

**STUDY OF MATERNAL NEAR MISS INDICATORS IN A TERTIARY LEVEL
CENTER IN NEPAL**

**A Capstone project submitted to
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by

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Abbreviations

JHSPH -Johns Hopkins Bloomberg School of Public Health

IIHMR- Indian Institute of Health Management Research

UN - United Nations

MDG - Millennium Development Goals

SBA – Skilled Birth Attendants

SEAR – South East Asia Region

MMR – Maternal Mortality Ratio

SDG – Sustainable Development Goals

MNM – Maternal Near Miss

WHO – World Health Organization

MNMR – Maternal Near Miss Mortality Ratio

IOM – Institute of Medicine

ICU – Intensive Care Unit

WHO – World Health Organization

LB – Live Birth

MD – Maternal Death

WLTC – Women with life threatening conditions

SMOR – Severe Maternal Outcome Ratio

LSCS – Lower Segment Caesarean Section

D&C – Dilatation & Curettage

AIDP – Acute Inflammatory Demyelinating Polyneuropathy

Abstract

Introduction

Nepal is a low-income country in the South East Asia Region (SEAR) which has seen significant improvements in their Maternal Mortality Ratio (MMR) by decreasing the number of deaths from 553 to 186 between the year 2000 to year 2017 with a change of 66%(1). Traditionally, Maternal Mortality statistics has been used as a benchmark to evaluate the quality of maternal services provided. However, over the years, with the advent of lower maternal mortality, especially in the higher income countries, an indicator which can visualize the picture of maternal health was required. Therefore, the Maternal Near-Miss (MNM) approach may be used as an adjunct to understand the maternal mortality and morbidity.

Objectives

Objective 1: To determine the frequency of Maternal Near Miss (MNM) and Severe Maternal Outcome in a tertiary level center.

Objective 2: To determine the Severe Maternal Outcome Ratio, Maternal Near Miss Ratio (MNM: 1Maternal Death) and Maternal Near Miss Mortality ratio (MNM: 1Maternal Death) in a tertiary level center.

Objective 3: To determine the maternal mortality index in a tertiary level center.

Methods: Criteria for Baseline assessment from WHO near miss approach used for selection of cases. Maternal near miss indicators are calculated using the WHO near miss tool.

Results: Number of MNM cases was 21 and 24 in year 2017 and 2018 respectively. Severe Maternal outcome for 2017 and 2018 was 24 and 25 respectively. SMOR for 2016 and 2017 was

11.2 and 10.5 respectively. MNMR for 2017 and 2018 was 9.8 and 10.1 respectively. Maternal near miss mortality ratio was 7.0 and 24.0 for 2017 and 2018 respectively. Mortality index for 2017 and 2018 was 12.5% and 40% respectively.

Conclusion: An effective audit system is required in the tertiary center for maternal care and services

Keywords: Maternal Near Miss, Severe Maternal Complications, Maternal Mortality Index, Maternal Near Miss Mortality Ratio, Severe Maternal Outcome Ratio

Introduction

Improvement of Maternal Health has been one of the eight Millennium Development Goals agreed by the 191 UN member states to be achieved by the year 2015. However, an estimated 295000 women died due to complications of childbirth and pregnancy in the year 2015, of which almost all were attributed to low- and middle- income countries(2). If appropriate and timely management and care were provided, these deaths could have been preventable. The percentage of births that were carried out by skilled birth attendants (SBA) have significantly improved from 69% in 2012 to 81% in 2018(3). In spite of this significant improvement, in 2017, approximately 810 women died daily from causes related to childbirth and pregnancy which could have been preventable(2). 94% of all preventable maternal deaths occurred in low and lower-middle income countries which could be saved by skilled care during pregnancy and childbirth (2).

Country background

Nepal is a low-income country in the South East Asia Region (SEAR) which has seen significant improvements in their Maternal Mortality Ratio (MMR) by decreasing the number of deaths from 553 to 186 between the year 2000 to year 2017 with a change of 66% (as shown in table 1) (1). In the year 2000, the country had the second highest MMR among the SEAR countries. Despite witnessing second highest change in MMR among the SEAR countries and an increase in Skilled Birth Attendant Coverage from 19% to 58%(4) between 2006 to 2016, Nepal still has the second highest MMR among these countries. According to the 2018 SDG profile, Nepal has achieved 56% family planning coverage and 69% of pregnancy care (as shown in table 2) (4).

Maternal Near Miss approach

Traditionally, Maternal Mortality statistics has been used as a benchmark to evaluate the quality of maternal services provided. However, over the years, with the advent of lower maternal mortality, especially in the higher income countries, an indicator which can visualize the picture of maternal health was required. Therefore, the Maternal Near-Miss (MNM) approach may be used as an adjunct to understand the maternal mortality and morbidity. The WHO Working Group on Maternal Mortality and Morbidity Classifications and the WHO Multicountry Survey on Maternal and Newborn Health Research Group formulated a standardized method in the year 2011 called “WHO near-miss approach” which can be performed at individual healthcare center level or district level which could be further scaled up to the entire health system (5).

Country	2000	2005	2010	2015	2017	Overall change in MMR between 2000 and 2017 (%)
Nepal	553	415	305	236	186	66
Bangladesh	434	343	258	200	173	60
Bhutan	423	310	247	203	183	57
Democratic People's Republic of Korea	139	120	106	91	89	36
India	370	286	210	158	145	61
Indonesia	272	252	228	192	177	35
Maldives	125	75	67	54	53	58
Myanmar	340	299	265	246	250	26
Srilanka	56	45	38	36	36	36
Thailand	43	43	42	38	37	14
Timor-Leste	745	415	219	160	142	81

Table 1: Trends in maternal mortality from 2000 to 2017 among the SEAR countries (1).

Country	Family planning coverage	Pregnancy care
Nepal	56%	69%
Bangladesh	62%	37%
Bhutan	85%	78%
Democratic People's Republic of Korea	71%	100%
India	64%	51%
Indonesia	79%	85%
Maldives	43%	90%
Myanmar	75%	59%
Srilanka	74%	99%
Thailand	89%	91%
Timor-Leste	38%	47%

Table 2: Family planning coverage and pregnancy care coverage of SEAR countries in 2018

(4,6–15)

Objectives

Despite improvements in MMR, Nepal still has one of the highest numbers of maternal deaths in the south east Asia region. W.H.O. has recommended the near-miss approach as a standardized approach designed for assessment of care in order to improve the quality of maternal health care provided (5). Therefore, the objectives of the study have been designed to determine the maternal near miss indicators provided in the near miss tool, in order to conduct the baseline assessment of a tertiary center in Nepal.

Objective 1: To determine the frequency of Maternal Near Miss (MNM) and Severe Maternal Outcome in a tertiary level center.

Objective 2: To determine the Severe Maternal Outcome Ratio, Maternal Near Miss Ratio (MNM) and Maternal Near Miss Mortality ratio (MNM: 1Maternal Death) in a tertiary level center.

Objective 3: To determine the maternal mortality index in a tertiary level center.

Methods

The Tribhuvan University Teaching Hospital which was established in the year 1982 is a 700 bedded tertiary level hospital in Nepal. This hospital is the site of teaching and research activities for Institute of Medicine (IOM). The Department of Obstetrics and Gynecology is one of the oldest departments of IOM currently with 53 fully functional beds.

A retrospective cross-sectional study based on the hospital records was conducted in the Department of Obstetrics and Gynecology and the Intensive Care Unit of the teaching hospital. A proposal for the study was applied to the Institutional Review Committee of IOM which was accepted with terms and conditions defining ethical grounds for the study. All the records of the women admitted to the Department of Obstetrics and Gynecology, of Tribhuvan University Teaching Hospital between 1 January 2017 till 31st December 2018 were identified retrospectively and the data was extracted of all antenatal and postnatal cases, termination of pregnancy, delivery hospitalizations and ICU admissions. The following data were extracted after the approval of the initial proposal submitted: age, parity, any previous abortions, socioeconomic status, whether booked or referred cases, gestational age, if any laparotomy performed excluding Caesarean section, use of blood products, neonatal outcome, maternal

outcome, if medical termination of pregnancy was performed and the gestational age at which it was performed, if readmission of patient occurred within 42 days due to any complications.

Specific diagnosis of the patients was not available due to time constraints and ethical reasons.

However, frequency of different obstetric and non-obstetric causes was identified in order to calculate the maternal near miss indicators. Data was anonymized and stored in a database by the Institute of Medicine which was provided for purpose of analysis. Analysis of the data and calculation of the maternal near miss indicators were carried out on Microsoft Excel software.

In this study, the WHO near miss approach has been adopted to analyze the objectives of the study. According to WHO, maternal near-miss cases are those “woman who nearly died but survived a complication that occurred during pregnancy, childbirth or within 42 days of termination of pregnancy. Maternal near miss ratio is the number of maternal near-miss cases per 1000 live births and Maternal near-miss mortality ratio are the number of maternal near-miss cases per maternal death.”(5)

The following WHO near-miss approach criteria for baseline assessment has been adopted in this study.

Criteria for Baseline assessment from WHO near-miss approach for maternal health (5)

Severe maternal complications

- Severe postpartum hemorrhage
- Severe pre-eclampsia
- Eclampsia
- Sepsis or severe systemic infection

- Ruptured uterus
- Severe complications of abortions

Critical interventions or intensive care unit use

- Admission to intensive care unit
- Interventional radiology
- Laparotomy (hysterectomy, excludes caesarean section)
- Use of blood products

Life threatening conditions (Near-miss criteria)

- Cardiovascular dysfunction
 - Shock, cardiac arrest (absence of pulse/heartbeat and loss of consciousness), use of continuous vasoactive drugs, cardiopulmonary resuscitation, severe hypoperfusion (lactate $>5\text{mmol/l}$ or $>45\text{mg/dl}$), severe acidosis ($\text{pH} < 7.1$)
- 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 anesthesia, severe hypoxemia (O_2 saturation $<90\%$ for ≥ 60 minutes or $\text{PAO}_2/\text{FiO}_2 < 200$)
- Renal Dysfunction
 - Oliguria non-responsive to fluids or diuretics, dialysis for acute renal failure, severe acute azotemia (creatinine $\geq 300\text{micromol/ml}$ or $\geq 3.5\text{mg/dl}$)
- Coagulation/hematological 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 pre-eclampsia, severe acute hyperbilirubinemia (bilirubin > 100 micromol 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

Maternal vital status

- Maternal death

Selection of cases

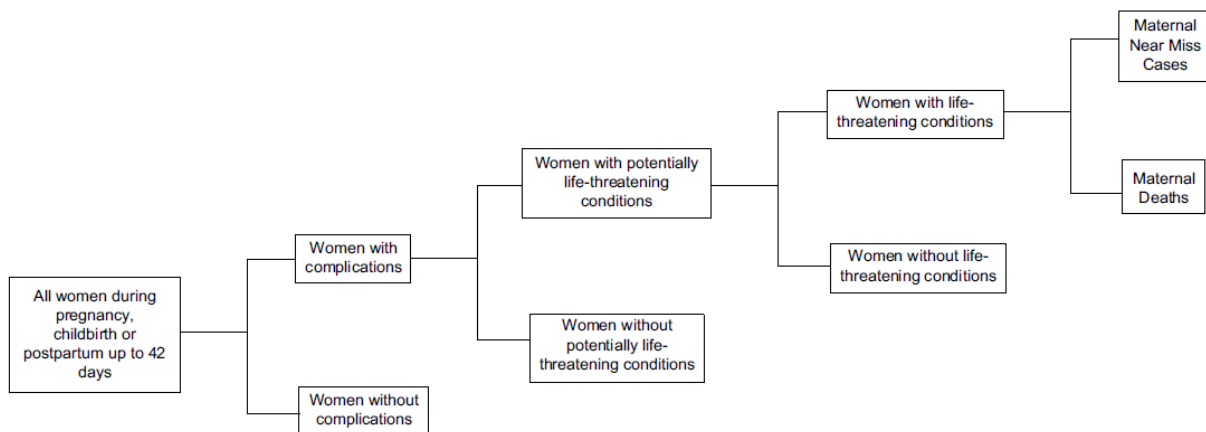


Figure 1: The obstetric population, maternal near miss and maternal death (16)

<u>Operational definitions</u>	
Severe postpartum hemorrhage	Genital bleeding after delivery, with at least one of the following: perceived abnormal bleeding (1000 ml or more) or any bleeding with hypotension or blood transfusion.
Severe pre-eclampsia	Persistent systolic blood pressure of 160 mmHg or more or a diastolic blood pressure of 110 mmHg; proteinuria of 5 g or more in 24 hours; oliguria of <400 ml in 24 hours; and HELLP syndrome or pulmonary edema. Excludes eclampsia.
Eclampsia	Generalized fits in a patient without previous history of epilepsy. Includes coma in pre-eclampsia.
Severe systemic infection or sepsis	Presence of fever (body temperature >38°C), a confirmed or suspected infection (e.g. chorioamnionitis, septic abortion, endometritis, pneumonia), and at least one of the following: heart rate >90, respiratory rate >20, leukopenia (white blood cells <4000), leukocytosis (white blood cells >12 000).
Uterine rupture	Rupture of uterus during labor confirmed by laparotomy.

Table 3: Operational definitions of severe maternal complications (5).

Although a minimum sample size for producing near miss indicators has not been established, it has been generally expected that the prevalence of severe maternal outcomes are around 7.5 cases per 1000 deliveries (5). The following table shows the number of eligible women according to the inclusion criteria of the study and the number (including range) of women who are expected to be eligible by the standard established by WHO.

Variable	Year		WHO Standard (5)
	2017	2018	
Number of Deliveries	2192	2451	2000
Number of eligible women	314	345	75 (37-300)

Table 4: Eligible women for the study and WHO standard

Maternal near-miss indicators given by the WHO near miss approached (as described in table 5) was calculated from the data received after classifying the cases with severe maternal outcomes and life-threatening conditions into their respective categories.

Indicator	Definition
Maternal near miss (MNM)	a woman who nearly died but survived a complication that occurred during pregnancy, childbirth or within 42 days of termination of pregnancy
Maternal death (MD)	Death of a woman while pregnant or within 42 days of termination of pregnancy or its management, but not from accidental or incidental causes.
Livebirth	birth of an offspring which breathes or shows evidence of life
Severe maternal outcome	life-threatening condition (i.e. organ dysfunction including all maternal deaths and maternal near-miss cases).
Women with life-threatening conditions (WLTC)	women who either qualified as maternal near-miss cases or those who died (i.e. women presenting a severe maternal outcome). It is the sum of maternal near-miss and maternal deaths (WLTC = MNM + MD)

Severe maternal outcome ratio	number of women with life-threatening conditions (MNM+MD) per 1000 live births (LB). This indicator gives an estimate of the amount of care and resources that would be needed in an area or facility [SMOR= (MNM+MD)/LB]
MNM ratio (MNMR)	number of maternal near-miss cases per 1000 live births (MNMR=MNM/LB). Similarly, to the SMOR, this indicator gives an estimation of the amount of care and resources that would be needed in an area or facility.
Maternal near-miss mortality ratio (MNM:1 MD)	refers to the ratio between maternal near miss cases and maternal deaths. Higher ratios indicate better care.
Mortality Index	number of maternal deaths divided by the number of women with life-threatening conditions expressed as a percentage [MI = MD/(MNM+MD)]. The higher the index the more women with life threatening conditions die (low quality of care), whereas the lower the index the fewer women with life-threatening conditions die (better quality of care).
Perinatal outcome indicators	e.g. perinatal mortality, neonatal mortality or still birth rates; in the context of maternal near-miss could be useful to complement the quality-of-care evaluation.

Table 5: Maternal near miss indicators (5)

Results

A total of 2192 women and 2450 women were admitted into the Department of Obstetrics and Gynecology of the Tribhuvan University teaching hospital in the year 2017 and 2018 respectively. Total number of live births in the year 2017 was 2134 and in the year 2018 it was 2387. Maternal deaths in the department for the year 2017 was 3 while in 2018 the number of maternal deaths was 1. All the maternal deaths that occurred in the year 2017 and 2018 were referred cases from primary health care and were due to severe postpartum hemorrhage (PPH). Table 5 shows the number of patients admitted into the Intensive care unit (ICU) and their diagnosis based on obstetric and non-obstetric causes. The most common obstetric cause for ICU admission in both 2017 and 2018 was uterine rupture. The most common non-obstetric cause for ICU admission in 2017 and 2018 was Diabetes and heart disease respectively.

Obstetric cause	2017	2018
Hemorrhage	8	10
Antepartum Hemorrhage	2	3
Postpartum Hemorrhage	1	2
Ectopic pregnancies	5	5
Hypertensive disorder	8	10
Severe pre-eclampsia/ Eclampsia	6	2
Uterine Rupture	10	15
Sepsis	3	3
Post LSCS Laparotomy/ Hematoma	1	3
Post LSCS for monitoring	0	2
Obstructed Labor	5	1
Post D&C Bleeding	5	4
Total	54	60
Non-Obstetric Cause		
Heart disease	6	8
Respiratory disease	5	6
Anemia	6	6

Seizure disorder	3	3
Liver Disease	5	5
Diabetes	9	4
AIDP	0	1
Pancreatitis	2	0
Stroke	0	1
Ileus	0	1
Total	36	35
Total Number of ICU cases	90	95

Table 6: Frequency of patients based on diagnosis (obstetric and non-obstetric causes).

In the year 2017 and 2018, 184 and 212 preterm births took place. All women who had early, and moderately preterm births were kept in ICU under observation and blood products were used in their management. Blood products were also used in management of 6 patients from 2017 and 2018 who experienced late preterm birth. Table 6 shows the frequency of different diagnosis of the patients who experienced early and moderately preterm birth in year 2017 and 2018.

Diagnosis	2017		2018	
	Early Preterm	Moderately Preterm	Early Preterm	Moderately Preterm
Cervical Disease	4	6	3	8
Breakdown of maternal-fetal tolerance	16	14	14	23
Decline in Progesterone action	10	18	5	10
Uterine Over distention	3	15	2	9
Decidual Senescence	2	2	1	5
Vascular Disorder	1	3	2	6
Infection	2	1	3	4
Stress	1	1	2	1
Diabetes	0	2	2	2
Hypertension	0	1	1	0
Hypo/hyperthyroidism	0	0	2	1
Others/ Unknown	6	1	7	9
Total	45	64	44	78

Table 7: Frequency of different diagnosis of early and moderately preterm births in year 2017 and 2018. (<32 weeks: Early Preterm; 32-34 weeks: moderately preterm)

According to the data extracted, out of the 58 stillbirths that occurred in 2017 and the 63 stillbirths that occurred in 2018, 12 births in 2017 and 20 births in 2018 were born dead due to delay in admission as they belonged to remote areas with no basic health facilities. Table 7 shows the causes of stillbirth and their frequencies in both 2017 and 2018.

Type	2017	2018
Antepartum		
Congenital	3	4
Antepartum Hemorrhage	16	16
Maternal Hypertensive Disease	6	7
Maternal Infection	4	8
Fetal Growth Restriction	1	2
Unexplained	1	2
Other (Cardiovascular disease, fetal hydrops)	3	4
Inadequate information	2	2
Intrapartum		
Congenital	NIL	2
Intrapartum Hypoxia (acute)	10	10
Preterm Labor	5	2
Intrapartum infection	3	3
Inadequate information	4	1
Total	58	64

Table 8: Causes of stillbirth and their frequencies in the year 2017 and 2018.

In the year 2017, the department carried out 12 terminations of pregnancy of which 8 were surgical abortion. In the year 2018, 20 terminations of pregnancy were carried out which were all medical abortions. All the patients required use of blood products but were not required to be readmitted within 42 days due to any complication.

Based on the frequencies of diagnosis, the patients were classified into the severe maternal complications criteria of the WHO near-miss approach. A total of 36 women in the year 2017 and 42 women in 2018 had severe maternal complications. Table 8 shows the frequencies of women based on the criteria.

Severe Maternal Complications	2017	2018
Severe postpartum haemorrhage	12	18
Severe pre-eclampsia and Eclampsia	6	2
Sepsis or severe systemic infection	3	3
Ruptured Uterus	10	15
Severe complications of abortions	5	4
Total	36	42

Table 9: Frequencies of severe maternal complications in year 2017 and 2018.

Total number of patients that required clinical interventions or intensive care unit use was calculated based on the preterm birth cases, stillbirths, laparotomy cases, ICU admission cases, neonatal mortality cases, maternal mortality cases and medical termination of pregnancy cases. Those cases which have been admitted into the ICU were excluded from the “use of blood products” as overlapping of data may occur. Data based on interventional radiology was unavailable due to time constraints and ethical reasons. 14 patients underwent laparotomy excluding caesarean section in 2017 while 16 patients underwent laparotomy excluding caesarean section in 2018. Total number of patients that required clinical interventions or ICU use in 2017 was 314 patients, and in 2018 was 345 women. Table 9 shows the frequency of patients based on the criteria for critical interventions or intensive care unit use.

Critical Interventions or intensive care unit use	2017	2018
Admission to intensive care unit	262	286
Interventional radiology	UA	UA
Laparotomy (includes hysterectomy, excludes caesarean section)	14	16
Use of blood products (excluding ICU cases, early and moderately preterm, stillbirth cases)	38	43
Total	314	345

Table 10: Frequency of patients requiring critical interventions or intensive care unit use.

Calculation of the frequencies of patients that suffered different life-threatening conditions were based on the frequencies of the diagnosis related to particular life-threatening condition. Due to technical reasons, time constraints and ethical issues, renal, coagulation or hematological, and uterine dysfunction data was not available. Table 10 shows the frequencies of different life-threatening conditions in patients.

Life-threatening conditions (near miss criteria)	2017	2018
Cardiovascular dysfunction	6	8
Respiratory dysfunction	5	6
Renal dysfunction	UA	UA
Coagulation/Hematological dysfunction	UA	UA
Hepatic dysfunction	7	5
Neurological dysfunction	3	5
Uterine dysfunction	UA	UA
Total	21	24

Table 11: Frequencies of life-threatening conditions (near miss criteria) in 2017 and 2018.

Based on the afore mentioned information, the maternal near-miss indicators for the years 2017 and 2018 were calculated. Frequency of maternal near-miss cases for 2017 and 2018 was 21 and 24 women respectively. The frequency of severe maternal outcome or women with life threatening conditions was 24 and 25 women respectively.

The severe maternal outcome ratio (SMOR) for the year 2017 was 11.2 per 1000 live births, while in 2018 it was 10.5 per 1000 live births. The maternal near miss ratio for 2017 and 2018 was 9.8 and 10.1 per 1000 live births respectively. Maternal near miss mortality ratio for the department in the year 2017 was 7.0 maternal near miss per maternal death, and in 2018 was 24.0 maternal near miss per maternal death.

The calculated maternal mortality index for 2017 was 12.5% and in 2018 it was 4.0%.

The stillbirth rate in 2017 and 2018 was 26.5 and 25.7 per 1000 births respectively. Neonatal mortality in the department was 9.8 and 10.9 per 1000 live births. Table 11 shows summary of all the calculated indicators.

S.No.	Indicator	Result		Unit
		2017	2018	
1	Maternal near miss (MNM)	21	24	person
2	Maternal death (MD)	3	1	person
3	Live birth (LB)	2134	2387	Live birth
4	Severe maternal outcome or Women with life-threatening conditions (WLTC)	24	25	person
5	Severe maternal outcome ratio	11.2	10.5	per 1000 live births
6	MNM ratio (MNMR)	9.8	10.1	per 1000 live births
7	Maternal near-miss mortality ratio (MNM:1 MD)	7.0	24.0	per maternal death
8	Mortality Index	12.5	4.0	Percent
9	Stillbirth rate	26.5	25.7	per 1000 births
10	Neonatal Mortality	9.8	10.9	per 1000 live births

Table 12: Summary of maternal near miss indicators for 2017 and 2018

Discussion

As a premier institute, the department of obstetrics and gynecology caters to a large number of patients referred from different parts of the country, including remote areas with less access to basic health facilities. Therefore, majority of the stillbirth patients recorded in the hospital has been referred from different centers in the country.

The near miss indicators calculated according to the guideline by WHO near miss approach suggest that there has been an overall improvement in the provision of services in the hospital from 2017 to 2018. There is a contradiction between the severe maternal outcome ratio (SMOR) and maternal near miss ratio. Both the indicators are used to estimate the amount of care and resources that would be needed in the facility (5). The higher maternal near-miss mortality ratio in 2018 shows that the quality of care is better. This is also supported by the decrease in mortality index in 2018 which shows that fewer women with life threatening conditions may die, indicating high quality of care.

All the maternal deaths in the institute were cases that were referred from primary health care level. Due to untimely reporting of the patients to the institute and excessive loss of blood, the patients were not saved. Strengthening of maternal health services by increasing the resources and care up to optimum levels at primary, secondary and tertiary level will be required with the establishment of a better referral system. It is also important that quality management and care of patients are carried out in the lower levels to identify potentially life-threatening cases. This would improve the overall maternal services provided within the country thus further decreasing the maternal mortality ratio.

Limitations

The WHO near miss approach assumes that all maternal deaths involve at least one life-threatening condition or organ dysfunction. Additionally, it is also assumed that women with one or more life-threatening conditions are those who have severe complications related to pregnancy. Inadequacy of data due to its retrospective nature, constraints of time and resources, and due to ethical reasons, was one of the biggest limitations of this study. The maternal near miss indicators calculated may be underestimated due to limitations in the data available. This will lead to an information bias. However, uniform criteria and assumptions applied in calculation of values in both the years may make them comparable to each other.

Conclusion

The WHO near miss approach may be used to improve clinical care and reduce the preventable maternal morbidity and mortality through use of evidence-based practices. However, due to limitations of data, the baseline assessment in this study may not be adequate to reach a conclusion on the quality of care provided. An effective audit system for maternal care and services needs to be established in the tertiary center which would record all the necessary data and give reliable results.

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