The WHO maternal near miss approach: consequences at Malawian district level

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Abstract

Introduction
WHO proposes a set of organ-failure based criteria for maternal near miss. Our objective was to evaluate what implementation of these criteria would mean for the analysis of a cohort of 386 women in Thyolo District, Malawi, who sustained severe acute maternal morbidity according to disease-based criteria.

Methods and Findings
A WHO Maternal Near Miss (MNM) Tool, that was created to compare disease-, intervention- and organ-failure based criteria for maternal near miss, was completed for each woman, based on a review of all available medical records.

Using disease-based criteria developed for the local setting, 341 (88%) of the 386 women fulfilled the WHO disease-based criteria provided by the WHO MNM Tool, 179 (46%) fulfilled the intervention-based criteria, and only 85 (22%) the suggested organ-failure based criteria.

Conclusions
Application of these organ-failure based criteria, which require relatively sophisticated laboratory and clinical monitoring, underestimates the occurrence of maternal near miss in low resource settings. Therefore, these organ-failure based criteria are not appropriate for use in low resource settings and the suggested WHO approach is not suited to compare maternal near miss across settings.
Introduction

Maternal mortality remains one of the major public health problems of our time and poor quality of obstetric services continues to be an important associated factor.\(^1\) In order to identify and correct deficiencies in health care delivery, maternal mortality audits are performed in many health facilities throughout the world.\(^2\) However, the absolute number of maternal deaths occurring at the level of health facilities is often low. Therefore, case reviews are increasingly directed at women who survived a serious health condition during pregnancy and childbirth, in addition to women who did not.\(^3\) Peer-review of severe morbidity has the added advantage of being potentially less threatening to the morale of participants compared to mortality audit: ‘near misses’ may sometimes be presented as great saves.

A pregnant or recently delivered woman who nearly died from a critical condition is often described as a ‘near miss’ or ‘severe acute maternal morbidity’. The WHO working group on maternal mortality and morbidity classifications (‘the working group’) proposed the term ‘maternal near miss’ (MNM) which can be defined as ‘any woman who nearly died but survived a complication that occurred during pregnancy, childbirth or within 42 days of termination of pregnancy’.\(^4\)

In order to advance the use of the MNM concept and compare near miss estimates across settings and over time, the working group set out to arrive at uniform criteria for the identification of MNM. The choice is between three distinct types of criteria that have been used in the past: (A) clinical criteria related to a specific condition, such as eclampsia or hemorrhage (‘A-criteria’), (B) intervention-specific criteria such as admission into an intensive care unit or the performance of laparotomy (‘B-criteria’), or (C) a set of criteria whereby organ system dysfunction such as shock or renal dysfunction is identified (‘C-criteria’).\(^5\)

According to the working group, the ‘organ-system dysfunction based approach’ is the most promising of the three options and should form the basis for a standardized set of inclusion (type ‘C’) criteria. To ensure the usefulness of this approach in resource-poor settings, markers that can generally only be diagnosed by intensive care monitoring which is usually not available in such settings would need to be supplemented by simpler clinical markers such as gasping, oliguria or jaundice.\(^6\) With the objective of evaluating the implications of an organ-system dysfunction based approach, WHO developed a ‘Maternal Near Miss Tool’ (WHO-MNM Tool) (Annex A).

We sought to examine the implications of applying this tool and the organ-failure based approach to the situation of an under-resourced district in sub-Saharan Africa. In addition, we also wanted to compare the feasibility and appropriateness of applying each of the three suggested types of MNM criteria (disease-, intervention- and organ-specific) in such a setting.
Methods

Setting
Thyolo District is an area that had a population of around 600,000 in 2004, with an adult HIV-prevalence of 21% and a total fertility rate of 5.7. It is located in Southern Malawi, a low-income country in sub-Saharan Africa. Similar to other districts in Malawi and the wider region, the health system is comprised of one large public district hospital and several small peripheral government- and mission-run health facilities. In many districts, non-governmental organizations provide technical and logistic support to the public health system including in Thyolo where Médecins Sans Frontières is present. Care in the public health system is provided free-of-charge.

Participants
A study of maternal mortality and MNM was performed in Thyolo District Hospital over a two-year period from September 2007 to August 2009 (the ‘4M-Study’: study of maternal mortality and maternal morbidity in Thyolo). Forty-six cases of maternal mortality and 340 women with MNM defined according to disease-specific criteria were prospectively identified.

The near miss criteria applied in the ‘4M-study’ were: (1) uterine rupture, defined as the occurrence of clinical symptoms (pain, fetal distress, acute loss of contractions, hemorrhage) or intrauterine fetal death that led to laparotomy, at which the diagnosis was confirmed, or laparotomy for uterine rupture after vaginal birth; to this definition we added rupture confirmed by autopsy or clinical symptoms with a high suspicion of rupture in case of death; (2) eclampsia or severe pre-eclampsia with a maternal indication for termination of pregnancy; (3) major obstetric hemorrhage (including hemorrhage from complicated abortions and ectopic pregnancies), defined as a fulfilled need for transfusion of at least two units of 450 ml of whole blood (we adjusted the commonly cited criterion of four units because of scarcity of blood for transfusion in the local setting) or a hemoglobin level below 6 g/dl measured after vaginal bleeding or an estimated blood loss of more than 1 liter; (4) severe obstetric and non-obstetric peripartum infections, defined as all infections for which intravenous antibiotics or intravenous anti-malarials were prescribed or surgical treatment was performed, as well as neoplasms resulting primarily from HIV-infection (e.g. Kaposi’s sarcoma and HIV-associated lymphoma); (5) any other complication the clinician considered severe, with the qualification ‘severe’ confirmed by at least two senior clinicians (a small rest group that turned out to comprise only 5% of the total number of MNM cases). These criteria derived from similar international studies.

In the 340 women who sustained MNM, 375 MNM diagnoses were made: 119 infections, 119 major obstetric hemorrhages, 75 cases of (severe pre-)eclampsia, 43 uterine ruptures
and 19 other complications. Case fatality rates ranged from 4% in the (pre-)eclampsia group to 16% in the infection group. HIV-infection played a major role, with 30% of MNM cases and 50% of maternal deaths occurring in HIV-positive women. Systematic obstetric audit and feedback took place in the same period, during which a significant reduction of maternal complications was found.

**Intervention**

We revisited the medical records of women included into the 4M-study. Medical records included the admission file, labor graph and antenatal records. Obstacles to correctly complete the WHO-MNM tool were identified by studying inter-assessor variance. This was done by having subsets of cases assessed by five assessors who independently completed an MNM tool for each case within the subset. Differences between the assessors were discussed and consensus was reached upon how to apply the criteria given in the tool. Based on this consensus, a WHO-MNM tool was completed for each woman by two of the authors (TvdA and JL). Correct completion was then verified by a third investigator (JB).

**Data collection and analysis**

From all completed MNM tools the following parameters were collected into Microsoft Excel: inclusion diagnoses (A-, B- and C-criteria groups and individual diagnoses A0-A4, B0-B3, C0-C6, see Annex A), maternal and perinatal mortality, mode of delivery and contributory conditions. The moment of occurrence (before or after hospital arrival) was not of specific interest for this study and therefore not included in the analysis. All parameters were analyzed using SPSS Version 19.0 software package: proportions of each parameter were calculated with the significance level set at 5%.

**Results**

General characteristics of the 386 included women are shown in Table 1.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specified</th>
<th>N</th>
<th>Percentage of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>Maternal</td>
<td>46</td>
<td>11.9</td>
</tr>
<tr>
<td></td>
<td>Perinatal</td>
<td>106</td>
<td>27.5</td>
</tr>
<tr>
<td>Final mode of assisted delivery</td>
<td>Caesarean section</td>
<td>134</td>
<td>34.7</td>
</tr>
<tr>
<td></td>
<td>Vacuum extraction 1</td>
<td>17</td>
<td>4.4</td>
</tr>
<tr>
<td>HIV-positive</td>
<td></td>
<td>120</td>
<td>31.1</td>
</tr>
<tr>
<td>Obstructed labor</td>
<td></td>
<td>81</td>
<td>21.0</td>
</tr>
<tr>
<td>Previous caesarean section</td>
<td></td>
<td>37</td>
<td>9.6</td>
</tr>
</tbody>
</table>

Twenty-three cases were assessed during the inter-assessor comparison. Concordance between different assessors ranged between four out of seven (57%) and eight out of
eight (100%) for A-criteria, between one out of five (20%) and five out of five (100%) for B-criteria, and between zero out of three (0%) and two out of three (67%) for C-criteria.

The most important difficulties to fill in the tools observed by the assessors are shown in Table 2 and the solutions agreed between assessors in Table 3. Assessors agreed unanimously that all of the cases they assessed constituted ‘maternal near miss’ according to the WHO-definition.

**Table 2. Difficulties perceived by assessors.**

1. No A-inclusion criterion for antepartum hemorrhage, despite consensus that all assessed cases of APH constituted MNM.
2. Not clear whether to include convulsions as part of eclampsia under C5 (neurological dysfunction: uncontrollable fits?).
3. Ectopic pregnancies and their complications are not part of the disease-specific (‘A’) criteria.
4. Unclear which infections can be defined as ‘severe systemic infections’ (A3).
5. Unclear whether to include a suspected ruptured uterus under criterion A4 or not.
6. Unclear whether to include uterine repair (in order to spare the uterus) and hysterectomy for uterine rupture under C6 (uterine dysfunction).
7. Not clear whether any caesarean section should be included as laparotomy (B2).
8. Not clear which definition of shock should be used.
9. Unclear what is meant by C5 (hepatic dysfunction): only in the presence of pre-eclampsia?
10. Malaria treatment is not part of the process indicators.
11. Not clear whether blood transfusion as a process indicator should be based on a minimum of units transfused.

**Table 3. Agreed solutions.**

1. Do not include APH-cases under ‘A-criteria’.
2. Do not include convulsions as part of eclampsia under C5, unless they fulfill the criterion ‘uncontrollable fits’ mentioned in the tool: mortality or continued fits despite administration of anticonvulsants.
3. Do not include ectopic pregnancies unless cases strictly fulfill any other criteria.
4. Include all cases for which intravenous antibiotics or intravenous anti-malarials or surgical treatment was used.
5. Include cases of suspected uterine rupture only if they fulfill the definition used in the 4M-study.
6. Do not include repair for uterine rupture under C6, but do include hysterectomy for uterine rupture, since the criterion is explicitly described as ‘hemorrhage or infection leading to hysterectomy’.
7. Do not include caesarean section under B2; only include ‘other’ laparotomies.
8. Use the definitions provided by Say et al.: shock is ‘a persistent severe hypotension, defined as a systolic blood pressure <90mmHg for ≥60 minutes with a pulse rate at least 120 despite aggressive fluid replacement (>2l).
9. Strictly apply definition of hepatic dysfunction as given in MNM tool: only jaundice in presence of pre-eclampsia and severe acute hyperbilirubinemia to be included.
10. Record cases in which malaria treatment was given separately.
11. Include all cases in which any blood transfusion was given, regardless of the amount.

Of all 386 women that had initially been included into the 4M-study, 341 (88%) fulfilled one or more of the WHO disease-specific A-criteria. The remaining 45 cases were: 23 antepartum hemorrhages, six ectopic pregnancies, three abortions complicated by severe hemorrhage, two cases of Kaposi’s Sarcoma, two cases of stroke, two cases of very severe anemia during
pregnancy, two puerperal psychoses, one sudden cardiac arrest, one obstructed labor with necrosis, one burst abdomen post-caesarean, one vaginal tear due to unsafe abortion, and one maternal death with unknown cause.

Of the 386 women, 179 (46%) fulfilled one or more ‘B-criteria’. In total 224 B-events were recorded: 163 cases in which blood transfusion had been given and 61 cases in which laparotomy had been performed. There had been no intensive care admissions or invasive radiological procedures, since neither of these services was available at this facility.

Only 85 women (22%) fulfilled organ failure based C-criteria. In total 90 C-events were recorded. Table 4 shows the number of events recorded in each (sub-) category.

Table 4. Inclusions per (sub-) category in 386 women with 421 critical events

<table>
<thead>
<tr>
<th>Category</th>
<th>Sub-category</th>
<th>N</th>
<th>Percentage of inclusions per category</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: disease</td>
<td>0: PPH</td>
<td>107</td>
<td>27%</td>
</tr>
<tr>
<td></td>
<td>1: Pre-eclampsia</td>
<td>20</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>2: Eclampsia</td>
<td>71</td>
<td>18%</td>
</tr>
<tr>
<td></td>
<td>3: Infection</td>
<td>148</td>
<td>38%</td>
</tr>
<tr>
<td></td>
<td>4: Ruptured uterus</td>
<td>46</td>
<td>12%</td>
</tr>
<tr>
<td>B: intervention</td>
<td>Blood products</td>
<td>163</td>
<td>73%</td>
</tr>
<tr>
<td></td>
<td>1: Interventional radiology</td>
<td>0</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>2: Laparotomy</td>
<td>61</td>
<td>27%</td>
</tr>
<tr>
<td></td>
<td>3: Admission into ICU</td>
<td>0</td>
<td>n/a</td>
</tr>
<tr>
<td>C: organ failure</td>
<td>Cardiovascular</td>
<td>29</td>
<td>32%</td>
</tr>
<tr>
<td></td>
<td>1: Respiratory</td>
<td>14</td>
<td>16%</td>
</tr>
<tr>
<td></td>
<td>2: Renal</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>3: Coagulation/Hematologic</td>
<td>4</td>
<td>4%</td>
</tr>
<tr>
<td></td>
<td>4: Hepatic</td>
<td>13</td>
<td>14%</td>
</tr>
<tr>
<td></td>
<td>5: Neurologic</td>
<td>8</td>
<td>9%</td>
</tr>
<tr>
<td></td>
<td>6: Hysterectomy</td>
<td>21</td>
<td>23%</td>
</tr>
</tbody>
</table>

Discussion

Our findings have several important implications for the approach to finding universal criteria for MNM, especially in resource-poor settings. Firstly, the application of disease-, intervention- and organ failure specific criteria would lead to different proportions of severe acute maternal morbidity being included as maternal near-miss. Disease-specific criteria ‘pick up’ most of the severe morbidities, while organ failure criteria as preferred by WHO would lead to a considerably lower number of ‘near-miss’ cases identified. At district level in a low-resource setting, the absence of sophisticated laboratory diagnostics and the lack of manpower to perform extensive clinical monitoring clearly prevent inclusion of MNM based on C-criteria.
Secondly, the inter-assessor concordance shows that the fulfillment of C-criteria appears to be subject to perceptual differences between assessors, to a larger extent than the fulfillment of A- or B-criteria. This indicates that the use of C-criteria would have to be accompanied by extensive instructions to health workers as to how to apply these criteria in practice.

Thirdly, the B-criteria appear to be relatively straightforward and would lead to inclusion of a considerable proportion of clinical MNM, but these criteria do not allow for a significant differentiation among cases, as only two out of four interventions (blood transfusion and laparotomy) are commonly available at district level in low-income settings. Moreover, those cases that would undoubtedly be considered MNM on clinical grounds but in which neither of these two interventions are performed would not be included as MNM in the WHO Tool. These B-criteria could be relevant in order to identify the severity of some of the conditions classified as A-criteria.

We suggest that the disease-specific A-criteria would be the most convenient MNM criteria in low-resource settings. If antepartum hemorrhage and complications of ectopic pregnancy and abortion would be included under these A-criteria, most of the severe acute morbidity would be included as MNM. We felt that the inclusion of approximately 190 women on a yearly basis, or 16 women per month, made for a manageable workload (9). We also feel that most of the severe morbidity cases based on modified disease-specific criteria would fulfill the definition of MNM given by WHO.

One limitation of our study is that it built on the outcome of a previous study of maternal morbidity and mortality that relied on independent inclusion criteria. These study criteria will account for some underreporting of total maternal morbidity that could be considered MNM. For instance, women who received only one unit for blood transfusion would not have been included into the ‘4M’-study unless major blood loss would have been recorded or a very low hemoglobin would have been measured, and were therefore not included into this present analysis, although they would have fulfilled the WHO B0-criterion. It is likely that, unless the disease-specific criteria for hemorrhage are adjusted to include ‘major’ hemorrhage only, over-representation of hemorrhage as MNM would occur. In addition, our application of the 4M-criterion for the inclusion of severe systemic infection (intravenous medication or surgical treatment) could allow for over-reporting of infections. However, our previous finding that even with this relatively ‘mild’ criterion the case fatality rate for peripartum infections stood at 16% (the highest rate of all different morbidities), we do not think that over-reporting played any role of importance.17 In the study setting, potent intravenous antibiotics are relatively scarce and not as commonly used as in many high-income countries. Therefore, use of this type of medication may be an appropriate indicator for the severity of an infection in low-resource settings.
It must also be noted that the identification of severe maternal morbidity in Thyolo had the specific interest of several staff in the district. Therefore, the results cannot automatically be expected to be similar in other districts. Moreover, since MSF provided some extra laboratory capacity in Thyolo (creatinine- and bilirubin measurements testing, full blood cell counts) some inclusions, particularly in the C-group, may not have happened in districts with less sophisticated readings.

Reaching consensus on universal criteria to compare maternal outcome across time and space may be a useful undertaking, provided that these criteria would not underestimate poor maternal outcomes in those areas where these are expected to be highest. We subscribe to the statement made by the WHO Working Group that the guiding principle for the development of criteria should be that these are ‘feasible for use in any setting regardless of the development status’. To our opinion, based on the findings of this study, the WHO-MNM approach to use these organ failure based criteria does not fulfill this principle.
Reference List


Annex A. WHO Maternal Near Miss Tool

Maternal Near Miss Tool

**Identification**

Facility code: 
Individual identification code: 

**Screening Questions**

In the questions 1 to 4, please specify:
1. The condition was not present during the hospital stay.
2. The condition was present at the time of death or was not evident until 12 hours of hospital stay.
3. Information not available / unknown or not applicable.

1. Severe complications / potentially life-threatening conditions
   - **A1** Severe postpartum hemorrhage
   - **A2** Severe preeclampsia
   - **A3** Septicemia
   - **A4** Uterine rupture

2. Critical interventions or intensive care unit admission
   - **B1** Blood transfusion (includes any blood, platelets or plasma)
   - **B2** Interventional radiology (uterine artery embolization)
   - **B3** Admission to Intensive Care Unit

3. Organ dysfunction / life-threatening conditions
   - **C1** Cardiac dysfunction
   - **C2** Respiratory dysfunction
   - **C3** Renal dysfunction
   - **C4** Hepatic dysfunction
   - **C5** Neurologic dysfunction

4. Maternal death
   - **D1** Death during pregnancy or within 42 days of termination of pregnancy
   - **D2** Death within 42 days of termination of pregnancy

**Please note:**
1. If you answered “Yes” or “No” to any of the questions 1 to 4, go to question 5.
2. If you answered “Yes” to all of the questions 1 to 4, the woman is not eligible for this assessment. Do not answer the questions 5 to 14.
3. If in doubt about the diagnosis, consult an attending physician.
4. In the questions 5 to 14, if information is not available, unknown or not applicable, fill with “NA”.

**Maternal and Perinatal Information**

5. Date of admission
6. Date of delivery or abortion
7. Date of discharge or death

**Individual data collection form**

WHO Maternal Near Miss Tool

*July 2000*

**Process Indicators**

- **A1** Delivery or abortion occurred before or in the hospital facility.
- **A2** Delivery within 3 hours of arrival in the hospital facility.
- **A3** Laporatomy within 3 hours of hospital arrival or in another hospital.
- **A4** Woman referred to any higher maternity hospital.

12. Above the line of interventions, please specify whether the woman received any of the following:

- **B1** Oxytocin
- **B2** Other uterotonic

**Prevention of postpartum hemorrhage**

- **C1** Oxytocin
- **C2** Other uterotonic

**Management of postpartum hemorrhage**

- **D1** Oxytocin
- **D2** Removal of retained products
- **D3** Ergometrine
- **D4** Oxytocin
- **D5** Methyldopa
- **D6** Oxytocin
- **D7** High-dose vitamin C
- **D8** Vitamin B12

**Antenatal care**

- **E1** Magnesium sulfate
- **E2** Other anticonvulsant

**Maternal mortality**

- **F1** Metastatic tumor
- **F2** Others

**Underlying causes of death / near miss**

- **G1** Maternal death
- **G2** Poor antenatal care
- **G3** Pregnancy-related infection
- **G4** Medical conditions
- **G5** Other obstetric complications
- **G6** Unrecognized complications
- **G7** Medical complications
- **G8** Unknown

**Contributory associated conditions**

- **H1** Anemia
- **H2** Hypertension
- **H3** Pregnancy-related complications
- **H4** Other complications

**Date of data collection**

- **d** Date
- **m** Month
- **y** Year

**Data collection:**

Signature: