maternal health outcomes and care. *BJOG* 2016; 123 : 946-53.
21. Mohammadi S, Essén B, Fallahian M, Taheripanah R, Saleh Gargari S, Källestål C. Maternal near-miss at university hospitals with cesarean overuse: An incident case-control study. *Acta Obstet Gynecol Scand* 2016; 95 : 777-86.
22. Tunçalp O, Hindin MJ, Souza JP, Chou D, Say L. The prevalence of maternal near miss: A systematic review. *BJOG* 2012; 119 : 653-61.
23. Madeiro AP, Rufino AC, Lacerda ÉZG, Brasil LG. Incidence and determinants of severe maternal morbidity: A transversal study in a referral hospital in Teresina, Piauí, Brazil. *BMC Pregnancy Childbirth* 2015; 15 : 210.
24. Hirose A, Borchert M, Niksear H, Alkozai AS, Gardiner J, Filippi V. The role of care-seeking delays in intrauterine fetal deaths among 'near-miss' women in Herat, Afghanistan. *Paediatr Perinat Epidemiol* 2012; 26 : 388-97.
25. Purandare C, Bhardwaj A, Malhotra M, Bhushan H, Chhabra S, Shivkumar P. Maternal near-miss reviews: Lessons from a pilot programme in India. *BJOG* 2014; 121 (Suppl 4) : 105-11.
26. Knight M, Lewis G, Acosta CD, Kurinczuk JJ. Maternal near-miss case reviews: The UK approach. *BJOG* 2014; 121 (Suppl 4) : 112-6.
27. Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries Across the UK (MBRACE-UK). *Saving lives, improving mothers' care core report: Lessons learned to inform maternity care from the UK and Ireland confidential enquiries into maternal deaths and morbidity 2017-19*. Available from: https://www.npeu.ox.ac.uk/assets/downloads/mbrace-uk/reports/maternal-report-2021/MBRRACE-UK_Maternal_CORE_Report_2021_-_FINAL.pdf, accessed on December 23, 2022.
28. Kayiga H, Ajeani J, Kiondo P, Kaye DK. Improving the quality of obstetric care for women with obstructed labour in the national referral hospital in Uganda: Lessons learnt from criteria based audit. *BMC Pregnancy Childbirth* 2016; 16 : 152.
29. van den Akker T, van Rhenen J, Mwangomba B, Lommerse K, Vinkhumbo S, van Roosmalen J. Reduction of severe acute maternal morbidity and maternal mortality in Thyolo District, Malawi: The impact of obstetric audit. *PLoS One* 2011; 6 : e20776.
30. Lazzarini M, Richardson S, Ciardelli V, Erenbourg A. Effectiveness of the facility-based maternal near-miss case reviews in improving maternal and newborn quality of care in low-income and middle-income countries: A systematic review. *BMJ Open* 2018; 8 : e019787.

For correspondence: Dr Ragini Kulkarni, Department of Operational Research, ICMR-National Institute for Research in Reproductive and Child Health, JM Street, Parel, Mumbai 400 012, Maharashtra, India
e-mail: kulkarnir120@gmail.com