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Maternal near miss indicators at a tertiary care hospital and its implications

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Abstract

Objective: Maternal near-miss studies offer valuable insights into the effectiveness of maternal healthcare systems. This study examines near-miss indicators at a tertiary care hospital in India, aiming to identify areas for improvement and inform strategies for enhancing maternal health outcomes.

Methods: A prospective observational study was conducted at SCB Medical College, Odisha, India, from July 2015 to June 2016. Data on severe maternal outcomes were collected using WHO criteria. Near-miss indicators were calculated, which included severe maternal outcome ratio, maternal near-miss ratio, maternal near-miss mortality ratio, mortality index and hospital care indicators.

Results: The study identified 212 near-miss cases and 84 maternal deaths among 9336 live births. The maternal mortality ratio was 899 per 100,000 live births, a near-miss ratio of 22.7 per 1000 live births, mortality index of 28.3%. Hemorrhage, hypertensive disorders, and sepsis were common causes of near misses. Hospital access and intrahospital care indicators revealed deficiencies in accessibility and quality of care.

Discussion: High MNMR suggests inadequacies in health infrastructure and services in the vicinity of our centre as most cases were referred. But high mortality index highlights deficiencies in management at our centre further reinforced by poor hospital indicators and ICU admission rate. Hemorrhage leading to shock and use of vasoactive drugs imply a definitive delay in diagnosis and treatment. Most near-miss cases underwent caesarean section and had poor perinatal outcomes.

Conclusion: Strengthening peripheral healthcare, use of evidence-based medicine and expansion of ICUs can mitigate near-miss events and improve outcomes

Future Research: Longitudinal studies and the development of a maternal severity index are recommended for ongoing monitoring and quality assessment.

Keywords: Maternal Near-Miss; Severe Maternal Outcome; Hospital Indicators

1. Introduction

When a woman survives a severe complication during her pregnancy, delivery or postpartum period (within 42 days of termination of pregnancy), she is identified as a near-miss case.[1] In the year 2011, the World Health Organization (WHO) released its document on the evaluation of maternal health care by using maternal near-miss indicators. These indicators provide valuable information about the factors contributing to maternal near misses and deaths, such as medical errors, delays in seeking care, and inadequate availability of supplies and equipment.[2] The collection of data

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regarding severe maternal outcome cases (including both maternal deaths and near misses) identifies the key areas that require intervention, these problems can then be tackled in a systematized approach by healthcare providers and policymakers and henceforth, reducing the substantial burden of maternal morbidities.[3]

Since the publication of the WHO near-miss approach, there have been multiple studies on maternal near misses at various hospitals throughout the world. However, there is wide variation in the reported near-miss indicators across all these studies,[4] confirming the need for locality-based audits as the health issues in some African countries may not always be extrapolated into an Indian setting and vice versa. Even in an Indian setting, there are states with maternal mortality comparable to developed nations but some states represent the nadir in health with values even worse than many very low-income countries. Therefore, these near-miss reports must be published from all districts or locations worldwide regularly and more frequently from those with poor healthcare for continuous assessment of interventions in place and improving them if necessary.

The objective of this study is to calculate the near-miss indicators in a tertiary care centre in India and draw inferences from these values about the strategies to be in place for improvement. This study fills a crucial void in the existing literature by providing localized health data and focuses on assessing the maternal healthcare landscape surrounding a leading teaching institute within the state. In addition to calculating near-miss indicators, the study delves into the implications of these indicators and it highlights key issues that must be addressed within and around the institute to advance the status of women's health. This comprehensive approach not only identifies areas requiring immediate attention but also lays the groundwork for future strategies to enhance maternal healthcare outcomes in the region.

2. Material and methods

This is a prospective observational study conducted at SCB Medical College in Odisha, India, aimed to assess near-miss indicators in obstetric patients over one year from July 2015 to June 2016.

- **Setting**: The study was conducted at a teaching hospital in Odisha, India, which serves a population of around 7 million, primarily comprising individuals from lower economic backgrounds. The hospital is a referral centre for critically ill obstetric patients in the region.
- **Inclusion Criteria**: Patients admitted to obstetrics wards, emergency rooms, and intensive care units were screened for life-threatening conditions using the WHO 2009 criteria for maternal near-miss cases. Patients with gynaecological complaints or conditions not related to pregnancy, as well as those with complications beyond 42 days post-termination of pregnancy, were excluded.
- **Ethical Approval**: The research received clearance from the Institutional Review Board and the Institutional Ethics Committee. Data were collected anonymously from patient records, therefore individual informed consent was not required.
- **Data Collection**: Prospective surveillance involved daily visits to obstetric wards, intensive care units, and emergency rooms. All the admitted patients were screened against WHO criteria for identification of near-miss cases (Table 1).[1] Data were collected on organ dysfunction, underlying causes, critical interventions, duration of hospital admission, mode and outcome of pregnancy.[5]

Table 1 WHO 2009 criteria for identification of near-miss cases

Cardiovascular dysfunction	Shock, cardiac arrest (absence of pulse/heart beat and loss of consciousness), use of continuous vasoactive drugs, cardiopulmonary resuscitation, severe hypoperfusion (lactate >5 mmol/l or >45 mg/dl), severe acidosis (pH <7.1)
Respiratory dysfunction	Acute cyanosis, gasping, severe tachypnea (respiratory rate >40 breaths per minute), severe bradypnea (respiratory rate <6 breaths per minute), intubation and ventilation not related to anaesthesia, severe hypoxemia (O2 saturation <90% for ≥60 minutes or PAO2/ FiO2 <200)
Renal dysfunction	Oliguria non-responsive to fluids or diuretics, dialysis for acute renal failure, severe acute azotemia (creatinine ≥300 μmol/ml or ≥3.5 mg/dl)
Coagulation/haematological dysfunction	Failure to form clots, massive transfusion of blood or red cells (≥5 units), severe acute thrombocytopenia (<50 000 platelets/ml)
Hepatic dysfunction	Jaundice in the presence of preeclampsia, severe acute hyperbilirubinemia (bilirubin >100 μmol/l or >6.0 mg/dl)

Neurological dysfunction	Prolonged unconsciousness (lasting ≥12 hours)/coma (including metabolic coma), stroke, uncontrollable fits/status epilepticus, total paralysis
Uterine dysfunction	Uterine haemorrhage or infection leading to hysterectomy
Adapted from Say et al; WHO working group on Maternal Mortality and Morbidity classifications.[1]	

Outcome Measures: Near-miss indicators were calculated according to WHO guidelines, including the severe maternal outcome ratio (SMOR), maternal near-miss ratio (MNMR), maternal near-miss mortality ratio (MNMMR), and mortality index (MI).[5]

- SMOR: Number of women with life-threatening conditions [maternal near-miss (MNM) cases + maternal deaths (MD)] per 1000 live births
- MNMR: Number of maternal near-miss cases per 1000 live births.
- MNMMR: Ratio between the number of maternal near-miss cases and maternal deaths [MNM:1MD]
- MI: Number of maternal deaths divided by the number of women with life-threatening conditions multiplied by 100 (expressed in percentage) [MI= MD/ (MNM + MD)].

The study also examined hospital access indicators, particularly focusing on cases presenting within 12 hours of admission (SMO12 cases), intrahospital SMO cases (diagnosed 12 hours after admission), and intensive care unit admission rate and mortality.

2.1. Statistical analysis

Data were entered and analysed using Microsoft Excel 2019 (Version 16.78.3). Outcome indicators were calculated per 1,000 live births for SMOR and MNMR, as ratios for MNMMR, or as percentages for MI. Categorical study variables were presented as proportions, while continuous variables were described using the mean ± standard deviation. The Chi-square test was employed for comparisons between categorical variables. Differences were considered statistically significant if the two-tailed p-values were less than 0.05.

3. Results

3.1. Near miss Indicators (Table 2)

Table 2 Maternal near-miss indicators

Severe maternal outcome ratio SMOR=MNM+MD per 1000 live births	31.7
Maternal near miss ratio MNMR=MNM per 1000 live births	22.7
Maternal near miss mortality ratio MNM/1MD	2.5:1
Mortality index MI=MD/(MNM+MD)	28.3%

During the study period, there were 10,116 deliveries out of which 9336 were live births. Among them, there were 212 near-miss cases according to WHO criteria[1] and 84 maternal deaths. The total number of SMO cases (severe maternal outcome) was 296. The maternal mortality ratio was 899 per 100,000 live births, the maternal near miss ratio was 22.7 per 1000 live births, the maternal near miss mortality ratio was 2.5:1 and the mortality index was 28.3%.

3.2. Hospital indicators (Table 3)

Table 3 Hospital indicators

Hospital access indicators	**SMO12 cases**	**224**
	Proportion of SMO12 cases among SMO cases	75.7%
	SMO12 mortality index	31.7%
Intrahospital care	Intrahospital SMO cases	72
	Intrahospital SMO rate per 1000 live births	7.7
	Intrahospital mortality index	18%
ICU care	SMO cases admitted to ICU	44
	Proportion of SMO cases admitted to ICU	14.8%
	Mortality index for ICU cases	43.2%
	Proportion of maternal deaths without ICU care	77.4%

The number of SMO12 cases was 224 out of a total 296 SMO cases. The proportion of SMO12 cases among all SMO cases was 75.7%. The SMO12 mortality index was 31.7% which is slightly higher than the overall mortality index. There were 72 intrahospital SMO cases which was 24.3% of all SMO cases. The intrahospital SMO rate was 7.7 per 1000 live births. The intrahospital mortality index was 18%. There were only 44 SMO cases (25 near misses and 19 maternal deaths) who were admitted to the ICU (intensive care unit), so the ICU admission rate was only 14.8% which was very low. The mortality index for these SMO cases admitted to the ICU was 43.2%.

3.3. Underlying causes (Table 4)

Table 4 Underlying causes of near-miss events

Underlying causes	**Number of near miss cases**	**%**
Pregnancy with abortive outcome (hemorrhage in 1st trimester pregnancy)	40	18.9%
Ectopic pregnancy	34	16%
Abortion	6	2.8%
Obstetric haemorrhage	72	33.9%
Antepartum haemorrhage	27	12.7%
Postpartum haemorrhage	45	21.2%
Hypertensive disorders	52	24.5%
Severe preeclampsia	32	15%
Eclampsia	20	9.4%
Pregnancy related sepsis	24	11.3%
Ruptured uterus	9	4.2%
Others/Medical/Surgical cause	15	7%
Anemia	4	1.9%
Hepatitis	2	0.9%
Others	9	4.2%
Total	212	100%

The average age of the near-miss cases was 25± 4 years. Obstetric haemorrhage was the most frequent cause of maternal near misses (34%). There was another around 20% due to haemorrhage in 1st trimester of pregnancy (ectopic

pregnancy and abortion). Therefore, hemorrhagic complications in pregnancy accounted for more than 50% of near-miss cases. The second most common cause was hypertensive disorders (24% of the near-miss cases) followed by sepsis (11.3%). Most of these cases were referred from peripheries (92%) and they were not booked at the study centre (Table 5).

Table 5 Referral status of near-miss cases

Referral status	Near miss cases	Percent	p-value
Booked	17	8%	<0.0001
Referred	195	92%	

Organ dysfunction (Table 6) and Life-threatening conditions (Table 7)

Table 6 Organ dysfunction in near-miss cases

Organ dysfunction	Near miss cases	%
Cardiovascular	137	64.6
Respiratory	18	8.5
Renal	40	18.9
Coagulation/ hematologic	7	3.3
Hepatic	10	4.7
Neurologic	4	1.9
Uterine dysfunction/ hysterectomy	39	18.4
Multiple organ dysfunction	70	33

Table 7 Life-threatening conditions in near miss (NM) cases

Organ dysfunction	Life threatening conditions	Number of NM cases	Percent of total (N=296)
Cardiovascular	Shock	137	64.6
	Use of continuous vasoactive drugs	97	45.8
	Cardiac arrest	0	0
	Cardio-pulmonary resuscitation	0	0
	Severe hypoperfusion (lactate>5mmol/L or >45 mg/dL)	2	0.9
	Severe acidosis (pH<7.1)	0	0
Respiratory	Acute cyanosis	0	0
	Gasping	1	0.5
	Severe tachypnea (respiratory rate > 40 bpm)	18	8.5
	Severe bradypnea (respiratory rate < 6 bpm)	2	0.9
	Severe hypoxemia (PAO2/FiO2 < 200 or O2 saturation < 90% for ≥60 min)	4	1.9
	Intubation, ventilation	16	7.5
Renal	Oliguria	40	18.9
	Dialysis	21	9.9

	Severe azotemia (creatinine ≥ 300 µmol/ml or ≥3.5 mg/dL)	15	7.1
Coagulation/ hematologic	Failure to form clots	3	1.4
	Massive transfusion (≥5 units)	7	3.3
	Severe thrombocytopenia (<50,000)	2	0.9
Hepatic	Jaundice in presence of preeclampsia	10	4.7
	Severe acute hyperbilirubinemia (bilirubin >100 µmol/L or > 6.0 mg/dL)	6	2.8
Neurologic	Prolonged unconsciousness (lasting ≥ 12 hours)/coma (including metabolic coma)	4	1.9
	Stroke	2	0.9
	Status epilepticus/ uncontrollable fits	1	0.5
	Total paralysis	0	0
Uterine	Haemorrhage or infection leading to hysterectomy	39	18.4

Cardiovascular dysfunction was the most common organ dysfunction among the near miss cases with a massive contribution of 64.6% followed by renal (18.9%) and uterine dysfunction (18.4%). Multi-organ dysfunction was present in 33% of cases. Among the life-threatening conditions, shock was present in 64.6% of near-miss cases, use of continuous vasoactive drugs was in 45.8% of cases, oliguria in 18.9% of cases and hysterectomy for haemorrhage or infection was done in 18.4% of cases.

3.4. Mode of termination (Table 8) and Pregnancy outcome (Table 9)

Table 8 Mode of termination of pregnancy

Mode	Near miss cases	%	p-value
Vaginal delivery	56	26.4	0.0027
Caesarean section	108	50.9	
Curettage/ vacuum aspiration	7	3.3	
Laparotomy for ectopic pregnancy	25	11.7	
Laparotomy for ruptured uterus	14	6.6	
Women still pregnant at hospital discharge	2	0.9	

Table 9 Outcome of pregnancy

Outcome	Near miss cases	%	p-value
Term birth	69	28.30%	0.95
Preterm birth	72	28.77%	
Stillbirth	39	18.40%	
Abortion (includes ectopic abortions)	32	24.53%	

Most of these pregnancies were terminated via Caesarean section (50.9%) and the number of term and preterm births among these cases were similar. Ectopic pregnancies with near-miss indicators were 11.7% and ruptured uterus was seen in 6.6% of cases and both conditions were managed with laparotomy.

4. Discussion

Our study reported a concerning maternal mortality ratio of 899 per 100,000 live births, significantly exceeding the country's average.[6] The maternal near miss ratio (MNMR) was also high and it was 22.7 per 1000 live births. A recent systematic review stated that in lower to middle-income countries the median maternal near-miss ratio was 15.9 with an interquartile range of 8.9-34.7 which is comparable to our study.[4] However, the MNMR in developed nations are significantly low as demonstrated in an Australian study with an MNMR of 7/1000 live births and no maternal deaths within a study period of 6 months.[7]

Kulkarni et al.'s review in India highlighted a wide variation in MNMR, ranging from 3.9 to 379.5 per 1000 live births.[8] While most studies utilized the WHO near-miss approach, this disparity emphasizes discrepancies in healthcare standards nationwide. Our study, conducted in Odisha, adds context to this variation by comparing findings with two prior studies within the state. One study conducted at a private hospital reported a high MNMR of 34 per 1000 live births, coupled with a low mortality index of 4.3%.[9] This discrepancy suggests efficient management of referred near-miss cases, possibly due to abundant medical resources. However, the prevalence of near misses among socioeconomically moderate individuals hints at underlying social stigmas and systemic healthcare deficiencies. Conversely, another study in a government-funded setting, akin to ours, reported a lower MNMR of 11.2 per 1000 live births but a higher mortality index of 36.5%.[10] This disparity highlights issues with care quality within the facility. Our study, conducted in a tertiary care government hospital, exhibited a mortality index of 28.3%, which highlights inadequacies in care delivery. Addressing these deficiencies through infrastructure upgrades, staff training, and protocol optimization is essential to improve outcomes and reduce mortality rates.

The high Maternal Near-Miss Ratio (MNMR) indicates significant deficiencies in healthcare infrastructure and services in the peripheral areas of the study center. These deficiencies lead to inadequate antenatal check-ups, insufficient pregnancy scans, untreated pregnancy-related anemia, lack of blood pressure monitoring, unsafe abortion practices, and other factors that do not align with evidence-based medicine. The fact that most near-miss cases were referred underscores the urgent need to strengthen peripheral healthcare. This can be achieved by establishing better-equipped referral hospitals with blood banks and high-dependency units, and by training health staff for prompt emergency management and immediate resuscitation. Additionally, raising awareness among pregnant women about the importance of attending health centers for adequate antenatal care, and ensuring early referral and admission of high-risk cases to tertiary hospitals, can reduce the risk of near-miss events.

The high mortality index further highlights issues at our study center, such as delays in diagnosis and management, failure to follow protocol-based management, hesitancy and delays in transferring patients to the operating theater, inadequate availability of blood products, and insufficient supply and maintenance of medications (e.g., compromised oxytocin due to lack of cold chain maintenance, and other critical drugs like magnesium sulfate). Furthermore, critical care facilities are lacking, including ventilators, defibrillators, dialysis access, and more. Obstetric critical cases require a multidisciplinary management approach, which is also deficient.

The WHO near-miss approach offers a comprehensive framework for evaluating the quality of care, covering hospital access indicators, intrahospital care, and ICU care indicators. Despite its importance, few studies have addressed this framework, with only two studies from Ethiopia discussing its implications.[11,12] In our study, the proportion of Severe Maternal Outcomes (SMO) cases was 75.7%, slightly lower than the 82.5% reported in the Ethiopian study.[11] However, our SMO mortality index (MI) was significantly higher at 31.7%, compared to 18.9% in the Ethiopian study.[11] This high mortality index suggests potential deficiencies in hospital access, which may result from inadequate peripheral healthcare, limited transportation options, delayed recognition of warning signs, or excessive distances from referring centers.

Additionally, the intrahospital SMO rate in our study was 7.7 per 1000 live births, markedly higher than the Ethiopian study's rate of 0.4.[11] The intrahospital SMO MI was also notably elevated at 18%, compared to 7.4% in the Ethiopian study.[11] These findings indicate suboptimal quality of care at our study center. Furthermore, the ICU admission rate was concerningly low, with only 15% of SMO cases admitted to the ICU. The ICU mortality index was alarmingly high at 43.2%, and a significant proportion (77.4%) of maternal deaths did not receive ICU care. These statistics highlight critical deficiencies in ICU utilization and care provision, underscoring the need for significant improvements within our study center's healthcare system.

Obstetric haemorrhage, hypertensive disorders in pregnancy, and sepsis emerge as the primary contributors to maternal near-miss cases, as indicated by our study and others globally.[8,13,14] Haemorrhage-complicating pregnancies comprise more than 50% of near-miss cases and its high prevalence in low-middle-income countries emphasizes the

urgent need for targeted interventions and improved access to timely and appropriate obstetric care. Haemorrhage leading to shock, cardiovascular dysfunction and use of vasoactive drugs indicates a definitive delay in care. Addressing the three types of delays in obstetric care, i.e., delay due to lack of awareness, problems of accessibility, and lack of appropriate healthcare facilities and trained staff,[15] is crucial in reducing the burden of maternal near misses. Hypertensive disorders in pregnancy also are a significant contributing cause of maternal near-miss, especially in developed nations,[4] and need comprehensive antenatal care and early detection protocols with timely intervention and management, to reduce the risk of maternal morbidity and mortality associated with these conditions. Anaemia is the most frequent indirect cause of maternal near misses,[16] which may immediately exsanguinate a patient with haemorrhage into a state of shock. Therefore, anaemia must be addressed during the antenatal check-ups and healthy nutrition, supplements and medications must be provided.

At our centre, more than 50% of near-miss cases underwent caesarean section (CS) which aligns with the study published in Tanzania where >50% of severe maternal outcome cases underwent CS at their University hospitals and 13% of SMO events were associated with CS complications.[17] Therefore, it is advocated to avoid unnecessary CSs by promoting CS indication audits and reducing CS complications by training staff to reduce surgical and anaesthetic complications, enforcing strict protocols for antibiotic prophylaxis, and enhancing postoperative surveillance measures.[17]

In our study, approximately 47% of near misses experienced either a preterm birth or a stillbirth. This finding aligns with recent research from Uganda, which revealed a substantial correlation between near-miss cases and adverse perinatal outcomes, indicating a fourfold higher risk compared to non-near-miss cases.[18] Additionally, a hospital-based cross-sectional study corroborated these findings, demonstrating a higher incidence of preterm births and stillbirths among near misses compared to total admissions.[19] These outcomes stem from the complexities of pregnancies afflicted by life-threatening conditions, necessitating early termination or resulting in intrauterine deaths.

This study analyzes near-miss indicators to identify critical areas needing intervention in maternal healthcare. The findings can guide future research to enhance maternal outcomes by prioritizing interventions, effectively allocating resources, and developing targeted strategies. The study's one-year duration and lack of follow-up are limitations, suggesting the need for longitudinal studies to assess intervention effectiveness and maternal health trends. Additionally, creating a maternal severity index for each SMO case could provide an objective assessment of critical care quality and allow comparisons across healthcare facilities.

5. Conclusion

The high maternal near-miss ratio of our study indicates inadequate peripheral healthcare, caused by too few referring centres, long distances between centres, and poor transportation. Strengthening peripheral health services with well-resourced centres, equipped ambulances, trained staff, and community health education can reduce near-miss events. The high mortality index highlights severe deficiencies in managing near misses at our study centre, confirmed by high intrahospital SMO cases, a high intrahospital SMO mortality index, and poor ICU care. Implementing evidence-based medicine and expanding ICU capacity may improve outcomes.

This study provides a systematic framework for identifying critical intervention areas, allocating resources effectively and developing targeted strategies to enhance maternal healthcare outcomes. However, longitudinal studies are needed to evaluate intervention effectiveness and maternal health trends.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare no competing interests.

Statement of ethical approval

The research has been approved by the Institutional Ethics Committee, S.C.B. Medical College, Odisha, India.

Statement of informed consent

Written informed consent was obtained from all participants of this study.

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