Implementing the Risk Identification (RI) and Modified Early Obstetric Warning Signs (MEOWS) tool in district hospitals in Rwanda: A cross-sectional study

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Abstract

Background: Despite reaching Millennium Development Goal (MDG) 3, the maternal mortality rate (MMR) is still high in Rwanda. Most deaths occur after transfer of patients with obstetric complications from district hospitals (DHs) to referral hospitals; timely detection and management may improve these outcomes. The RI and MEOWS tool has been designed to predict morbidity and decrease delay of transfer. Our study aimed: 1) to determine if the use of the RI and MEOWS tool is feasible and acceptable in DHs in Rwanda and 2) to determine the role of the RI and MEOWS tool in predicting morbidity.

Methods: A cross-sectional study enrolled parturient admitted to 4 district hospitals during the study period from April to July 2019. Data was collected on compliance rate to RI and MEOWS tool, acceptability, and prediction of morbidity (hemorrhage, infection, and pre-eclampsia).

Results: Among 798 parturient enrolled in this study, the mean age was 20.3 years (Sd=6.8), most of them had insurance (95%), the mean of length of stay was 3.1 days (Sd=2.08), and the morbidity rate was 10.3%. The RI and MEOWS tool compliance rate was 76.3 and acceptability rate among 22 respondents was 90.9%. The RI and MEOWS tool had accuracy of 14.29%, P value <0.001, relative risk of 0.277 42 (0.1718-0.4487), sensitivity of 73.68%, specificity of 93.86%, positive predictive value of 11.57%, and negative predictive value of 41.67%.

Conclusion: RI and MEOWS tool is a feasible and acceptable in the DHs of Rwanda. In addition, having moderate or high scores on the RI and MEOWS tool predict morbidity. After consideration of local context, this tool can be considered for scale up to other district hospitals in Rwanda or other low resources settings.

Background

Although Rwanda reached Millennium Development Goal (MDG) 3 (Promote gender equality and empower women), the maternal mortality rate (MMR) in the country is still high. MMR has been reduced from almost 500 per 100,000 live births in 2010 to approximately 200 per 100,000, but this is still far from the 2030 target of 140 per 100,000 (MOH, 2015). As in many countries, the hospital system in Rwanda includes District Hospitals (DH, about 40) and central Referral Hospitals (RH, 3).
Most maternal deaths occur after transfer of patients with obstetric complications from a DH to a RH (Jackson et al, 2015). This referral system is associated with delays at each level (DH and RH). This suggests that early recognition of patients at high risk of complications might allow earlier transfer before the development of complications and speed up the access to care at higher level by minimizing delays through easy situation awareness, communication, and decision making among teams. For example, studies done in Ireland and Zimbabwe reported an improvement in the time interval between trigger and antibiotic administration, and pre-operative stabilization of women undergoing caesarean section following the implementation of the Early Warning Signs (EWS) tool (Maguire et al, 2015; Merriel et al, 2017).

Multiple effective tools exist to identify parturient at risk, and in other countries have been shown to improve outcomes (Berg et al, 2005; CEMACH, 2007; CMQCC, 2013; NICE, 2015; Main et al, 2017). However, these tools have never been tested in Rwanda, where patient populations and structure of healthcare delivery are quite different from the context of the tool validations.

We therefore wished to determine the effectiveness of one comprehensive tool developed to fit the context of DHs of Rwanda, the RI and Modified Early Obstetric Warning Signs (MEOWS) tool (See table 1) (Berg et al, 2005; CEMACH, 2007; CMQCC, 2013; NICE, 2015; Main et al, 2017). This tool is based on the risk factors of hemorrhage and preeclampsia used by Berger et al, 2005 in California; the risk factors of sepsis used by NICE in 2015, in UK; and regular assessment of 5 physiologic variables: respiratory rate, pulse rate, blood pressure, temperature and mental state (CEMACH, 2007).

Our study had as primary objective to determine if the use of the RI and the MEOWS tool is a feasible and acceptable technique in the setting of DH in Rwanda.

Our secondary goals were to test for association between abnormal RI and MEOWS score and presence of morbidity, and to evaluate the accuracy and the usefulness of the RI and MEOWS tool.

**Methods**

**Aim**

This study aimed to evaluate the feasibility of implementing the risk factors identification and MEOWS tool in the setting of DH in Rwanda.
Setting

This study was conducted in 4 DH referring to the 2 main RH in Rwanda: the Centre Hospitalier Universitaire de Kigali (CHUK) and the Centre Hospitalier Universitaire de Butare (CHUB). The DH in the study were at Nyanza, Kabutare, Muhima, and Kibagabaga. They are located within 1 hour drive to the Referral hospitals and have a large number of deliveries (Table 2). They were selected to provide representative examples of typical DHs in various parts of the country.

Study design

To assess our primary objective, we retrospectively collected clinical data from the time period after tool implementation to assess how often and how completely the tool was actually used. Also, staff were interviewed about acceptability of the tool and ability to incorporate it into their workflow. Appendix 2 provides the questionnaires and lists the data items collected.

To assess our secondary objective, we retrospectively collected clinical data from time periods both before and after tool implementation to test for association between abnormal RI and MEOWS score and presence of morbidity by calculating the relative risk. Also, in order to evaluate the usefulness of the RI and MEOWS tool, we calculated the sensitivity, specificity, the accuracy, positive predictive values, negative predictive values, positive and negative likelihood ratios.

Our patient sample size included all parturient presenting at the hospitals between January 1, 2019 and June 30, 2019.

Intervention

From January to March 2019, the RI and MEOWS tool was adapted to Rwanda context using a modified Delphi method, where a team of 2 anesthesiologists and 2 senior anesthesia residents developed suggested changes to fit the context of DHs in Rwanda. The main changes were related to the availability of laboratory tests, the different healthcare providers, and the structure of the Rwandan referral system (Table 1).

Table 1: The Risk identification (RI) and Modified Early Obstetric Warning Score (MEOWS) tool

| Criteria | High risk | Moderate risk | Low |
|----------|-----------|---------------|-----|
|          |           |               |     |
Hemorrhage

Recognition:
- On admission:
  1. Placenta previa, low lying placenta
  2. Suspected Placenta accreta or percreta
  3. Hematocrit < 30, refusal of transfusion, AND other risk factors:
  4. Platelets < 100,000
  5. Active bleeding (greater than show)
  6. Known coagulopathy

-Evaluate for development of additional risk factors in labor and postpartum:
  • Prolonged 2nd Stage labor
  • Prolonged oxytocin use
  • Active bleeding
  • Chorioamnionitis
  • Magnesium sulfate treatment

-1 or more high risk criteria: High risk of hemorrhage

Response:
- Consider referral if not in labor
- If in labor close monitoring, type and screen, order 2 units of blood, delivery

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Recognition:
- On admission:
  1. Prior cesarean birth(s) or uterine surgery
  2. Multiple gestation
  3. > 4 previous vaginal births
  4. Chorioamnionitis
  5. History of previous PPH
  6. Large uterine fibroids

-Evaluate for development of additional risk factors in labor and postpartum:
  • Prolonged 2nd Stage labor:
  • Prolonged oxytocin use
  • Active bleeding
  • Chorioamnionitis
  • Magnesium sulfate treatment

-1 or more moderate risk criteria: Moderate risk of hemorrhage

Response:
- Consider referral if not in labor (clinical judgment)
- If in labor close monitoring, type and screen

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Recognition:
- On admission:
  1. No previous uterine incision
  2. Singleton pregnancy
  3. < 4 previous vaginal births
  4. No known bleeding disorder

-Evaluate for development of additional risk factors in labor and postpartum:
  • Prolonged 2nd Stage labor:
  • Prolonged oxytocin use:
  • Active bleeding
  • Chorioamnionitis
  • Magnesium sulfate treatment

No moderate or high risk of hemorrhage: Low risk of hemorrhage

Response:
- Standard of care
| Conclusion | screen, book 2 units of blood, delivery |
|------------|---------------------------------------|
| **Preeclampsia/Eclampsia** |
| **Recognition:** | **Recognition:** |
| CNS: | CNS: |
| Awareness: unresponsive | Awareness: Agitated/confused |
| • Drowsy | • Difficulty speaking |
| **Headache: Unrelieved headache** | **Headache:** |
| • Mild headache | • Nausea, vomiting |
| **Vision: Temporary blindness** | **Vision: Blurred or impaired** |
| CVS: | CVS: |
| SBP: ≥160 | SBP: 140-159 |
| DBP: 50-89 | DBP: 50-89 |
| HR: 61-110 | HR: 111-129 |
| Chest pain | Chest pain |
| RS: | RS: |
| RR: <10 or >30 | RR: 25-30 |
| GIT: | GIT: |
| Nausea and vomiting | Nausea and vomiting |
| Abdominal pain | Abdominal pain |
| Renal: u.o in mls: ≤30 (in 2 hrs) | Renal: u.o: 30-49 |
| Proteinuria: | Proteinuria: |
| Not relevant | • > +1, • 300mg/24 hours |
| Platelet: <50 | Platelet: |
| ASAT/ALAT: >70 | ASAT/ALAT: |
## Conclusion

| Parameter | Value |
|-----------|-------|
| Cr        | >1.2  |
| MgSO4 toxicity: Respiration | <12 |

1 or more high risk criteria: High risk of preeclampsia/eclampsia

Response:

Immediate evaluation (ABCDE approach)
- Transfer to higher acuity level
- 1:1 staff ratio
- Labetalol/hydralazine in 30 min
- In-person evaluation
- Magnesium sulfate loading or maintenance infusion
- O2 at 10 L per rebreather mask
- R/O pulmonary edema
- Chest x-ray
- Safe referral to tertiary center

| Parameter | Value |
|-----------|-------|
| Platelet | 50-100 |
| ASAT/ALAT | >70 |
| Cr | 0.9-1.1 |
| MgSO4 toxicity: Depression of patellar reflexes |

1 or more moderate risk criteria: Moderate risk of preeclampsia/eclampsia

Response:

- Notify In charge RN or Midwife
- In-person evaluation
- Order labs/tests
- Anesthesia consult
- Consider magnesium sulfate
- Supplemental oxygen
- Physician should be made aware of worsening or new-onset proteinuria

| Parameter | Value |
|-----------|-------|
| Platelet | 0.9-1.1 |
| ASAT/ALAT | >70 |
| Cr | <0.8 |
| MgSO4 toxicity: DTR +1
- Respiration 16-20 |

No moderate or high risk criteria: of preeclampsia/eclampsia

Response:

Proceed with protocol for normal pregnancy

### Sepsis

Recognition for every woman (on admission):

Risk factors:
1. Gestational diabetes, diabetes or other

Recognition for every woman (on admission):
other comorbidities
2. needed invasive procedure such as caesarean section, forceps delivery, removal of retained products of conception within 6 weeks
3. prolonged rupture of membranes
4. continued vaginal bleeding or an offensive vaginal discharge

Diagnosis criteria
1. CNS: new altered mental state on examination
2. RS: $RR>25$ : -----------
or need of $FiO_2>40\%$ to keep Sat$>92\%$: -----------
3. CVS: $SBP<90\ mmHg$: ------ or $HR>130$: -----------
4. Renal: No urine in 18 hours: -------
or if foley catheter $U.O<0.5\ ml/kg/h$: ---- -------
5. Temperature $>39\degree C$: -----------
6. Skin: Mottled appearance, Cyanosis of skin, lips or tongue, Non-blanching rash of skin: -----------

-1 or more high risk criteria: High risk of comorbidities
2. needed invasive procedure such as caesarean section, forceps delivery, removal of retained products of conception within 6 weeks
3. prolonged rupture of membranes
4. continued vaginal bleeding or an offensive vaginal discharge

Diagnosis criteria
1. CNS: History of new altered mental state: -----------
2. RS: $RR>21-24$ : -----------
3. CVS: $SBP:91-100\ mmHg$: ------or $HR:100-130$: -----------
4. Renal: No urine in 12-18 hours: -----------
or if foley catheter $U.O: 0.5-1\ ml/kg/h$: ------ -------
5. Temperature $<36\degree C$: --------
6. Skin: Signs of potential infection, including redness, swelling or discharge at surgical site or breakdown of wound: --------
Conclusion

Sepsis

Response:
- Immediate review by senior clinical decision maker (ABCDE approach)
- Blood test:
  - Blood gas for glucose and lactate
  - Blood culture
  - Full blood count
  - C-reactive protein
  - Urea and electrolytes
  - Creatinine
  - Clotting screen
- 500 ml bolus every 15 min, repeat up to 3 times, if SBP<90 mmHg give adrenaline 1mg/500 ml NS to keep MAP>65 or SBP>90
- MEOWS
- IV antibiotics within 1h
- Source control within 6 hours, if deep infection refer to a tertiary hospital
- Refer to a tertiary hospital

Moderate risk of sepsis

Response:
- Blood test:
  - Blood gas for glucose and lactate
  - Blood culture
  - Full blood count
  - C-reactive protein
  - Urea and electrolytes
  - Creatinine
  - Clotting screen
- Review by senior clinical decision maker within 1 hour
- IV antibiotics within 1h
- 500 ml bolus every 15 min, repeat up to 3 times
- If no definitive condition identified, repeat structured assessment at least hourly
- MEOWS

No high or moderate risk criteria of sepsis

Response:
- Clinical assessment and manage according to clinical judgement
### 1.2 Modified Early Obstetric Warning Score (MEOWS) tool

| Score | 3 | 2 | 1 | 0 | 1 | 2 | 3 |
|-------|---|---|---|---|---|---|---|
| Temperature | <35°C | 35-37.4°C | 37.5-39°C | >39°C |
| Systolic *BP | ≤70 | 71-79 | 81-89 | 90-139 | 140-149 | 150-159 | ≥ |
| Diastolic *BP | | ≤45 | 46-89 | 90-99 | 100-109 | ≥ |
| Pulse | ≤40 | 40-50 | 51-100 | 101-110 | 111-129 | ≥ |
| Respiratory Rate | ≤8 | 9-14 | 15-20 | 21-29 | ≥ |
| AVPU | Alert | Responds to Voice | Responds to Pain | Ur |
| Urine output mLs/hr | <10 | <30 | Not Measured |

If the pulse rate is higher than the systolic blood pressure then score 2 for ‘Pulse’

**MEOWS** less or equal to 2: Current plan

**MEOWS** =3-5: Repeat observations, Senior midwife to review, Medical review

**MEOWS** high or equal to 6: Inform Coordinator or Senior Midwife, Medical review, Anesthesia review, Referral

From March to June 2019, the research team implemented the RI and MEOWS tool (Table 1). For each
hospital, the research team conducted a 20 min teaching session explaining use of the risk factors identification and MEOWS tool to all maternity staff during the regular morning meeting. In addition, a co-investigator (HI) selected one coach per hospital to ensure the availability of printed forms in each patient’s file and to provide mentorship to all maternity staff as needed. Furthermore, the coach was available to support the data collection team.

Statistical analysis and sample size calculation

Our primary endpoint was the fraction of parturient for which the RI and MEOWS tool was fully completed and number of staff that felt it was acceptable as a tool to include in their workflow. Descriptive statistics were used, we reported frequencies and percentages for categorical data, and mean and standard deviation ranges continuous data.

For the secondary outcomes, we tested for association between abnormal RI and MEOWS score at admission and presence of morbidity at discharge by calculating relative risk for individual scores. All statistical tests, we regarded a value of $p < 0.05$ as statistically significant.

Sensitivity, specificity, positive predictive values, negative predictive values, positive and negative likelihood ratios were calculated for the sample. SPSS version 2013 was used for analysis.

As a similar study done in UK had a sample size of 676 (Singh, 2016). In order to have an adequate sample we recruited patients from 4 district hospitals conducting at least 250 deliveries each month.

Results

Among 798 parturient enrolled in this study, the mean age was 20.3 years (SD=6.8), most of them had insurance (95%), the mean of length of stay was 3.05 days (SD=2.08), and the morbidity rate was 10.3% (Table 2). Among 478 forms used, 363 (75.9%) forms were fully completed, 79 (16.5%) partially completed, and 36 (7.5%) were not completed at all.

When asked about their experience during use of the RI and MEOWS tool, most of the respondents reported that the tool was easy or very easy to use (92%), they were willing to use the tool regularly (90.9%), the tool had improved awareness of patient safety (91.3%), and the tool decreased delay in recognition and management of critically ill obstetric patients (86.4%).

When asked about challenges faced during use of the RI and MEOWS tool, common responses
included that the tool was long, it was difficult to use with a low staff to patient ratio, English language was a barrier, and there was unavailability of printed forms.

The RI and MEOWS tool had accuracy of 14.29%, P value <0.001, relative risk of 0.277 (0, 1718-0, 4487), sensitivity of 68%, specificity of 86%, positive predictive value of 57%, and negative predictive value of 67%.

Table 2: Characteristics of the 4 district hospitals involved in the implementation of the RI and MEOWS study

| Criteria                                      | Nyanza | Kabutare |
|-----------------------------------------------|--------|----------|
| Number of maternity staff                     |        |          |
| Midwifes                                      | 13     | 15       |
| General practitioners                         | 9      | 3        |
| Non physician anaesthetists                  | 4      | 5        |
| Obstetricians                                 | 1      | 0        |
| Paediatricians                                | 2      | 1        |
| Average number of deliveries per month        |        |          |
| Vaginal deliveries                            | 152    | 163      |
| Caesarean sections                            | 133    | 105      |
| Total                                         | 285    | 268      |

The table 2 describes the capacity (number of staff and deliveries) of the 4 district hospitals selected to be included into our study.

Table 3: Patients’ demographics, completeness of the use of the RI and MEOWS tool, and outcome

| Variable           | Number (%)     |
|--------------------|----------------|
| Age (Mean, SD)     | 28.30, 6.38    |
| Gravida (Mean, SD) | 2.58, 1.91     |
| Parity (Mean, SD)  | 1.43, 1.67     |
|                                |                  |
|--------------------------------|------------------|
| ANC (Mean, SD)                 | 2.83, 1.15       |
| Married                        |                  |
| Yes                            | 420 (89.0)       |
| No                             | 52 (11.0)        |
| Insurance                      |                  |
| Yes                            | 450 (95.1)       |
| No                             | 23 (4.9)         |
| Social category                |                  |
| 1                              | 37 (15.7)        |
| 2                              | 82 (34.9)        |
| 3                              | 115 (48.9)       |
| 4                              | 1 (0.4)          |
| District hospital              |                  |
| Kibagabaga                     | 135 (28.2)       |
| Muhima                         | 136 (28.5)       |
| Kabutare                       | 139 (29.1)       |
| Nyanza                         | 65 (13.6)        |
| Tool use                       |                  |
| Completed                      | 363 (75.9)       |
| Partially completed            | 79 (16.5)        |
| Not completed                  | 36 (7.5)         |
| Morbidity                      |                  |
| Yes                            | 49 (10.3)        |
| No                             | 429 (89.7)       |
| Length of stay (Mean, SD)      | 3.05 (2.08)      |
| Outcome                        |                  |
| Referral                       | 11 (2.3)         |
| ICU                            | 7 (1.5)          |
| Demographics          | Number (%)|
|-----------------------|-----------|
| Hospital name         |           |
| Kibagabaga            | 14 (56)   |
| Kabutare              | 11 (44)   |
| Profession            |           |
| Midwife               | 23 (92)   |
| Nurse                 | 2 (8)     |
| Experience            |           |
| < 1                   | 8 (3)     |
| 2-4                   | 9 (3)     |
| 5-7                   | 6 (2)     |
| 8-10                  | 1 (4)     |
| >10                   | 1 (4)     |

Table 4: Respondents’ demographics

Table 5: Respondents’ experience during use of the RI and MEOWS tool
| Questions                                                                                                                                                                                                 | Responses                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| How do you think using the risk factors identification and MEOWS tool within the existing patient file was?                                                                                          | Very difficult                        |
|                                                                                                                                  | 0 (0%)                                 |
| To what extent are you willing to use regularly the Risk identification and MEOWS tool to your facility?                                                                                           | Very resistant                         |
|                                                                                                                                  | 0 (0%)                                 |
| To what extent do you believe use the risk identification and MEOWS tool has improved awareness of patient safety at your health care facility?                                                   | Not at all                             |
|                                                                                                                                  | 0 (0%)                                 |
| To what extent do you believe use of the Risk identification and MEOWS tool has decreased delay in recognition and management of critically ill obstetric patients to your facility? | Not at all                             |
|                                                                                                                                  | 0 (0%)                                 |

Table 6: Comparison of RI and MEOWS tool scores (Moderate/High versus Low) and Morbidity (Yes versus No)
| MEOWS level          | Chi-Square (P value) | RR (95% CI)       | Sensitivity | Specificity |
|----------------------|----------------------|-------------------|-------------|-------------|
| Moderate or High     | < 0.0001             | RR: 0.277 {0, 1718-0, 4487} | 73, 68%     | 93, 86%     |
| Low                  |                      |                   |             |             |

Morbidity: defined as PPH or Preeclampsia or Infections versus, PPV: Positive predictive value, NPV: Negative Predictive Value

Our study found that the RI and MEOWS tool predict morbidity (P< 0.0001) with a sensitivity of 73.68% and specificity of 93.86%.

**Discussion**

The completion of the RI and MEOWS tool by 77% of participants suggests an adequate feasibility.

Our result was consistent with other previous studies although the level of completeness of our study was not as substantial as in other studies like the study done in UK, Ireland, and Zimbabwe that reported an improvement in the frequency of documentation of vital signs, the time interval between trigger and antibiotic administration, and pre-operative stabilization of women undergoing caesarean section following the implementation of the Early Warning Signs (EWS) tool (Cantwell et al, 2008; Maguire et al, 2015; Merriel et al, 2017).

When asked about challenges faced during use of the RI and MEOWS tool, most of the respondents reported that the tool was long, the staff to patient ratio was low, the English language was a barrier, and the printed forms were sometimes unavailable. These are challenges that need to be addressed for a successful implementation of the RI and MEOWS tool (Mhyre et al, 2014; Knight et al, 2014).

There are other challenges to be considered for the successful implementation of the MEOWS tool which have been reported in the literature. These include the lack of multidisciplinary coordination and buy-in, inadequate education about the tool, suboptimal integration within the hospital culture, lack of leadership support, and suboptimal alignment with other quality improvement projects (Friedman et al, 2018).
Our study found that the abnormal RI and MEOWS tool predicted morbidity ($P < 0.0001$) with a high sensitivity of 73.68%, a high specificity of 93.86%, but with a low accuracy of 14.29%, a low positive predictive value of 11.57%, and a low negative predictive value of 41.67%.

These findings are also similar to the results from other multiple studies conducted in different settings. For example, Singh S et al., (2012 and 2016), did 2 studies implementing the MEOWS with more than 1600 patients in total; the results showed a high sensitivity (89%) and (86.4%), high specificity (79%) and (85.2%), an acceptable PPV (39%) and (53.9%), and a high NPV (98%) and (96.9%) for both studies respectively (Singh S et al., 2012), (Singh S et al., 2016).

In addition, the Obstetric EWS tool has been found to be effective in predicting severe morbidity (in general obstetric population) and mortality (in critically ill obstetric patients) (Umar et al, 2019). Furthermore, the implementation of the Obstetric EWS has been found to contribute to improved quality of care, prevent progressive obstetric morbidity and improve health outcomes (Umar et al, 2019). However, there is limited evidence of the effectiveness of the Obstetric EWS in reducing maternal death across all settings (Umar et al, 2019).

There are several limitations to consider while interpreting the results of this study. Firstly, our study was conducted in only 4 district hospitals and the results and conclusions may not be applicable to other hospital settings. These hospitals, however, are representative of the country of Rwanda, and the results of this study could be applied to the remaining hospital systems within this country and similar other countries. Secondly, the sample size was small; the study was not powered to determine a difference in mortality. Some data were missing as they were collected retrospectively; therefore this study was unable to determine the actual difference in interval time from admission to care which would have demonstrated if the use of the MEOWS tool improves the quality of care.

Conclusion
The RI and MEOWS tool is a feasible and acceptable in the DHs of Rwanda. In addition, having moderate or high scores on the RI and MEOWS tool predict morbidity. After consideration of local context, this tool can be considered for scale up to the rest of district hospitals of Rwanda or other low resources settings. Further studies are needed to evaluate the impact of the RI and MEOWS tool on
maternal mortality in low resources settings.

**Abbreviations**

RI and MEOWS Risk Identification and Modified Early Obstetric Warning Signs

MMR  Maternal Mortality Rate

MDG  Millennium Development Goal

UK  United Kingdom

MOH  Ministry of Health

DH  District Hospital

RH  Referral Hospital

CEMACH  Confidential Enquiry into Maternal and Child Health

CMQCC  California Maternal Quality Care Collaborative

NICE  National Institute for Health and Care Excellence

CHUK  University Teaching Hospital of Kigali

CHUK  University Teaching Hospital of Butare

SPSS  Statistical Package for the Social Sciences

WFSA  World Federation Society of Anesthesiologists

**Declarations**

_Ethics approval and consent to participate_

Ethical approval was obtained from the University of Rwanda College of Medicine and Health Sciences Institutional Review Board (Reference number No 157/CMHS IRB/2019). Informed consents were obtained from the maternity staff involved in the study.

_Consent for publication_

Not applicable

_Availability of data and materials_

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

_Competing interests_
The authors declare that they have no competing interests.

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None

**Authors' contributions**

ET and HI led the study design, protocol development, data analysis and manuscript writing. JPM, TT and MD contributed to study design, protocol development and results interpretation. ET and HI led and supervised data collection and led data cleaning. All authors critically reviewed and approved the final manuscript.

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