COLLEGE OF MEDICINE AND HEALTH SCIENCES
SCHOOL OF MEDICINE AND PHARMACY
DEPARTMENT OF ANESTHESIOLOGY, CRITICAL CARE AND EMERGENCY MEDICINE

Implementation of the Risk Factor Identification and the Modified Early Obstetric Warning Signs tools for early detection and management of critically ill Obstetric Patients at 4 District Hospital in Rwanda.

A dissertation submitted as partial fulfillment of the requirement for the award of Degree of Master of Medicine in Anesthesiology.

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DECLARATION

I, Dr. Honorine Ingabire, to the best of my knowledge hereby declare and certify that the work presented in this dissertation entitled "Implementation of the Risk Factor Identification and the Modified Early Obstetric Warning Signs tools for early detection and management of critically ill Obstetric Patients at four District Hospital in Rwanda: a cross-sectional study done in 4 district hospitals during January through July 2019" is entirely my own. It is original work and it has been published at ***BMC Pregnancy and Childbirth https://doi.org/10.1186/s12884-020-03187-1.*** It is submitted to the College of Medicine and Health Sciences in partial fulfillment of the academic requirements for the award of Masters of Medicine in Anesthesiology, University of Rwanda.

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ABSTRACT

Background: The maternal mortality rate remains high in Rwanda and most deaths occur in patients from District Hospitals (DHs) to Referral Hospitals (RHs). Anticipation and timely diagnosis may improve the outcome. The Risk Factor Identification (RI) and Modified Early Obstetric Warning Sign (MEOWS) are easy and effective tools in that regard but have not been evaluated in Rwanda. We evaluated their feasibility in DHs in Rwanda and determined the role of the MEOWS tool in predicting morbidity as defined by RI.

Objectives: 1) To determine the feasibility of RI and MEOWS in DHs in Rwanda.
2) To determine the association between the MEOWS tool and morbidity as defined by RI tool.

Methods: A cross-sectional study was conducted from January to June 2019. Enrolled patients were from 4 district hospitals. For the feasibility we checked the completion rate of the tools. Data was entered into Excel and analyzed with SPSS 23. Prediction for accuracy of MEOWS and RI was calculated.

Results: Among 478 RI and MEOWS forms used, 75.9% forms were fully completed suggesting adequate feasibility. In addition, the MEOWS predicted morbidity with a sensitivity of 28.9%, a specificity of 93.5%, a PPV of 36.1%, a NPV of 91.1%, an accuracy of 86.2%, and a relative risk of 4.1 (95% Confidential Interval (CI), 2.4-7.1). When asked about challenges faced during the 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 the forms were printed in was a barrier, and the printed forms were sometimes not available.

Conclusion: The use of the RI and MEOWS tool is feasible in DHs in Rwanda. In addition, having a moderate or high score on the MEOWS tool predicts morbidity. After consideration of the local context, this tool can be adapted and considered for scale up to other DHs in Rwanda or other low-resource settings.

Keywords: Risk identification, Modified early obstetric warning signs, Early warning system, Morbidity, Quality improvement and Rwanda**.**

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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
CHUB: University Teaching Hospital of Butare
SPSS: Statistical Package for the Social Sciences
WFSA: World Federation Society of Anesthesiologists
CASIEF: Canadian Anesthesiologist Society International Education Foundation
ASAGHO: American Society of Anesthesiology and Global Humanitarian Outreach

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DEDICATION

To my parents: KAMANZI Joseph and UWAMARIYA Speciose.

To my lovely husband: Dr NYANDWI Tharcisse.

To my children: HIRWA Hugo Parfait and IRISA Huguette Parfaite

To my fellow residents

To all anesthesia providers in all teaching hospitals

This work is dedicated.

CHAPTER 1. INTRODUCTION

1.1 Background

Maternal mortality is a worldwide health problem. In 2017, about 295 000 women died during and following pregnancy and childbirth. Of these deaths, 94% were preventable and occurred in low-resource settings. (WHO 2019). Even though the maternal mortality rate in Rwanda did dramatically decrease from 468 per 100 000 live births in 2010 to 210 per 100 000 live births in 2015, this is still far from the target of 140 per 100 000 live births in 2030.

In 2015, at the University Teaching Hospital of Kigali, it was found that the most common causes of maternal near miss and maternal deaths were sepsis (33.9%), postpartum hemorrhage (28.1%), complications of eclampsia and pre-eclampsia (18.2+5,8) %. (Mivumbi et al). The majority of these causes were preventable. There are different tools that have been used in other countries to improve outcomes of critically ill obstetric patients. In the United Kingdom, they found the implementation of the Obstetric Early Warning System prevented bad outcomes of critically ill obstetric patients. These tools have never been used in Rwanda for the detection and management of critically ill obstetric patients. The tools are Risk Identification and Modified Early Obstetric Warning Signs.

The Modified Early Obstetric Warning Signs tool evaluates respiratory rate, heart rate, systolic blood pressure, diastolic blood pressure, level of consciousness, and urinary output. Each vital sign has range of value to be scored, total score can be </= 2, 3-5 and >6, and named low, moderate and high respectively. For Risk Identification, there is a combination of risk factors for sepsis, pre-eclampsia and postpartum where risk may be low, moderate or high for each condition.

1.2 Literature review

Although Rwanda has reached Millennium Development Goal 3, the maternal mortality rate (MMR) remains among the highest in the World. Indeed, MMR in Rwanda has been reduced from nearly 500 per 100,000 live birth in 2010 to approximately 200 per 100,000 in 2015, but that is unacceptable compared to high income countries like United Kingdom where MMR is 7 per 100.000 live birth.

In order to decrease MMR, efforts should be made at all levels, especially in the hospitals close to the community. An early recognition of patients at high risk of complications may allow timely transfers before the development of life-threatening complications. To achieve this, skills like situational awareness, communication, and decision making among health workers on the front-line are needed. Studies conducted in Ireland and Zimbabwe reported an improvement in the time interval between trigger and antibiotic administration, and pre-operative stabilization of women undergoing cesarean section following the implementation of the Early Warning Signs (EWS) tool (Maguire et al,2015; Merriel et al,2017).

Several other effective tools have been used to identify patients at risk, and have shown to improve outcomes in some studies (Berg et al, 2005; CEMACH, 2007; CMQCC,2013; NICE,2015; Main et al,2017). The Risk Identification tool is based on the risk factors for peri-partum hemorrhage and pre-eclampsia and has been used by Berger et al, 2005 in California and allowed them to detect patients at risk early so they could be promptly treated to reduce bad outcomes. Also, a risk factor for sepsis has been used by NICE in 2015 in the UK; and regular assessment of five physiological variables such as respiratory rate, pulse rate, blood pressure, temperature and mental status allowed a diagnosis of the syndrome without delay and allowed a timely management (CEMACH, 2007). All these tools have been combined to produce the Risk Identification tool that screens for risk of having postpartum hemorrhage, sepsis and pre-eclampsia. None of these tools have previously been evaluated in Rwanda.

1.3 Rationale

Maternal Mortality is still high in low-income countries compared to developed countries and most causes of maternal mortality are potentially preventable. Like many countries in the world, the health system in Rwanda includes District Hospitals (DHs) as the first hospital facilities close to the community. Most maternal deaths occur among patients referred from the DHs and provincial hospitals to Referral Hospitals (RHs) for obstetric complications (Jackson et al. 2015). This referral system is challenged by delayed diagnosis and treatment at DHs leading to the transfer of patients in critical conditions. It is known there are some tools that can be used to identify and manage critically ill patients in obstetrics early. Among them, the Risk Identification (RI) and the Modified Early Obstetric Warning Signs (MEOWS) have been largely tested. Indeed, as the most common causes of maternal death in low-income countries are postpartum hemorrhage, sepsis and hypertensive disorders during pregnancy (pre-eclampsia and eclampsia), the use of these tools may be of huge importance to preventing maternal death. However, these tools have never been used or evaluated in Rwanda and to our knowledge, there is not any other tool in place used to identify patients at high risk. We conducted this study, on one hand, to test for the association between abnormal MEOWS and morbidity defined as sepsis, preeclampsia and postpartum hemorrhage as determined by RI, and on the other hand, to evaluate the accuracy of MEOWS tool to predict morbidity in Rwandan settings. We also aimed to determine the feasibility of using the tools by health care professionals in 4 DHs in Rwanda.

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1.4 Objectives

1.4.1 The primary objective

- To determine the feasibility of implementing of Risk Identification and Modified Early Obstetric Warning Signs tools in Districts Hospital in Rwanda

1.4.2 The secondary objectives

- To determine participants experiences with the use of MEOWS and RI tools in DHs.
- To determine the accuracy, sensitivity, specificity, positive and negative predictive values of prediction of morbidity by MEOWS.

CHAPTER 2: METHODS

2.1. Study design

This is a cross-sectional study through which we collected clinical data from patients records after the implementation of the tools in 4 DHs.

2.2. Setting

The study was conducted in 4 Districts Hospitals that refer to 2 main Referral Hospitals in Rwanda: the Centre Hospitalier Universitaire de Kigali (CHUK) and the Centre Hospitalier Univesrtaire de Butare (CHUB). The DHs in the study were Nyanza, Muhima, Kabutare and Kibagabaga. These are located within a one hour drive to the Referral Hospitals and have a large number of deliveries. They were selected to provide representative examples of typical DHs in various parts of the country.

2.3. Intervention

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

From April to June 2019, the research team implemented the RI and MEOWS tool (Table 1). For each hospital, the research team conducted a 20-minute teaching session explaining the Risk Identification and MEOWS tools to all maternity staff during the regular morning meeting.

In addition, a co-investigator selected one coach per hospital to look after 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.

2.4. Study population

All patients (obstetric patients) who consulted for delivery at these 4 DHs, during the same time of the study.
Health workers in maternity services (nurses, midwives and doctors).

2.5. Sample size

We recruited obstetric patients with inclusion criteria from the 4 District Hospitals that conduct at least 250 deliveries each month and we referred to a similar study done in the UK where the sample size was 676.

2.6. Analysis

For the primary objective, to evaluate the feasibility, we determined the completion rate of all tools. For the secondary outcome, we tested association between an abnormal MEOWS score at admission and the presence of morbidity, a composite outcome of infection, hemorrhage and pre-eclampsia defined by RI by calculating relative risk and we interviewed health workers about their experiences using the RI and MEOWS.

2.7. Statistical

Descriptive statistics were used, we reported frequencies and percentages for categorical data, and mean and standard deviation ranges for continuous data. We tested for the association between an abnormal MEOWS score at admission and the presence of morbidity at discharge by calculating relative risk for individual scores. For all statistical tests, we regarded a value of $p<0,05$ as statistically significant. For Sensitivity, specificity, positive predictive value, negative predictive value, positive and negative likelihood ratios, the accuracy has been calculated.

2.8. Inclusion criteria

All patients (obstetric patients) who consulted for delivery at the 4 DHs between March 1, 2019 and June 30, 2019.
Nurses, Midwives and Doctors in Maternity services at the mentioned DHs.

2.9. Exclusion criteria

- Unconscious patients unable to provide voluntary consent.
- Patients with mental disability.
- Refusal to give consent form.

2.10. Ethical consideration

2.10.1. Confidentiality

Once consent forms were signed, participants were provided with a unique identifying number that was known only to the participant and the principal investigator. Thereafter, all data had been collected under that unique identifying number. Only the unique number identifier remained and the questionnaires were kept in the file of the patient then afterwards locked in the cupboard of the unit manager.

2.10.2 Informed consent

All participants were requested to sign consent forms that were attached to the questionnaires, which were kept in the file of the patient.

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2.10.3 Ethical approval

Ethical approval has been signed and given by the College of Medicine and Health Sciences Institutional Review Board (CMHS/IRB **157/CMHS IRB/2019**).

2.11. Algorithm

2.11.1. Risk Identification tool

Criteria	High risk	Moderate risk	Low risk
Hemorrhage	**Recognition:** **-On admission:** 1. Placenta praevia, 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	**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	**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	-Evaluate for development of additional risk factors **in labor and postpartum**: • Prolonged 2nd Stage labor: • Prolonged oxytocin use • Active bleeding • Magnesium sulfate	-Evaluate for development of additional risk factors **in labor and postpartum**: • Prolonged 2nd Stage labor • Prolonged oxytocin use: • Active bleeding

	treatment **-1 or more high risk criteria: High risk of hemorrhage**	treatment **-1 or more moderate risk criteria: Moderate risk of hemorrhage**	•Chorioamnionitis • Magnesium sulfate treatment **No moderate or high risk of hemorrhage:**
Conclusion	**Response:** -Consider referral if not in labor -If in labor close monitoring, type and screen, order 2 units of blood, delivery	**Response:** -Consider referral if not in labor (clinical judgment) -If in labor close monitoring, type and screen, book 2 units of blood, delivery	**Low risk of hemorrhage** **Response:** -Standard of care
Preeclampsia/Eclampsia	**Recognition:** **CNS:** **Awareness:** unresponsive	**Recognition:** **CNS:** **Awareness:** •Agitated/confused • Drowsy • Difficulty speaking	**Recognition:** **CNS:** **Awareness:** Alert/oriented
	Headache: Unrelieved headache	**Headache:** • Mild headache • Nausea, vomiting	**Headache:** None
	Vision: Temporary blindness	**Vision:** Blurred or impaired	**Vision impairment:**
	CVS: SBP: ≥160	**CVS:** SBP: 140-159	None

	DBP: 50-89 HR: 61-110 Chest pain **RS:** RR: <10 or >30 **GIT:** Nausea and vomiting Abdominal pain **Renal: urine output in mls:** ≤30 (in 2 hrs) **Proteinuria:** Not relevant **Platelet:** <50 **ASAT/ALAT:** >70 **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	DBP: 50-89 HR: 111-129 Chest pain **RS:** **RR:** 25-30 **GIT:** Nausea and vomiting Abdominal pain **Renal: urine output :** 30-49 **Proteinuria:** • > +1, • 300mg/24 hours **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	**CVS:** SBP: 100-139 DBP: ≥105 HR: > 130 No chest pain **RS:** **RR:**11-24 **GIT:** None None **Renal: urine output :** ≥50 **Proteinuria:** Trace **Platelet:** >100 **ASAT/ALAT:** <70 **Cr:** <0.8 **MgSO4 toxicity:** • DTR +1 • Respiration 16-20 **No moderate or high risk criteria: No risk of preeclampsia /eclampsia** **Response:** Proceed with protocol for
Conclusion			

	loading or maintenance infusion O2 at 10 L per rebreather mask • R/O pulmonary edema • Chest x-ray •Safe referral to tertiary center	•Physician should be made aware of worsening or new-onset proteinuria	normal pregnancy
Sepsis	**Recognition for every woman (on admission):** Risk factors: 1.gestational diabetes, diabetes or 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 FiO2> 40% to	**Recognition for every woman (on admission):** Risk factors: 1.gestational diabetes, diabetes or 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**: History of new altered mental state: ---------- 2.**RS:** RR>21 -24: ---------- ---	**Recognition for every woman (on admission):** Risk factors: 1.gestational diabetes, diabetes or 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**

	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^{o}C:** ---------- 6.**Skin:** Mottled appearance, Cyanosis of skin, lips or tongue, Non-blanching rash of skin: ---------- --	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^{o}C:** -------- 6.**Skin:** Signs of potential infection, including redness, swelling or discharge at surgical site or breakdown of wound: --------	**criteria** No high risk or moderate risk criteria met: ---------- --------
Conclusion	**-1 or more high risk criteria: High risk of sepsis** **Response:** -immediate review by senior clinical decision maker (ABCDE approach) -Blood test: -blood gas for glucose and lactate·	**-1 or more moderate risk criteria: Moderate risk of sepsis** **Response:** -Blood test: -blood gas for glucose and lactate· _blood culture· _full blood count· _C-reactive protein· _urea and	**-no high or moderate risk criteria: Low risk of sepsis** **Response:** -Clinical

	_blood culture· _full blood count· _C-reactive protein· _urea and electrolytes· _creatinine· _clotting screen - **MEOWS** -IV antibiotics within 1h -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 -Refer to a tertiary hospital	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** -Source control within 6 hours, if deep infection refer to a tertiary hospital	assessment and manage according to clinical judgement

Table 1: Risk Factor Identification tool

2.11.2. 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	≥160
Diastolic * BP			≤45	46-89	90-99	100-109	≥110
Pulse		≤ 40	40-50	51-100	101-110	111-129	≥ 130
Respiratory Rate		≤ 8		9-14	15-20	21-29	≥30
AVPU				Alert	Responds to Voice	Responds to Pain	Unconscious
Urine output mLs/hr	< 10	<30		Not Measured			

Table 2: Modified Early Obstetric Warning Score (MEOWS) tool

If the pulse rate is higher than the systolic blood pressure then add a score of 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

CHAPTER 3: RESULTS

3. 1. Characteristics of our study patients

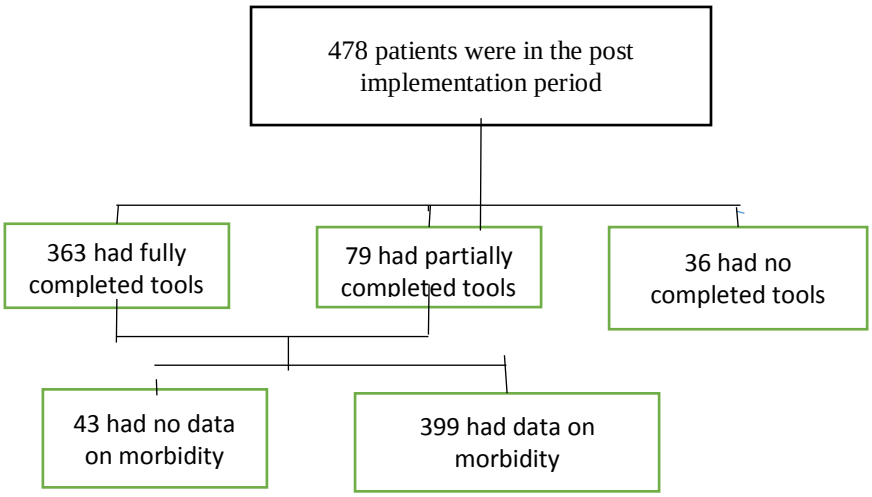

Figure 1. The enrollment of participants in the study

We enrolled 478 patients during implementation with the mean age of 28.3 +/-6.4 years, they had health insurance at a rate of 95.1%**.** The mean length of hospital stay was 3 +/-2 days and the morbidity rate was 11.3%. Among the 4 districts Hospitals 165(36.3%) patients had an ante-natal visit. Among the 399 patients with morbidity data, 2.51% experienced PPH, 4.01% pre-eclampsia, 4.76% sepsis, 3.01% others diseases and 85.71% with no morbidity.

Table 1. Patients' demographics, completeness of the use of the RI and MEOWS Tools.

Variable	**Number;** n, (%) **N=478**
Age (Mean, SD)	28.3 (6.4)
Gravida (Mean, SD)	2.6 (1.9)
Parity (Mean, SD)	1.4 (1.7)
ANC (Mean, SD)	2.8 (1.1)
Married	
Yes (%)	420 (89.0)
Insurance	
Yes (%)	450 (95.1)
UBUDEHE Category	
1	37 (15.8)
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 (both tools)	363 (76.3)
Partially completed (one of the tools)	79 (16.6)
Not completed (none of the tools)	36 (7)
Morbidity	
Yes	45 (11.3)
No	354 (88.7)
Length of stay (Mean, SD)	3. (2)

Table 2 Comparison of MEOWS tool scores (Moderate/High versus Low) and morbidity (Yes versus No), N: 399. Cross tabulation of MEOWS tool scores and Morbidity.

		Morbidity	
		Yes	No
MEOWS level:	**Moderate or High**	13	23
MEOWS level:	**Low**	32	331

Table 3 Comparison of MEOWS tool scores (Moderate/High versus Low) and Morbidity (Yes versus No), N: 399. The characteristics of MEOWS tool.

RI& MEOWS Level	*p value*	RR (95%CI)	Sensitivity	Specificity	Accuracy	PPV	NPV
Moderate Or High Low	<0.0001	**4.1 (2.4-7.1)**	**28.9%**	**93.5%**	**86.2%**	**36.1%**	**91.1%**

There was an association of moderate to high MEOWS and the morbidity with a relative risk of 4.1 (95% CI, 2.4-7.1); p<0.001**.** The calculated sensitivity of MEOWS in the prediction of morbidity is 28.89% with a specificity of 93.50%, a positive predictive value of 36.11 and a negative predictive value of 91.1% and the accuracy is 86.3%.

3.2. Feasibility of implementation of Risk Identification and MEOWS tools

Among 478 forms used 363 (76.3%) forms were fully completed, 79 (16.6%) were partially completed, and 36 (7%) were not completed at all. During the interviews about participants experiences using the RI and MEOWS tools, most of the respondents reported that the tools were easy or very easy to use (92%) and that they were willing to use the tool regularly (90.9%), that the tool improved awareness of patient safety (91.3%) and that he tool decreased the delay in recognition and management of critically ill obstetric patients (86.4%).

Table:4 Respondents' perception on the tools

Questions	Responses			
How do you think using the risk factors identification and MEOWS tool within the existing patient file was?	Very difficult 0 (0%)	Difficult 2 (8%)	Easy 16 (64%)	Very easy 7(28%)
To what extent are you willing to use regularly the Risk identification and MEOWS tool to your facility?	Very resistant 0 (0%)	Resistant 2 (9.1)	Willing 9 (40.9)	Very willing 11 (50%)
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%)	Somewhat significant 2 (8.7%)	Significant 9 (39.1%)	Very significant 12 (52.2%)
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%)	Somewhat significant 3 (13.6%)	Significant 4 (18.2%)	Very significant 15 (68.2%)

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

CHAPTER IV: DISCUSSION

Our study has shown the use of RI and MEOWS tools is feasible when the tools are fully completed at a rate of 76.3% and acceptable to be used where 90.9% of respondents reported they were willing to use them. In addition, 91.3% of interviewees reported that these tools had improved awareness of patient safety. With regards to the accuracy of using MEOWS to predict morbidity as defined by RI the tools were 86.2% accurate, which is a high accuracy.

These findings were consistent with other studies. In Ethiopia, a similar study done for assessing the feasibility of introducing the MEOWS tool found it was feasible and had a great impact on post operation vital signs records. Also, the staff was committed to applying MEOWS to all obstetric patients. (Moore et al, 2018).

During the implementation of RI and MEOWS, our staff was challenged by the length of the tool which took much time to complete, the barrier of the English language and unavailability of forms. These challenges will be addressed to successfully implement RI and MEOWS tools (Mhyre et al, 2014, Knight et al, 2014).

Other challenges that can be considered for a successful implementation of RI and MEOWS are multidisciplinary coordination, inadequate education about the tool, suboptimal integration into hospital culture, lack of leadership support and lack of optimal alignment with other quality improvement projects, which were reported in another study. (Friedman, et al 2018).

There was an association of moderate to high MEOWS and the morbidity with an RR=4.1 (95% CI, 2.4-7.1)**.** The calculated sensitivity of MEOWS in the prediction of morbidity as defined by RI is 28.89% with a specificity of 93.50%, a positive predictive value of 36.11% and a negative predictive value of 91.1%. The accuracy was 86.2%.

These results differ a bit from a similar study done in Uganda, at St Francis Hospital-Nsambya, by Dr Omona Kizito et al, 2016. That study was testing sensitivity, specificity, positive predictive value and negative predictive values. With 502 patients, they found MEOWS was 81,7 % sensitive (95 %CI 80-94%),76.3% specific (95% CI 74-81%), positive predictive value 36,3(95% CI 31-44%), and negative predictive value of 96,2% (95%CI94-99%), then they concluded that use of the MEOWS tool is effective in low-income settings

like Uganda. The low sensitivity of MEOWS to predict morbidity in our study may be explained by the development of morbidity at the end, like patients who develop postpartum hemorrhage with no identified risk at the beginning, low levels of knowledge of nurses and midwives and the absence of non-communicable disease like cardiovascular diseases in morbidity.

Although it has been found that the use of MEOWS is effective in predicting morbidity and mortality in severely ill obstetric patients (Umar et al, 2019), there is limited evidence of the effectiveness of MEOWS in reducing maternal death across all settings. (Umar et al, 2019). The tools showed patients with 2.51% experienced PPH, 4.01% preeclampsia, 4.76% sepsis, 3.01% others diseases and 85.71% experienced no morbidity, with sepsis being the most common morbidity found.

Our study was conducted in 4 district hospitals, these hospitals 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 other similar countries, but further research must be done to improve the accuracy and effectiveness of using RI and MEOWS.

CHAPTER 5. CONCLUSION AND RECOMENDATIONS

The implementation of RI and MEOWS tools at the district hospital level in Rwanda is feasible and relatively acceptable from healthcare perspectives. However, having moderate or high scores with the MEOWS tool moderately predicted obstetric morbidity defined as by RI for different reasons, but mainly the lack of incorporation of the tool with some non-communicable diseases such as cardiovascular disease. Given the local context with a high prevalence of targeted conditions by the tools and the lack of any stronger tool for use for the same purpose, the tools can still be considered for use in district hospitals in Rwanda to identify obstetric patients to transfer to referral hospitals for more intensive and specialized care. Meanwhile, there is a need to conduct a study to evaluate the impact of the RI and MEOWS tools on maternal mortality. Moreover, an incorporation of other conditions that may render critical an initially relatively normal obstetric condition in those tools should be subject to evaluation in future studies.

Therefore, it can be recommended that:

- Nurses, midwives and district hospital doctors use the tool to standardize their basis of clinical decisions for management of obstetric patients and to educate young staff and students in healthcare professions to recognize critically-ill obstetric patients early.
- There is a need to revise the RI to integrate clinical conditions associated with increased morbidity in obstetric patients from Rwanda and probably other similar low-income countries.

REFERENCES

1. Ministry of Health (MOH), Rwanda Annual Health Statistics 2015.
2. Jackson JR, Rulisa SR, DecesareJZ. Et al. Maternal Mortality and Near Miss Morbidity at the University Teaching Hospital in Kigali, Rwanda. *RMJ 2015,Vol.72 (2);*
3. Berg CJ, Harper MA, Atkinson SM, et al. Preventability of pregnancy-related deaths: results of a statewide review. *Obstet. Gynecol. 2005; 106(6): 1228-1234.*
4. National Institute for Health and Care Excellence (NICE) guideline NG51 *https://www.nice.org.uk/guidance/ng51,2015*
5. Lewis G. (ed) 2007. The Confidential Enquiry into Maternal and Child Health (CEMACH) Saving Mothers' Lives: reviewing maternal deaths to make motherhood safer - 2003-2005. The Seventh Report on Confidential Enquiries into Maternal Deaths in the United Kingdom. London: CEMACH
6. Lyndon A, Lagrew D, Shields L, Main E, Cape V. Improving Health Care Response to Obstetric Hemorrhage. (California Maternal Quality Care Collaborative (CMQCC) Toolkit to Transform Maternity Care) Developed under contract #11-10006 with the California Department of Public Health; Maternal,Child and Adolescent Health Division; Published by the California Maternal Quality Care Collaborative, November 2013.
7. Maurice L. Druzin, MD; Laurence E. Shields, MD; Nancy L. Peterson, RNC, PNNP, MSN; Valerie Cape, BSBA. Preeclampsia Toolkit: Improving Health Care Response to Preeclampsia (California Maternal Quality Care Collaborative Toolkit to Transform Maternity Care) Developed under contract #11-10006 with the California Department of Public Health; Maternal, Child and Adolescent Health Division; Published by the California Maternal Quality Care Collaborative, November 2013.
8. Cantwell R, Clutton-Brock T, Cooper G, et al. Saving Mothers' Lives: reviewing maternal deaths to make motherhood safer: 2006-2008. The Eighth Report of the Confidential Enquiries into Maternal Deaths in the United Kingdom. *BJOG 2011;118(Suppl 1):1–203*
9. Main EK, Cape V, Abreo A, et al. Reduction of severe maternal morbidity from hemorrhage using a state perinatal quality collaborative. *Am J Obstet Gynecol 2017;216:298.e1-11.*
10. Maguire PJ, O'Higgins AC, Power KA, Daly N, McKeating A, Turner MJ. Maternal bacteremia and the Irish maternity early warning system. *Int J Gynecol Obstet. 2015;* https://doi.org/10.1016/j.ijgo.2014.11. 022 PMID: 25670063

11. Merriel A, Murove BT, Merriel SWD, Sibanda T, Moyo S, Crofts J. Implementation of a modified obstetric early warning system to improve the quality of obstetric care in Zimbabwe. *Int J Gynecol Obstet. 2017;* https://doi.org/10.1002/ijgo.12028 PMID: 28099733
12. Seiger N, Maconochie I, Oostenbrink R, Moll HA. Validity of different pediatric early warning scores in the emergency department. *Pediatrics 2013;132(04):e841–e85022*
13. Gold DL, Mihalov LK, Cohen DM. Evaluating the Pediatric Early Warning Score (PEWS) system for admitted patients in the pediatric emergency department. *Acad Emerg Med 2014;21 (11):1249–1256*
14. Bokhari SW, Munir T, Memon S, Byrne JL, Russell NH, Beed M. Impact of critical care reconfiguration and track-and-trigger outreach team intervention on outcomes of haematology patients requiring intensive care admission. *Ann Hematol 2010;89(05): 505–512*
15. Mhyre JM,D'Oria R, Hameed AB, et al. The maternal early warning criteria: a proposal from the national partnership for maternal safety. *Obstet Gynecol 2014;124(04):782–786*
16. Knight M, Kenyon S, Brocklehurst P, Neilson J, Shakespeare J, Kurinczuk JJ (Eds.) on behalf of MBRRACE-UK. Saving Lives, Improving Mothers' Care - Lessons learned to inform future maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2009 -12.
Oxford: National Perinatal Epidemiology Unit, University of Oxford; 2014
17. Friedman AM, Campbell ML, Kline CR, et al. Implementing Obstetric Early Warning Systems. *Am J Perinatol Rep 2018;8:e79–e84.*
18. Singh S, McGlennan A, England A, Simons R. A validation study of the CEMACH recommended modified early obstetric warning system (MEOWS)*. *Anaesthesia 2012; 67: 12–18*. https://doi.org/10.1111/j.1365-2044.2011.06896.x PMID: 22066604
19. Singh S, Guleria K, Vaid NB, Jain S. Evaluation of maternal early obstetric warning system (MEOWS chart) as a predictor of obstetric morbidity: a prospective observational study. *Eur J Obstet Gynecol Reprod Biol.* 2016; https://doi.org/10.1016/j.ejogrb.2016.09.014 PMID: 27792988
20. Umar A, Ameh CA, Muriithi F, Mathai M: Early warning systems in obstetrics: Asystematic literature review. *PLoS ONE 2029 14(5)*: e0217864.https://doi.org/10.1371/journal.pone.0217864.

APPENDICES

1. **Data collection tool**

A. Use of the Risk identification (RI) and Modified Early Obstetric Warning Score (MEOWS) tool

1.Age: .....

2. Marital status: a. Married b. Single c. Divorced d. Widowed

3. Insurance: a. Yes b. No, if yes, please specify the type: ……

4. Obstetric history: a. Gravidity: ..... b. Parity: ..... c. ANC visits: .....

5. Ubudehe social category: .....

6. Origin: .....

7. Number of Vital signs checks post-delivery: a. 1h: …… b. 2h:……. c. 4h:…… d.8h:……..

e. 12h:…… f. 24h: ……..

8. RI and MEOWS tool

a. RI and MEOWS tool is **available** in the file: a. Yes b. No

If yes, is it **completed:** a. Yes b. No

b. **Risk identification group for common complications below** (Circle the corresponding group)

- PPH: 1. High risk 2. Moderate risk 3. Low risk
- Infection: 1. High risk 2. Moderate risk 3. Low risk
- Preeclampsia: 1. High risk 2. Moderate risk 3. Low risk

c. MEOWS Score: …….

Please select the group: 1. High (score≥6) 2. Moderate (score of 3-5) 2. Low (score≤2)

9. Delay

1. Time of admission: …….
2. Time to transfusion:…….
3. Time to antibiotic:……
4. Time to MgSO4: ……
5. Time to referral: ……

10.Morbidity

1. Post-partum hemorrhage: a. Yes b. No
2. Infection: a. Yes b. No
3. Preeclampsia: a. Yes b. No

4. Other, please specify ……

11. Outcomes

- Referred: a. Yes b. No
- Reoperation: a. Yes b. No
- Hysterectomy: a. Yes b. No
- ICU admission: a. Yes b. No
- Length of stay (days): .....
- Death: a. Yes b. No

B. Survey with staff on their experience on the use of the RI and MEOWS tool

Thank you for participating in this survey – your experience and responses to these questions will be invaluable in helping our team to implement successfully the **RI and MEOWS tool** in your facility.

This questionnaire aims to explore your experience and perception on a potential implementation of **RI and MEOWS tool**. It will take you approximately 10 - 15 minutes to complete.

- Participation, although encouraged, is voluntary. You may opt out at any stage.
- All answers will be kept confidential and treated anonymously, however we will provide you with the opportunity to provide more feedback at the end of the survey.
- Please only complete one survey.

If you have any questions, please do not hesitate to contact tuyishime@gmail.com

General Information

1. Initials *(optional)*

2. Email address

3. Name of health-care facility/organization

4. Please select your professional background.

○ Midwife

○ Nurse

- Medical doctor
- Anaesthetic provider
- Administrator
- Other:

5. How many years of experience do you have attending births?

- 1 year or less
- 2 - 4 years
- 5 - 7 years
- 8 - 10 years
- 10 years or more

6. On average, how many births are conducted in the facility each week?

7. Number of maternity staff:

Nurses:……

Midwifes:……..

Medical doctors:……

8. Are the following equipment and supplies available in your facility? :

Always = 75-100%

Occasionally = 50-75%

Seldom = 25-50%

Never = 0-25%

Essential Resource

Fill below each item its estimated availability

(Always/occasionally/seldom/never available)

Electricity	Clean water	Soap or alcohol hand rub	Disinfectant	Autoclave	Clean gloves
Stethoscope	Thermometer	Blood Pressure Instrument	Parthograph	Fetoscope/ Doppler	Oxygen
Suction Machine	Mucus extractor	Neonatal Ambu Bag	Baby Scale	Needle/Syringe	Urine Dip Sticks
Sterilized Blade/Scissor	Cord Tie/Clamp	Clean Pads for Mother	Clean Towel	Bag of IV Fluids	Injectable Oxytocin
Cytotec tablets	Injectable Magnesium Sulfate	Antibiotics for Mother	Antibiotics for Infant	Antihypertensives	Blood products

9. How many maternity staff have participated in any training on Emergency Obstetrics and neonatal care in the last 12 months?

a) <25%

b) 25 to 50%

c) 50 t0 75%

d) > 75%

Please describe

The Risk identification (RI) and MEOWS tool

10. Do you believe using the RI and MEOWS tool can improve practice in your facility?

- ○ Yes
- ○ No

11. To what extent do you believe use of the RI and MEOWS tool will improve the practice in your facility around childbirth?

- ○ Very significantly
- ○ Significantly
- ○ Somewhat
- ○ Not at all

12. How do you think using the RI and MEOWS tool within the existing patient file was?

- ○ Very easy
- ○ Easy
- ○ Difficult
- ○ Very difficult

13. Please describe three factors that contributed positively to the use of the RI and MEOWS tool

14. Please describe three challenges faced during the use of the RI and MEOWS tool in your hospitals

15. To what extent are you willing to use regularly the RI and MEOWS tool to your facility?

- ○ Extremely willing
- ○ Willing
- ○ Neutral
- ○ Resistant
- ○ Very resistant
- ○ Not applicable

16. To what extent do you believe use of the RI and MEOWS tool has improved awareness of patient safety at your health-care facility?

- ○ Very significantly
- ○ Significantly
- ○ Somewhat
- ○ Not at all

17. To what extent do you believe use of the RI and MEOWS tool has decreased delay in recognition and management of critically ill obstetric patients at your health-care facility?

- ○ Very significantly
- ○ Significantly
- ○ Somewhat

○ Not at all

18. If you, a family member, or close friend were to give birth, would you want the RI and MEOWS tool to be used?

○ Yes

○ No

○ Neutral

19. Is there anything else you would like to comment on?