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## CLINICAL ARTICLE

## Assessment of maternal near-miss and quality of care in a hospital-based study in Accra, Ghana

Özge Tunçalp<sup>a,\*</sup>, Michelle J. Hindin<sup>a</sup>, Kwame Adu-Bonsaffoh<sup>b</sup>, Richard M. Adanu<sup>c</sup><sup>a</sup> Department of Population, Family and Reproductive Health, Johns Hopkins Bloomberg School of Public Health, Baltimore, USA<sup>b</sup> Department of Obstetrics and Gynaecology, Korle-Bu Teaching Hospital, College of Health Sciences, University of Ghana Medical School, Accra, Ghana<sup>c</sup> School of Public Health, University of Ghana, Accra, Ghana

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## ABSTRACT

**Objective:** To assess the baseline incidence of maternal near-miss, process indicators related to facility access, and quality of care at a tertiary care facility in urban Ghana. **Methods:** A prospective observational study of all women delivering at the facility, including those with pregnancy-related complications, was conducted between October 2010 and March 2011. Quality of maternal health care was assessed via a newly developed WHO instrument based on near-miss criteria and criterion-based clinical audit methodology. **Results:** Among 3438 women, 516 had potentially life-threatening conditions and 131 had severe maternal outcomes (94 near-miss cases and 37 maternal deaths). More than half (64.4%) of the women had been referred to the facility. The incidence of maternal near-miss was 28.6 cases per 1000 live births. Anemia contributed to most cases with a severe maternal outcome. More than half of all women with severe maternal outcomes developed organ dysfunction or died within the first 12 hours of hospital admission. Although preventive measures were prevalent, treatment-related indicators showed mixed results. **Conclusion:** The WHO near-miss approach was found to represent a feasible strategy in low-resource countries. Improving referral systems, effective use of critical care, and evidence-based interventions can potentially reduce severe maternal outcomes.

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## 1. Introduction

The concept of “maternal near-miss,” indicating very severe maternal morbidity, has evolved during the past 2 decades. Until recently, the definition of and identification criteria for maternal near-miss varied considerably [1]. In 2009, a WHO Working Group defined maternal near-miss morbidity as “a woman who nearly died but survived a complication that occurred during pregnancy, childbirth, or within 42 days of termination of pregnancy” [2]. This definition has been used to develop an instrument for assisting facilities specifically and health systems broadly to evaluate and improve the quality of care [3]. The identification criteria focus on the severest cases—that is, women presenting with organ dysfunction—thereby striking a practical balance between the burden of data collection and the provision of valuable information [2].

Ghana is situated in West Africa and, according to recent estimates, its maternal mortality ratio is 350 per 100 000 live births; this value is in line with its neighbors, and lower than the overall value for Sub-Saharan Africa, which is 500 per 100 000 live births [4]. Nationally, 57% of births occur in health facilities, and 59% are assisted by skilled health providers. In the Greater Accra region, more than 80% of deliveries occur in a health facility [5].

The aim of the present study was to assess the incidence of near-miss and related indicators at a tertiary care facility in urban Ghana. Quality of maternal healthcare was assessed by means of a newly developed WHO instrument based on new near-miss criteria and criterion-based clinical audit methodology.

## 2. Materials and methods

In a prospective study at the Department of Obstetrics and Gynecology, Korle-Bu Teaching Hospital (KBTH), University of Ghana, data from pregnant women admitted for delivery and from women with pregnancy-related complications who were experiencing severe morbidity between October 18, 2010, and March 14, 2011, were collected as part of a mixed method study to evaluate the quality of maternal care in the facility [6]. KBTH is the largest teaching hospital in Ghana; it is a tertiary referral center with approximately 10 000 deliveries per year and has a general intensive care unit (ICU) available to obstetric patients in need. The study protocol was approved by the Institutional Review Boards at the Johns Hopkins School of Public Health and University of Ghana Medical School College of Health Sciences. Because there was no contact with the patients, quantitative part of the study was exempt from informed consent procedures.

The study population included all women delivering at the facility, including those with pregnancy-related complications. Eligibility for the study was not restricted by gestational age; therefore, women having

\* Corresponding author at: 615 N Wolfe Street, Baltimore, MD 21205, USA. Tel.: +1 410 614 6676; fax: +1 410 9552303.

E-mail address: otuncalp@jhsph.edu (Ö. Tunçalp).

abortions or ectopic pregnancies who met the criteria were included [3]. Women who developed complications 42 days after termination of pregnancy were not eligible [3]. We also collected information on maternal deaths occurring at the facility during the study period.

Because there had been no prior studies using the WHO criteria in Sub-Saharan Africa when the study was being planned, sample sizes were calculated for different hypothetical near-miss prevalence rates of 0.75, 1.50, and 3 per 100 deliveries. On the basis of a minimum number of 40 near-miss cases at an expected prevalence of 1.5 per 100 deliveries (given the tertiary nature of the facility, a higher number severe maternal outcomes were expected), data from 3390 deliveries were needed [3].

The WHO maternal near-miss surveillance and assessment tool was modified to include more detailed data on background characteristics [3]. In addition to the near-miss criteria, the tool also includes the assessment of care provided via criterion-based clinical audit methodology, which identifies a target population with a clear indication for an effective intervention and assesses whether the standards of care have been met [7,8] (Fig. 1).

Information on demographic characteristics, maternal and perinatal information, process indicators, and near-miss screening were abstracted from patient files daily on the maternity wards and twice a week on the gynecology ward. The data were entered into an electronic data entry platform (EpiData, Odense, Denmark) every day and shared with the study primary investigators every week. On-site data quality checks were conducted daily.

Identifying potential near-miss cases was a 2-step process involving chart reviews, which were supplemented by information from the healthcare providers when needed. Women with potentially life-threatening conditions were identified on the basis of whether they had any severe complication (severe postpartum hemorrhage [PPH], severe pre-eclampsia, eclampsia, sepsis or severe systemic infection, or ruptured uterus). The following interventions were recorded: administration of blood products, requirement for a laparotomy excluding cesarean delivery, and admission to the ICU or more than 6 hours spent in recovery. Among these women, near-miss cases were identified by the diagnosis of organ system dysfunction based on clinical criteria, laboratory markers, and/or management-based proxies (Box 1). The definitions of the measures used in the study are given in Box 2.

In line with the WHO maternal near-miss tool, women were classified by whether severe maternal outcomes occurred after 12 hours or within 12 hours of hospital admission; the former indicates the quality of care that they received within the facility [3]. Data were also collected on the coverage of interventions used for the prevention and treatment

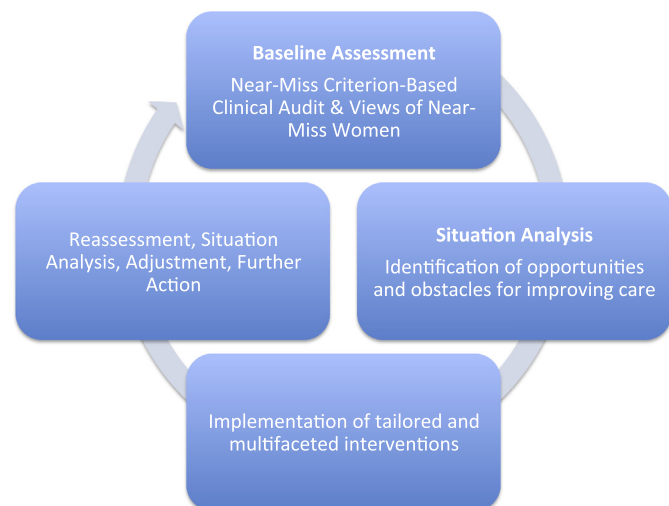


Fig. 1. Surveillance and assessment of maternal near-miss morbidity.

### Box 1

Criteria to identify potentially life-threatening conditions and maternal near-miss.<sup>a</sup>

#### Potentially life-threatening conditions

##### Severe complications

1. Severe postpartum hemorrhage. Genital bleeding after delivery with at least 1 of the following: perceived abnormal bleeding ( $\geq 1000$  mL) or any bleeding with hypotension or blood transfusion.
2. Severe pre-eclampsia. Persistent systolic blood pressure of 160 mm Hg or more or a diastolic blood pressure of 110 mm Hg; proteinuria of 5 g or more in 24 hours; oliguria of less than 400 mL in 24 hours; and HELLP syndrome or pulmonary edema. Excludes eclampsia.
3. Eclampsia. Generalized fits in a patient without a previous history of epilepsy. Includes coma in pre-eclampsia.
4. Sepsis or severe systemic infection: presence of fever (body temperature  $>38$  °C), confirmed or suspected infection (e.g. chorioamnionitis, septic abortion, endometritis, pneumonia), and at least 1 of the following: heart rate higher than 100 bpm, respiratory rate higher than 20 bpm, leukopenia (white blood cells  $<4000$ ), and leukocytosis (white blood cells  $>12\,000$ ).
5. Ruptured uterus. Ruptured uterus during labor.

##### Critical interventions

1. Use of blood products.
2. Laparotomy (including hysterectomy, excluding cesarean delivery).
3. Admission to intensive care unit or recovery room for 6 hours or more.

##### Near-miss criteria

##### Clinical organ dysfunction

1. Acute cyanosis.
2. Gasping.
3. Respiratory rate higher than 40 or lower than 6 bpm.
4. Shock.
5. Cardiac arrest.
6. Oliguria non-responsive to fluids or diuretics.
7. Any loss of consciousness lasting for more than 12 hours.
8. Stroke.
9. Uncontrollable fit or status epilepticus.
10. Global paralysis.
11. Jaundice in the presence of pre-eclampsia.

##### Laboratory markers of organ dysfunction

12. O<sub>2</sub> saturation less than 90% for more than 60 min.
13. PaO<sub>2</sub>/FiO<sub>2</sub> less than 200 mm Hg.
14. Creatinine more than 300  $\mu\text{mol/mL}$  or more than 3.5 mg/dL.
15. Bilirubin more than 100  $\mu\text{mol/L}$  or more than 6.0 mg/dL.
16. pH less than 7.1
17. Lactate more than 5 mEq/L.
18. Acute thrombocytopenia ( $<50\,000$  platelets).

##### Management-based proxies

19. Hysterectomy after infection or hemorrhage.
20. Use of continuous vasoactive drugs.
21. Cardio-pulmonary resuscitation.
22. Dialysis for acute renal failure.
23. Any non-anesthetic intubation or ventilation.
24. Transfusion of more than 5 units of blood or red cells.

<sup>a</sup> Terminology taken from Ref. [3].

**Box 2****Maternal near-miss indicators and terminology.<sup>a</sup>**

**Maternal near-miss (MNM):** A woman who nearly dies but survives a complication that occurs during pregnancy or 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.

**Live birth (LB):** The birth of an offspring, which breathes or shows evidence of life.

**Severe maternal outcome:** The sum of maternal near-miss cases and maternal deaths, synonymous with life-threatening conditions.

**Women with life-threatening conditions (WLTC):** All women who either qualify as having maternal near-miss or who die. Synonymous with severe maternal outcomes, it is the sum of maternal near-miss cases and maternal deaths.

**Maternal near-miss ratio (MNMR):** The number of maternal near-miss cases per 1000 live births.

**Severe maternal outcome ratio (SMOR):** The number of women with life-threatening conditions per 1000 live births. This indicator estimates the amount of care and resources needed in a facility or a region.

**Maternal near-miss mortality ratio:** The ratio between maternal near-miss cases and maternal deaths. Higher ratios indicate better care, because they signify a smaller number of maternal deaths relative to maternal near-miss cases.

**Mortality index:** The number of maternal deaths divided by the number of women with life-threatening conditions, expressed as a percentage. Higher indices signify low quality of care because more women with life-threatening conditions die, whereas lower indices signify better quality of care because fewer women with life-threatening conditions die.

<sup>a</sup> Terminology taken from Ref. [3].

of the main causes of maternal near-miss and death: that is, prevention and treatment of PPH, treatment of eclampsia, and prophylaxis for and treatment of infection or sepsis [3].

Exploratory data analysis was conducted to examine frequencies, distributions, and missing data. Stata version 12 (StataCorp, College Station, TX, USA) was used for descriptive analyses of background characteristics, maternal near-miss indicators, and process indicators in order to evaluate the baseline situation and to assess the quality of maternal healthcare. The results are presented in accordance with the WHO maternal near-miss approach [3].

**3. Results**

During the 5-month data collection period, there were 3206 live births, 328 stillbirths, 516 women with potentially life-threatening conditions, and 131 severe maternal outcomes (94 near-miss cases and 37 maternal deaths). Overall, data were recorded for 3438 women and 3379 deliveries, which captured approximately 88% of the total obstetric population (3842 deliveries) during the study period. More than half (64.4%) of all women had been referred to the facility.

Severe morbidity cases were identified according to 3 broad categories: severe complications, critical interventions, and organ dysfunction (Table 1). The most common complication among cases of potentially life-threatening conditions, near-miss, and maternal death were severe pre-eclampsia (41.5%), severe PPH (45.7%), and sepsis (45.9%), respectively. The most common critical intervention was administration of blood products (57.6%), followed by laparotomy (12.6%). Among near-miss cases, coagulation or hematologic dysfunction was the most frequently identified problem (63.8%), whereas cardiovascular dysfunction was the most common among maternal deaths (43.2%).

**Table 1**

Morbidity conditions among women with potentially life-threatening conditions, and among cases of near-miss, and maternal death.

Morbidity conditions	Number (percentage) of women
Women with potentially life-threatening conditions (n = 516) <sup>a</sup>	
Severe complications	294 (57.0)
Severe postpartum hemorrhage	69 (13.4)
Severe pre-eclampsia	214 (41.5)
Eclampsia	26 (5.0)
Sepsis or severe systemic infection	10 (1.9)
Ruptured uterus	3 (0.6)
Women undergoing critical interventions	313 (60.7)
Use of blood products	297 (57.6)
Laparotomy	65 (12.6)
Admission to intensive care unit/recovery room for 6 h or longer	8 (1.5)
Maternal near-miss cases (n = 94)	
Organ dysfunction	94 (100)
Cardiovascular dysfunction	28 (29.8)
Respiratory dysfunction	3 (3.2)
Renal dysfunction	7 (7.4)
Coagulation/hematologic dysfunction	60 (63.8)
Hepatic dysfunction	3 (3.2)
Neurologic dysfunction	1 (1.1)
Uterine dysfunction/hysterectomy	18 (19.1)
Multiple organ dysfunction	26 (27.6)
Maternal deaths (n = 37)	
Organ dysfunction	37 (100)
Cardiovascular dysfunction	16 (43.2)
Respiratory dysfunction	9 (24.3)
Renal dysfunction	12 (32.4)
Coagulation/hematologic dysfunction	7 (18.9)
Hepatic dysfunction	2 (5.4)
Neurologic dysfunction	6 (16.2)
Uterine dysfunction/hysterectomy	4 (10.8)
Unspecified organ dysfunction	2 (5.4)
Multiple organ dysfunction	19 (51.3)

<sup>a</sup> Includes women with severe complications and/or undergoing critical interventions.

Table 2 shows the conditions that contributed to severe morbidity, near-miss, and death. Anemia contributed to most cases of maternal near-miss and death (70.2% and 51.3%, respectively). HIV infection was a contributing factor in 8.1% of maternal deaths, but only in approximately 1% of cases of severe morbidity and near-miss. Sickle cell anemia, a common disease in the region, contributed to 21.6% of maternal deaths [9]. The overall prevalence of cesarean among all of the deliveries (excluding ectopic pregnancy and abortion cases) was 33.2%, although it was higher than 40% among women with potentially life-threatening conditions and severe maternal outcomes (Table 3).

The maternal mortality ratio at the facility was 1154 per 100 000 live births. Severe maternal outcomes and near-miss indicators based on the number of live births are given in Table 4. The severe maternal outcome ratio and maternal near-miss incidence ratio was, respectively, 40.8 and 28.6 per 1000 live births.

Among the 131 cases of near-miss or maternal death, 73 women (55.7%) developed organ dysfunction or died within the first 12 hours

**Table 2**

Contributory causes and/or associated conditions among women with potentially life-threatening conditions, near-miss cases, and maternal deaths.<sup>a</sup>

	Women with potentially life-threatening conditions (n = 516)	Maternal near-miss cases (n = 94)	Maternal deaths (n = 37)
Anemia	208 (40.3)	66 (70.2)	19 (51.3)
HIV infection	6 (1.2)	1 (1.1)	3 (8.1)
Previous cesarean delivery	72 (13.9)	16 (17.0)	3 (8.1)
Prolonged/obstructed labor	19 (3.7)	4 (4.3)	0 (0)
Sickle cell anemia	42 (8.1)	11 (11.7)	8 (21.6)

<sup>a</sup> Values are given as number (percentage).

**Table 3**  
Pregnancy outcome stratified by severity of maternal morbidity.<sup>a</sup>

Outcome	No severe complications	Potentially life-threatening conditions	Maternal near-miss cases	Maternal deaths	All women
Total no. of women	2791 (100)	512 (100)	91 (100)	21 (100)	3411 (100)
Vaginal delivery	1877 (67.3)	176 (34.4)	32 (35.2)	6 (28.6)	2091 (61.3)
Cesarean delivery	828 (29.7)	254 (49.6)	42 (46.1)	9 (42.9)	1133 (33.2)
Complete abortion, curettage, or vacuum aspiration	81 (2.9)	18 (3.5)	4 (4.4)	5 (23.8)	108 (3.2)
Laparotomy for ectopic pregnancy	1 (0.04)	64 (12.5)	13 (14.3)	1 (4.8)	79 (2.3)

<sup>a</sup> Values are given as number (percentage).

of hospital admission. Approximately 80% of these women had been referred from other facilities (Table 4). The mortality index was 16.4% in the first 12 hours of hospital admission, and 41.1% after 12 hours. The rate of ICU admission was 1.0% among all women, compared with 19.1% among women with severe maternal outcomes (near-miss and maternal deaths) and 24.3% among those who died.

Table 5 shows the use of interventions for the prevention and treatment of major maternal complications. Nearly all women (96.9%) received oxytocin for the prevention of PPH, whereas only 62.0% of women with severe PPH received oxytocin as a treatment agent. Almost all women with eclampsia (97.1%) received magnesium sulfate. Although antibiotics were administered to 96.9% of all women who had a cesarean delivery, only 40.6% of women with sepsis received parenteral antibiotics.

#### 4. Discussion

The high maternal near-miss ratio observed in the present study indicates the frequent occurrence of near-miss in this population. The high intra-hospital mortality index among near-miss cases suggests that the quality of care provided to women with severe morbidity needs to

be further reviewed in terms of the clinical management of these women. The major causes of potentially life-threatening conditions and near-miss cases were hypertension and obstetric hemorrhage—findings that are comparable to those of other studies in low-resource countries [10,11]. Anemia was associated with more than 50% of severe maternal outcomes; this proportion is higher than the value of 34% reported in a recent study of the general obstetric population in Accra [12]. It should be noted that anemia in the present population was diagnosed at any time during pregnancy, was identified regardless of severity, and excluded sickle cell anemia.

When analyzing access to care, it is essential to separate the near-miss cases on arrival from those that develop in the hospital. Near-miss cases on arrival suggest a failure in access to facilities and/or a failure of the referral system [13]. In the present study, 80% of the patients with a severe maternal outcome in the first 12 hours had been referred

**Table 4**  
Severe maternal outcomes, near-miss indicators, and facility-related indicators.

Maternal outcomes and indicators <sup>a</sup>	Value
Cases of SMO	131
Cases of maternal death	37
Cases of maternal near-miss	94
Overall near-miss indicators	
Severe maternal outcome ratio (per 1000 live births)	40.8 <sup>b</sup>
Maternal near-miss incidence ratio (per 1000 live births)	28.6 <sup>b</sup>
Maternal near-miss mortality ratio	2.5:1
Mortality index	28.2
Hospital access indicators <sup>c</sup>	
Cases of organ dysfunction or maternal death within 12 h of hospital stay	73
Percentage of cases of organ dysfunction or maternal death within 12 h of hospital stay among all SMO cases	55.7
Percentage of cases of organ dysfunction or maternal death within 12 h of hospital stay among admissions from other health facilities	79.5
Mortality index for cases of organ dysfunction or maternal death within 12 h of hospital stay	16.4
Intra-hospital care	
Intra-hospital SMO cases of organ dysfunction or maternal death after 12 h of hospital stay	56
Rate of intra-hospital SMO (per 1000 live births)	17.5
Intra-hospital mortality index	41.1
Intensive care use <sup>d</sup>	
Percentage of ICU admission	1.0
Percentage of ICU admission among women with SMO	19.1
Percentage of SMO among women admitted to ICU	75.8
Percentage of maternal deaths assisted without ICU admission	75.7

Abbreviations: ICU, intensive care unit; SMO, severe maternal outcome.

<sup>a</sup> Based on data from all women (n = 3438).

<sup>b</sup> On the basis of formative research at the facility, ICU admission also included women who stayed in the recovery room on the labor ward for longer than 6 h.

<sup>c</sup> The denominator for these 2 indicators is 'live births' (n = 3206).

<sup>d</sup> For 2 women, data on arrival times were missing and were excluded from the access indicators.

**Table 5**  
Use of interventions for prevention and treatment of major obstetric complications.

Interventions	Number (percentage) of women
Prevention of PPH	
Target population: women giving birth in health facilities	3379 (100)
Oxytocin	3263 (96.6)
Treatment of severe PPH <sup>a</sup>	
Target population: women with severe PPH	121 (100)
Oxytocin	75 (62.0)
Ergometrine	34 (28.1)
Misoprostol	59 (48.7)
Other uterotonics	1 (0.83)
Any uterotonics	81 (66.9)
Tranexamic acid	5 (4.13)
Removal of retained products	25 (20.7)
Balloon or condom tamponade	1 (0.83)
Artery ligation	0 (0)
Hysterectomy	18 (14.9)
Abdominal packing	1 (0.83)
Cases with SMO	52 (43.0)
Mortality	9 (7.4)
Anticonvulsants for eclampsia	
Target population: women with eclampsia	34 (100)
Magnesium sulfate	33 (97.1)
Other anticonvulsant	–
Cases with SMO	8 (23.5)
Mortality	4 (11.7)
Prevention of cesarean-related infection	
Target population: women undergoing cesarean	1133 (100)
Prophylactic antibiotic during cesarean	1054 (96.9)
Treatment for sepsis	
Target population: women with sepsis	32 (100)
Parenteral therapeutic antibiotics	13 (40.6)
Cases with SMO	22 (68.7)
Mortality	17 (53.1)
Ruptured uterus	
Target population: women with ruptured uterus	7 (100)
Laparotomy after 3 h of hospital stay	6 (85.7)
Cases with SMO	4 (57.1)
Mortality	0 (0)

Abbreviations: PPH, postpartum hemorrhage; SMO, severe maternal outcome.

<sup>a</sup> Women might have received more than 1 treatment for PPH.

from other facilities. These women constituted 56% of the overall severe maternal outcomes. These results highlight a number of potential intervention points, such as delays in reaching the hospital either because the referral chain from the community to different levels of facility is failing or because the woman and her caretakers are late in deciding to seek care. Given the high rate of both prenatal care attendance and facility delivery in the Greater Accra region [5], the former explanation seems more likely. It is also worth noting that, within the referral chain, access to the correct treatment on arrival might also have been delayed by the lower level facilities attended before reaching the tertiary care site. These results underline the persistent role of delays in severe maternal morbidity and mortality, especially in low-resource countries where maternal mortality ratios remain unacceptably high.

The data show that 44% of near-miss cases developed in the hospital. The near-miss cases in the hospital may be partly explained by the limited use of evidence-based interventions. The use of uterotonic drugs to prevent PPH was high; however, only 62% of women who developed PPH received oxytocin. Similarly, use of prophylactic antibiotics for cesarean delivery was high; however, only 41% of women with sepsis received parenteral treatment, and 1 in 2 women with sepsis died. The high patient load at the facility might be negatively influencing the quality of care. Although maternal care is free in Ghana, in many instances families need to purchase the necessary medications themselves [14]; this might disrupt care, especially when parenteral antibiotics are needed. These results show how, by providing aggregate data, criterion-based clinical audit methodology improves on case-by-case analysis.

Moving forward, there is a need for improvement in case management either by implementing guidelines or by conducting refresher training for hospital staff. In addition, given the high occurrence of pre-eclampsia within the study population, management indicators specific to this condition might be integrated.

Research shows that adequate provision of critical care, along with appropriate staffing, equipment, and management strategies, can improve the outcomes for women with life-threatening conditions [15]. Although access to ICU depends on facility protocols and availability, the substantial proportion of study women who experienced severe maternal outcomes without access to ICU care indicates a shortage of ICU beds and care in general. Of note, on the basis of the formative research, ICU admission also included women who stayed in the recovery room on the labor ward for more than 6 hours.

Currently, criterion-based clinical audits are being evaluated for their potential use in strategies to reduce both maternal near-miss and maternal mortality [3,7,8]. Although middle- and upper-income countries use audits widely to improve obstetric care, such audits in resource-poor settings—where “healthcare staff themselves identify and analyze deficiencies and apply the findings to improve their care practices”—are limited but increasing in number [16–18]. Audits by themselves or in conjunction with other interventions on severe maternal morbidity are being conducted with positive results in Sub-Saharan African countries including Ghana [19–21]. The effective and consistent use of clinical audits, followed by actions to address the identified weaknesses as quality assurance interventions, represents a viable strategy to reduce both maternal near-miss and maternal mortality in low-resource countries. To make long-lasting and effective changes in a facility and/or within a health system, however, it will be paramount to follow-up the actions and maternal health outcomes after an audit [22].

The study has several strengths. It has assessed the quality of care in a Ghanaian facility using the new WHO maternal near-miss criteria and approach. Formative research was conducted before the study to inform the design, data collection procedures, and tools; and there was further collaboration with the clinical and research staff to prepare for and conduct the study. By building relationships and creating interest and a supportive environment among senior level clinicians and management through this process, it was hoped to increase the likelihood of a long-lasting mechanism for surveillance and quality

improvement in the hospital, which might also diffuse to other facilities in the region.

In terms of limitations, the present study is a baseline assessment and situation analysis in a referral facility without a follow-up; therefore, it is descriptive in nature. Even though every effort was made to have complete information on each woman, including requesting more information from the attending obstetrician when necessary, the quality of medical records was an issue for some women. Notably, almost all of the maternal near-miss cases were identified via clinical criteria and management-based proxies rather than via laboratory markers. Although laboratory testing was available, often the markers were not requested on time or at all owing to the urgency of the management of these women. This observation should be taken into consideration in future studies using these criteria because it might lead to underestimation of the near-miss ratio.

As a tool to improve quality of care in facilities, the WHO near-miss approach has the potential to function as a catalyst for both strengthening the health system and improving the delivery experiences and outcomes of women. The present study indicates that, with sufficient training of the clinicians and research assistants within the facility, it is feasible to identify and collect data on near-miss cases and their management via this approach. The results suggest that improving referral systems and effective use of critical care and evidence-based interventions can potentially reduce severe maternal outcomes among the present population and improve the care in a facility with a high burden of complicated cases. They also underline the fact that, as facility deliveries are being encouraged to reduce maternal mortality, it is paramount to ensure that the health systems are ready to provide integrated continuous quality care—both routine and emergency—for women during and after pregnancy [23].

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## Conflict of interest

The authors have no conflicts of interest.

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