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Maternal near-miss and mortality in a teaching hospital in Tigray region, Northern Ethiopia

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Abstract

Objective: This study seeks to examine the prevalence of maternal morbidities and deaths in Ayder Comprehensive Specialized Hospital from 1 July 2018 to 30 June 2019.

Methods: This was a cross-sectional study. Total purposive sampling method was employed to collect data prospectively using modified World Health Organization criteria for baseline assessment of maternal near-miss and mortality. Pregnant women or those who are within 42 days postpartum/any form of pregnancy termination that satisfy the inclusion criteria were enrolled.

Results: A total of 691 mothers were recorded as having severe maternal complications. Out of these, 170 women developed severe maternal outcome, ending with 146 maternal near-miss cases and 24 maternal deaths. The maternal near-miss ratio and maternal mortality ratio were 28.5 per 1000 live births and 469.1 per 100,000 live births, respectively. The overall mortality index was 14%. The top underlying causes of severe maternal complications were the infamous triads of preeclampsia (n = 303, 43.8%), obstetric hemorrhage (n = 166, 24.0%) and sepsis (n = 130, 18.8%). About 62.5% of mothers who died were not admitted to intensive care unit.

Conclusion: This study found that the infamous triads of preeclampsia, obstetric hemorrhage and sepsis persist as the commonest causes of severe maternal complications in the study area. A significant number of women with severe maternal outcome were not admitted to intensive care unit. It also highlights that the severe maternal complications, severe maternal outcome, maternal near-miss ratio and mortality index in the study area are disproportionately higher than the global average. These staggering numbers call for a system re-thinking at multiple junctures.

Keywords

maternal mortality, maternal near-miss, mortality index, Ayder Comprehensive Specialized Hospital

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Introduction

Pregnancy and delivery are physiologic states most women wish to achieve in their lives. Yet, these life perpetuating processes could lead to disability or death. Complications affecting women during pregnancy, intrapartum or postpartum period can be short lived or can at times lead to permanent disabilities.[1]

Maternal near-miss (MNM) is a situation where women nearly die but survive severe life-threatening obstetric complications.[2] For every mother who dies, other 20–30 mothers suffer from severe obstetric complications with wide-reaching lifelong consequences.[3–5]

There are effective and affordable measures to prevent 80% of known causes of maternal deaths that occur globally.[6,7] In the past few decades, reduction of maternal mortality has often been seen as a hallmark of nations'

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development.[8] However, this remains a challenge particularly to developing countries.[8] As part of the Millennium Development Goals (MDGs) set in 2000, leaders of UN member states aspired to reduce maternal mortality by three-fourth toward the end of 2015 from where their respective countries' maternal mortality ratio (MMR) stood in 1990.[9] This was met with marginal success. The global MMR dropped by 44%, that is, from 385 in 1990 to 216 per 100,000 live births in 2015.[10–12]

Country wise, reflecting the attention paid by the government to achieve MDG 5A and MDG 5B, Ethiopia reduced maternal mortality by 71.8% between 1990 (MMR = 1250) and 2015 (MMR = 353) falling little short of 3.2% achieving the MDG 5.[10,13] Despite this marked progress, Ethiopia remains among the top 10 countries that contribute nearly 60% of global maternal deaths.[14,15]

Teaching hospitals host higher maternal deaths than national MMRs mainly because they treat severely ill patients.[16,17] Ayder Comprehensive Specialized Hospital (ACSH), as one of the main referral centers for critically ill obstetrics patients, hosts one of the highest number of maternal deaths in the country.[18] Cuffing up both necessary human and technical resources to effectively manage critically ill obstetrics patients coming to the center is of paramount importance. Equally important is to use systematically collected and analyzed data to design and steer interventional programs to favorably curb the burden of preventable causes of maternal morbidity and mortality. To this end, we believe that systematically analyzing cases of MNM and maternal death would bring a baseline data to end preventable maternal deaths in the institution where this study is conducted and by extension the population of the referral catchment area it serves.

World Health Organization (WHO) near-miss tool was developed in 2011 to practice using universal criteria set that is "feasible for use in any setting regardless of the development status."[19] However, some authors questioned the universality of the original WHO MNM criteria set. A study by van den Akker et al.[20] questioned particularly the universality of the organ failure-based criteria of the original WHO MNM near-miss tool. Another study by Tura et al.[21] accepted all the WHO MNM clinical criteria but criticized that only few of the laboratory and management segments of WHO MNM tool were applicable for the sub-Saharan Africa and by possible extension to other low-resource settings and proposed that an adapted sub-Saharan Africa MNM tool be used. However, at the time this study was conceived in the beginning of 2017, modified WHO near-miss criteria[22] were the accessible and convenient criteria set for our study setting.

Objective

This study seeks to examine the prevalence of maternal morbidities and deaths in ACSH from 1 July 2018 to 30 June 2019.

Methodology

Research design

This was a cross-sectional study. Total purposive sampling method was employed to collect data prospectively using modified WHO inclusion criteria for baseline assessment of MNM and mortality. From a study in a similar setup in Ethiopia, we estimated that 202 mothers with severe maternal complications (SMC) and 162 mothers with severe maternal outcome (SMO) would provide 80% power to observe association between delay three and SMO, at AOR 4.12 (2.34–7.26) and $p < 0.01$.[23] Thus, this assumption was used to calculate the minimum sample size of 202. Numerical data collection was concentrated on the occurrences of SMC, SMO and maternal mortality.

Setting

The study was carried out at ACSH from 1 July 2018 to 30 June 2019. This teaching hospital serves as a referral catchment area for more than 8 million people. It is also one of the main referral centers for critically ill obstetric patients in Northern Ethiopia. It hosts an average of 5000 deliveries annually.

Participants

Participants for this study were pregnant women or those within 42 days postpartum/any form of pregnancy termination during the period of 1 July 2018–30 June 2019 who visited ACSH and who satisfied the modified WHO near-miss inclusion criteria (Table 1). For this study, five potentially life-threatening conditions (PLTC) were used as part of the inclusion criteria set: severe pregnancy-related hemorrhage, severe preeclampsia, eclampsia, sepsis/severe systemic infection and ruptured uterus. Those who do not satisfy one of these inclusion criteria set were excluded from this study.

Ethical approval and consent to participate

Ethical approval was obtained from the Health Research Review Committee of Mekelle University, College of Health Sciences. As per the WHO near-miss approach, confidential information about the identity of individual participants (i.e. individual participant identification number, name, facility registry code, hospital arrival date, etc.) was kept undisclosed by the data collector in a separate logbook, which was used only to complete forms in case of doubts or missing data.[19] All results were de-identified and none of the information collected in the database could be traced back to any individual patient. Given the above precautions and that individual participants were not approached directly for data collection, the committee waived the need for written informed consent for this

Table 1. WHO near-miss criteria adapted to the local context of ACSH (reproduced from Nelissen et al.[22] with modification).

Original WHO criteria	Modified near-miss criteria
Clinical criteria	
Acute cyanosis	Acute cyanosis
Gasping	Gasping
Respiratory rate > 40 or < 6/min	Respiratory rate > 40 or < 6/min
Shock	Shock
Oliguria non-responsive to fluids or diuretics	Oliguria non-responsive to fluids or diuretics
Failure to form clots	Failure to form clots
Loss of consciousness lasting > 12 h	Loss of consciousness lasting > 12 h
Cardiac arrest	Cardiac arrest
Stroke	Stroke
Uncontrollable fit/total paralysis	Uncontrollable abnormal body movement
Jaundice in the presence of preeclampsia	Jaundice in the presence of preeclampsia
Laboratory-based criteria	
Oxygen saturation < 90% for ⩾ 60 min	Oxygen saturation < 90% for ⩾ 60 min
PaO_2/FiO_2 < 200 mmHg	
Creatinine ⩾ 300 μmol/L or ⩾ 3.5 mg/dL	Creatinine ⩾ 300 μmol/L or ⩾ 3.5 mg/dL
Bilirubin > 100 μmol/L or > 6.0 mg/dL	Bilirubin > 100 μmol/L or > 6.0 mg/dL
pH < 7.1	
Lactate > 5 mEq/mL	
Acute thrombocytopenia (< 50,000 platelets/mL)	Acute thrombocytopenia (< 50,000 platelets/mL)
Loss of consciousness and ketoacids in urine	
Management-based criteria	
	Admission to intensive care unit
Continuous vasoactive drugs	
Hysterectomy following infection or hemorrhage	Hysterectomy following infection or hemorrhage
Transfusion of ⩾ 5 units of blood	Transfusion of ⩾ 1 units of blood
Intubation and ventilation for ⩾ 60 min not related to anesthesia	Intubation and ventilation for ⩾ 60 min not related to anesthesia
Dialysis for acute renal failure	Dialysis for acute renal failure
Cardiopulmonary resuscitation	Cardiopulmonary resuscitation
SMC	
	Eclampsia
	Sepsis or severe systemic infection
	Uterine rupture

WHO: World Health Organization; ACSH: Ayder Comprehensive Specialized Hospital.
As shown in the table above, due to a setup limitation inclusion criteria, such as PaO_2/FiO_2, pH and lactate level determinations were not used.

research. Ethical approval number for this research is ERC0961/2017.

Data collection

A senior midwife was trained as a data collector. The data collector daily visited the emergency outpatient department, intensive care unit (ICU), medical and surgical wards for possible admission of women with SMC/maternal death. The research team members followed daily attendance of morning sessions, teaching rounds and case-based MNM and death audits and notified the data collector timely.

Data analysis

The primary outcome measure was the MNM ratio in ACSH during the study period. Secondary outcome indicators, such as the MMR, SMO ratio (SMOR) and the mortality index (MI), were calculated.

As per the WHO generic guide "near-miss approach for maternal health,"

> **SMC, that is, potentially** life-threatening **conditions (PLTC)** are defined as "potentially life-threatening conditions." For this study, five PLTC were used as part of the inclusion criteria set: severe pregnancy-related hemorrhage, severe preeclampsia, eclampsia, sepsis/severe systemic infection and ruptured uterus.
>
> **SMO or** Life-threatening **conditions (LTC)** refers to "a life-threatening condition, that is, organ dysfunction or death which includes MNM and maternal deaths (SMO = MNM + MD). SMOR is the number of MNM + MD per 1000 live births."

MNM ratio refers to "the number of maternal near-miss cases per 1000 live births (MNMR = MNM/LB). These two indicators, SMO ratio and MNM ratio give an estimate of the amount of care and resources that would be needed in an area or facility."

MNM ratio (MNMR) refers to "the number of maternal near-miss cases per 1000 live births (MNMR = MNM/LB). Similar 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."

MI "refers to the number of maternal deaths divided by the sum of women with LTC and maternal deaths expressed as a percentage (MI = MD/ (MNM + MD))." The higher the index the more women with LTC die (low quality of care), whereas the lower the index the fewer women with LTC die (better quality of care).

Data was entered and cleaned using IBM SPSS statistics data editor version 20. Frequency tables and cross-tabulations were produced for the demographic and clinical variables and for the underlying causes per the "WHO near-miss approach for maternal health dummy tables."

Result

During the study period, a total of 5116 live births were registered. A total of 691 women were recorded as having SMC. Of these, 170 women developed SMO (24 were maternal deaths and 146 MNM cases).

A majority (76.6%) of women who experienced SMC were in the age group of 20–34 years. The median age of the study participants was 27 ± 6.17 years. Age of study participants ranged from 17 to 50 years. Teenage pregnancy accounted for 5.4%, while pregnancy at advanced maternal age accounted for 17.9%. The majority (94.1%) of the mothers were from the Tigray region and mothers from neighboring Afar and Amhara regions constituted 28 (4.1%) and 12(1.7%), respectively.

Among the study participants, primigravids, gravida 2–4, and gravida 5 and above constituted 39.5%, 40.1% and 20.4%, respectively. Mean parity was 2.5 ± 2.1, minimum parity 0 and maximum parity 12. In terms of gestational age, majority 63% (n = 435) were term at presentation. Preterm and postterm accounted for 119 (17.2%) and 27 (3.9%), respectively. The remaining 110 (15.9%) was accounted for those who presented before the gestational age of viability, that is, < 28 weeks.

The major organ dysfunction sustained among cases were cardiovascular (84.7%), followed by respiratory dysfunction (44.7%) and uterine dysfunction (15.3%). Slightly more than 50% of the mothers had multiple organ dysfunctions (Table 2).

The major underlying PLTC were preeclampsia with severity features 43.8% (n = 303), obstetric hemorrhage 24.0% (n = 166) and sepsis 18.8% (n = 130). Women with underlying medical or surgical diseases have the highest MI (36.7%) followed by those with hypertensive disorders of pregnancy (20%) and pregnancy-related infection (17.2%). More than 50% of mothers who died have anemia.

Three-fourth of the women who died have an underlying medical condition. Hypertensive disorders of pregnancy, sepsis and obstetric hemorrhage contributed to 37.5%, 20.8% and 12.5% of maternal deaths, respectively (Table 3).

Vaginal delivery, Cesarean delivery and abortion accounted for 46.2%, 34% and 10.8% of mode of pregnancy termination, respectively. Overall, 33 (4.8%) mothers had laparotomy for ectopic pregnancy. However, 22 (3.2%) mothers underwent laparotomy for uterine rupture. Seven women did not have an outcome at diagnosis of which five died while pregnant and two mothers discharged improved before pregnancy termination. Perinatal mortality was recorded in 15.1% of the 575 deliveries, and 19.5% of the deliveries were preterm (Table 4).

The MNM ratio was 28.5 per 1000 live births (95% CI 21.2–27.9) with MI of 14%. For every maternal death, there were six MNM events. Over 85% of the women with SMO presented with organ dysfunction or maternal death within 12 h of hospital stay indicating a very high proportion of first and second delays. The MI of the women with SMO presenting with organ dysfunction within 12 h of hospital stay is also high (77%). The intrahospital SMO rate was relatively low (7.6%) (Table 5).

About 62.5% of maternal deaths occurred without ICU admission (Table 6). The low ICU admission rate (supposedly more than 70% of women with SMO in teaching and referral hospitals) could be explained due to the shortage of ICU beds in our setting. During the study period, there were eight ICU beds for all critically ill adult (both obstetric and nonobstetric) patients in ACSH. Moreover, the very high percentage of women dying without ICU admission reaffirms the limited number of ICU beds in the study setting.

About 91.8% of women in this study received any uterotonics for the prevention of postpartum hemorrhage (PPH). All women with eclampsia received anticonvulsants. The first-line anticonvulsant used in our setting was magnesium sulfate (97.8%) showing optimal care (magnesium sulfate is contraindicated for a negligible group of women and is supposed to be consumed by more than 95%).

Overall, 22 mothers had a uterine rupture. Only two of them had laparotomy after 3 h of the diagnosis showing optimal care of this population. Uterine rupture repair was

Table 2. Morbidity conditions in the audited sample of women with PLTC and SMO, ACSH, 1 July 2018–30 June 2019.

Morbidity conditions	N	%
Women with PLTC	691	100
Women with severe complications		
Severe postpartum hemorrhage	166	24.0
Severe preeclampsia	303	43.8
Eclampsia	46	6.7
Sepsis or severe systemic infection	130	18.8
Uterine rupture	22	3.2
Women undergoing critical interventions		
Use of blood products	256	37.0
Laparotomy	70	10.1
Admission to ICU	24	3.5
Organ dysfunction in mothers with SMO		
Cardiovascular dysfunction	144	84.7
Respiratory dysfunction	76	44.7
Renal dysfunction	14	8.2
Coagulation/hematologic dysfunction	15	8.8
Hepatic dysfunction	6	3.5
Neurologic dysfunction	2	1.2
Uterine dysfunction/hysterectomy	26	15.3
Multiple organ dysfunction	89	52.4
Organ dysfunction in maternal deaths		
Cardiovascular dysfunction	22	91.7
Respiratory dysfunction	19	79.7
Renal dysfunction	10	37.5
Uterine dysfunction/hysterectomy	2	8.3
Coagulation/hematologic dysfunction	1	4.2
Hepatic dysfunction	1	4.2
Neurologic dysfunction	1	4.2

PLTC: potentially life-threatening conditions; SMO: severe maternal outcome; ACSH: Ayder Comprehensive Specialized Hospital.

done in 2 of the 22 mothers while the remaining underwent hysterectomy (20 of the 27 hysterectomies recorded in this study).

There were 119 preterm deliveries in this study. Majority of them delivered after 3 h of admission (89.1%). Corticosteroids were used in 58.5% of those who delivered after 3 h of admission (Table 7). Early neonatal death was recorded in 32.4% of this target group. A high mortality rate with low corticosteroid administration is an important loophole to close.

Discussion

During this study, a total of 691 women were recorded prospectively as having SMC. Out of these, 170 women developed SMO ending with 146 MNM cases and 24 maternal deaths. The MNM ratio was 28.5 per 1000 live births.

The MNM ratio was significantly lower than the MNM ratio of 50.4 per 1000 live births described in a study conducted in Jimma University Teaching Hospital, in Southwest, Ethiopia.[23] A hospital-based study conducted by Worke et al. in Amhara region of Ethiopia and Wakgar et al. in southern region of Ethiopia described a similar MNM ratios of 26.6 and 33.3 per 1000 live births, respectively.[24,25] However, the MNM ratio in this study was nearly 3.5 times higher than the MNM ratio of an 8.01 per 1000 live births described in a facility-based cross-sectional study conducted in the capital, Addis Ababa[26] and nearly two times higher than a similar study conducted in University of Gondar Referral Hospital, a similar setup in Northwest Ethiopia.[27]

In general, MNM ratios are higher in teaching hospitals than community hospitals, presumably because of the large volume of high-risk referrals from large catchment areas to these centers.[18] Thus, this finding might not reflect outcomes at the level of health centers, primary hospitals or general hospitals in the catchment area. On the contrary, different tertiary hospitals in Rwanda showed significantly lower MNM and MMR than the present study.[3,28] The wide difference in MNM ratios from one teaching institution to another can be attributed to temporal differences during which the studies were conducted, differences in methodologies and inclusion criteria.

The MMR in this study was 469.1 per 100,000 live births. MMR has shown a slight decrement from a previous review published in 2017 in the same institution which showed an MMR of 569.7 per 100,000 live births.[18] The rate, however, is higher than the national average of 412 per 100,000 live births.[29,30]

The overall MI was similar to a study conducted in Zimbabwe (10.6%) which is a low-income country[31] but significantly higher than a study conducted in Turkey (5.06%), a high-income country.[32] Hypertensive disorders of pregnancy, sepsis and hemorrhage had MI of 20%, 17.2% and 3.6%, respectively. Women who had multiple obstetric complications had an MI of 17.4%. Women with underlying medical or surgical disease experience an extremely high MI (36.7%).

As described in previous studies conducted in Tigray region of Ethiopia, the high MI associated with hypertensive disorders of pregnancy may reflect delays associated with the extremely low level of mothers' awareness of pregnancy-induced hypertension,[33] low antenatal care (ANC) attendance rate and low BP measurement during ANC follow-up.[34] The high MI of women with pregnancy-related infection with close to 10% of women having no recorded parenteral antibiotics usage also raises concern.

Despite the high morbidity associated with obstetric hemorrhage, maternal death from conditions causing hemorrhage was low in this study. This may imply aggressive and stringent adherence to the standard management protocol of obstetric hemorrhage. Obstetric hemorrhage had been the top cause of maternal death in our setup.[18] This led to series of emergency drills, simulations and training on the management of obstetric

Table 3. Underlying causes of SMC (PLTC)[a] and SMO (LTC)[b], ACSH, 1 July 2018–30 June 2019.

Underlying cause and associated conditions	WWPLTCs (n = 691)		MNM (n = 146)		Maternal deaths (n = 24)		MI (%)
	Total number		Total number		Total number		
	N	%	N	%	N	%	
Underlying causes							
Pregnancy with abortive outcome	75	10.9	17	11.6	3	12.5	15
Obstetric hemorrhage	166	24.0	81	55.5F	3	12.5	3.6
Hypertensive disorders	349	50.5	36	24.6	9	37.5	20
Pregnancy-related infection	130	18.8	24	16.4	5	20.8	17.2
Other obstetric disease or complication	48	6.9	19	13.0	4	16.7	17.4
Medical/surgical/mental disease or complication	68	9.8	31	21.2	18	75	36.7
Contributory causes/associated conditions							
Anemia	76	11.0	18	12.3	13	54.2	
Previous cesarean section	54	7.8	12	8.2	2	8.3	
Prolonged/obstructed labor	14	2.0	7	4.8	1	4.2	
HIV infection	5	0.7	2	1.4	1	4.2	

SMC: severe maternal complications; SMO: severe maternal outcome; ACSH: Ayder Comprehensive Specialized Hospital; MNM: maternal near-miss; MI: mortality index; HIV: human immunodeficiency virus; WWPLTCs: Women with potentially life threathening conditions.
[a]Women with SMC (also called women with potentially life-threatening condition (WPLTC)) are those who developed severe acute maternal morbidity with the potential to progress to SMO.
[b]Women with SMO (also called women with life-threatening condition (WLTC)) are those who developed organ dysfunction or who died because of severe acute maternal complication.

hemorrhage for midwives and residents. Besides, in the event of a shortage of blood in the hospital, the hospital management developed a policy to prioritize pregnant and postpartum mothers with bleeding to curb avoidable deaths from obstetric hemorrhage. These interventions might have led to the decrement of maternal death because of this condition. However, though previous studies show relationships between shock index and PPH,[35] we have not examined the shock index because it is not included as WHO near-miss indicator.

The high MI (36.7%) of women with underlying medical or surgical diseases raises several areas of concern. This may reflect first-degree delay underscoring poor health-seeking behavior of clients.[33,34] They may also reflect a second delay because of a poor referral system and broken referral support while transferring patients to higher centers during which patients sustain irreversible damage before reaching referral centers.[18] Another concern relates to the weak interdepartmental collaboration in treating very sick patients with multiple comorbidities.[18] This emphasizes the need for a multidisciplinary approach when managing patients with medical conditions in pregnancy to recognize complications early and to deliver optimal management.

The top underlying causes of SMC were the infamous triads of preeclampsia with severity features (n = 303, 43.8%), obstetric hemorrhage (n = 166, 24.0%) and sepsis (n = 130, 18.8%). This is in agreement with a study conducted in Jimma University Teaching Hospital.[23] The finding of hypertensive disorders of pregnancy and obstetric hemorrhage as the most common underlying SMC is also supported in several studies conducted in low- and middle-income countries (LMIC).[36–40] Studies conducted in similar setups in Ethiopia are also in agreement with this finding.[26,41] On the contrary, a hospital-based study in southern Ethiopia reported dystocia as the most common underlying SMC.[42]

However, unlike the previous studies,[43] abortion and obstructed labor did not cause significant morbidity and mortality. The decreased death due to obstructed labor might be explained because of the increased involvement of the women development army and extension health workers in early referral and the recent expansion of hospitals with the capacity to do a cesarean delivery in Ethiopia.[10,25] The decrease in abortion-related complications might be due to the partial liberalization of abortion services in the country.[14]

The leading underlying causes of SMO in this study are similar to the top causes of maternal mortality quoted in various studies conducted in Ethiopia.[42,44–46] This denotes review of MNM can serve as a useful surrogate for review of maternal mortality. Because of this shared similarity in causation, recommendations drawn from MNM studies can be projected as a proxy for the implementation of strategies to decrease maternal mortality.

Out of the 170 women with SMO, 24 were admitted to ICU giving an ICU admission rate of 14.1% cases with SMO. About 62.5% of maternal deaths occurred without ICU admission. The low ICU admission rate (supposedly more than 70% of women with SMO in teaching and

Table 4. End of pregnancy and pregnancy outcome, ACSH, 1 July 2018–30 June 2019.

Pregnancy outcome	PLTC (n = 691)		MNM cases (n = 146)		Maternal deaths (n = 24)	
	N	%	N	%	N	%
End of pregnancy						
Vaginal delivery	319	46.2	67	45.3	10	41.7
Cesarean section	235	34	42	28.4	5	20.8
Complete abortion	15	2.2	5	3.4	0	0
Curettage/vacuum aspiration	37	5.4	8	5.4	3	12.5
Medical methods for uterine evacuation	23	3.3	4	2.7	0	0
Laparotomy for ectopic pregnancy	33	4.8	1	0.7	0	0
Laparotomy for uterine rupture	22	3.2	21	14.2	1	4.2
Women still pregnant at discharge from hospital or at death	7	1.0	0	0	5	20.8
Cesarean section rate	235/691	34.0	44	30.1	5	20.8
Preterm births	112/575	19.5	21	14.5	5	20.8
Perinatal deaths	87/575	15.1	31	21.2	5	20.8

ACSH: Ayder Comprehensive Specialized Hospital.

Table 5. SMO and MNM indicators, ACSH, 1 July 2018–30 June 2019.

Outcomes	Near-miss indicators
1. All live births in the population under surveillance	5116
2. SMO cases (number)	170
Maternal deaths (n)	24
MNM cases (n)	146
3. Overall near-miss indicators	
SMO ratio (per 1000 live births)	33.2
MNM ratio (per 1000 live births)	28.5
MNM mortality ratio	6.1:1
MI	14%
4. Hospital access indicators	
SMO cases presenting with organ dysfunction or maternal death within 12 h of hospital stay (SM012) (number)	145
Proportion of SM012 cases among all SMO cases	85.3%
Proportion of SM012 cases coming from other health facilities	131
SM012 MI	77.1%
5. Intrahospital care	
Intrahospital SMO cases (number)	39
Intrahospital SMO rate (per 1000 live births)	7.6%
Intrahospital MI	18%

SMO: severe maternal outcome; MNM: maternal near-miss; ACSH: Ayder Comprehensive Specialized Hospital.

Table 6. Intensive care use, ACSH, 1 July 2018–30 June 2019.

Intensive care use	24
Total number of women giving birth	5082
ICU admission rate	0.5%
ICU admission rate among women with SMO	14.1%
Proportion of maternal deaths without ICU admission	62.5%

ACSH: Ayder Comprehensive Specialized Hospital; ICU: Intensive care unit; SMO: severe maternal outcome.

referral hospitals)[19] could be explained due to the shortage of ICU beds in the study setting.[18] Moreover, the very high percentage of women dying without ICU admission reaffirms the limited number of ICU beds in the study setting. There is greater demand for ICU at our tertiary hospital from nonobstetric cases and referrals from large catchment area. Presumably, an ICU dedicated to maternity unit alone would have done a greater good. In line with this, an urgent need to the expansion of ICU services in all the primary

Table 7. Process and outcome indicators related with specific conditions, ACSH, 1 July 2018–30 June 2019.

Indicators	N	%
1. Prevention of PPH		
Target population: women giving birth in health care facilities	575	85.2
Oxytocin use	490	85.2
Use of any uterotonic (including oxytocin)	528	91.8
2. Treatment of severe PPH		
Target population: women with severe PPH	166	100
Oxytocin use	147	88.6
Ergometrine	8	4.8
Misoprostol	144	86.7
Any of the above uterotonics	166	100
Tranexamic acid	0	0
Removal of retained products	44	26.5
Hysterectomy	27	16.3
Proportion of cases with SMO	84	50.6
Mortality	3	1.8
3. Anticonvulsants for eclampsia		
Target population: women with eclampsia	46	100
Magnesium sulfate	45	97.8
other anticonvulsant	2	4.3
Any anticonvulsant	46	100
Proportion of cases with SMO	33	71.3
Mortality	5	10.9
4. Prevention of cesarean section-related infection		
Target population: women undergoing cesarean section	235	100
Prophylactic antibiotic during cesarean section	213	90.6
5. Treatment for sepsis		
Target population: women with sepsis	130	100
Parenteral therapeutic antibiotics	120	92.3
Proportion of cases with SMO	29	22.3
Mortality	5	3.8
6. Ruptured uterus (n = 22)		
Target population: women with ruptured uterus	22	100
Laparotomy	22	100
Laparotomy after 3 h of hospital stay	2	9.0
Proportion of cases with SMO	19	86.4
Mortality	1	4.5
7. Preterm birth (n = 119)		
Target population: women having a preterm delivery after 3 h of hospital stay	106	89.1
Corticosteroids for fetal lung maturation	62	58.5
Early neonatal mortality	34	32.4

ACSH: Ayder Comprehensive Specialized Hospital; PPH: postpartum hemorrhage; SMO: severe maternal outcome.

and general hospitals exists. This will avoid a possible irreversible damage that sick mothers sustain due to a risky long referral line augmented with a broken referral support system.[18]

Strengths of the study

To offset deficiencies and limitations of retrospective data collection from hospital records, data were prospectively collected.

Limitations of the study

This study was conducted in a teaching hospital. As critically ill obstetric patients are referred to such hospitals, the rates of maternal morbidity and mortality in this high-risk population may not reflect maternal health status in the general population. In addition, we used the "modified WHO near-miss criteria" developed by Nelissen et al. instead of the original criteria. This should be taken into consideration when interpreting results from this study. With more comprehensive MNM tools, such as adapted

sub-Saharan MNM criteria for low-resource setting by Tura et al.[47] coming into light, caution should be exercised on which model to select for interpretation and comparisons of similar future studies. Furthermore, certain parameters mentioned in the WHO near-miss criteria, such as pH, serum lactate level and PaO_2/FiO_2, were not used due to setup limitation.

Conclusion

In this study, the top underlying causes of SMC were the infamous triads of hypertension, hemorrhage and sepsis. The high MI in mothers with underlying medical and surgical diseases underscores the importance of multidisciplinary approach in handling such mothers. As a significant number of women are dying without ICU admission, the importance of ICU expansion cannot be overemphasized. A high neonatal mortality rate (NMR) with low corticosteroid administration noted in this study is also an important loophole to close. In conclusion, ACSH, Tigray regional health bureau and other relevant stakeholders should forge collaboration to plan the necessary program, make appropriate policies and dispose necessary resources to standardize the care of women with these conditions.

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Author contribution(s)

Hale Teka: Conceptualization; Data curation; Formal analysis; Funding acquisition; Investigation; Methodology; Project administration; Resources; Supervision; Writing – original draft; Writing – review & editing.
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Availability of data and materials

The datasets used for this research can be accessed from the primary author upon request.

Supplemental material

Supplemental material for this article is available online.

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