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Providing Education and Tools Increases Nurses' and Midwives' Assessment for Puerperal Sepsis in a Regional Referral Hospital in South Western Uganda

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ABSTRACT

Background: Puerperal sepsis causes at least 75,000 maternal deaths every year, mostly in low-income countries. Early identification of sepsis and initiation of sepsis care bundles are crucial the survival of patients. Education about the surviving sepsis campaign guidelines is critical for nurses to understand the indicators for sepsis that inform accurate screening and initiation of life-saving interventions. We sought to establish the effect of an education intervention and implementation of screening tools on maternal sepsis screening in a Regional Referral hospital in South Western Uganda

Methods: A pretest-posttest quasi-experimental study design was employed to determine the change in the level of knowledge regarding sepsis among a purposively selected sample of 16 midwives and 2 intern nurses. Translation of knowledge to practice was determined by pre-intervention retrospective chart review and post-intervention evaluation of the maternal sepsis screening.

The statistically significant change in knowledge and practice following the educational intervention was determined by Paired *t-tests* and Chi-square tests using SPSS version 16.

Results: There was an improvement in knowledge scores post the educational intervention from a mean score of 5.78 to 7.13. There was a statistically significant difference in the documentation of vital signs observed between the retrospective chart review and the screening done after the education intervention.

Conclusion: This study demonstrated that the provision of education and sepsis screening tools in an incremental improvement in puerperal sepsis screening which is an important step toward reducing maternal mortality.

Key Words: Maternal Sepsis, Puerperal sepsis. Sepsis, Sepsis bundles, Sepsis Screening, Surviving Sepsis Campaign

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Introduction

Globally 11 women per 1,000 live births have been reported to have an infection that has caused or contributed to severe post-partum complications and death (World Health Organisation, 2020). Many of the sepsis deaths occur during the puerperal period (within six weeks of childbirth) (World Health Organisation, 2014, World Health Organisation, 2019).

In Uganda, a low-income country, sepsis presents a substantial risk to maternal health. Deaths due to puerperal sepsis in the national referral hospital account for 12.7% of the maternal mortality rate annually (Wandabwa et al., 2011). In a regional referral hospital (RRH) in southwest Uganda, deaths due to puerperal sepsis amounted to 30.9% of annual maternal mortality and sepsis was deemed the most common cause of maternal mortality at the hospital (Ngonzi et al., 2016).

Delivery by cesarean section was an important risk factor contributing to the development of puerperal sepsis in the RRH in southwest Uganda. Cesarean delivery complicated by surgical site and urinary tract infections increased the likelihood of mothers developing puerperal sepsis, emphasizing the importance of early recognition of complications to prevent and manage puerperal sepsis (Lamont et al., 2011, Ngonzi et al., 2018). The Ugandan cesarean section rate as of 2021 was projected to increase by 36% which greatly increases the risk for infection and in the long term sepsis. (Atuheire et al., 2019). Global experts recommend prophylactic antibiotic administration 20 to 60 minutes before skin incision and this intervention has been widely practiced in the clinical settings without significant reduction in the maternal mortality rate due to puerperal sepsis (van Schalkwyk et al., 2010) With the high rates of cesarean section, the rate of maternal mortality due to puerperal sepsis is bound to increase in

developing countries if nurses and midwives cannot identify sepsis early in its development and initiate effective management (Asiimwe et al., 2014, Giuliano, 2006).

The Global Sepsis Alliance stipulates that saving the lives of patients at risk for sepsis does not only depend on the treatment of a particular infection, but rather focuses on early recognition and awareness of sepsis, rapid antimicrobial therapy, fluid resuscitation, and vital organ support (Global Sepsis Alliance, 2010). With the increasing burden of sepsis in low-income countries, early identification of sepsis is key to the survival of patients. But, this early recognition remains the greatest challenge facing effective sepsis management (McClelland and Moxon, 2014, Kissoon, 2014). Nurses and midwives, by their having more contact with patients, are pivotal in identifying patients who are unwell or whose conditions are deteriorating. By undertaking routine clinical observations, including vital signs, they initiate the early identification of women at risk for sepsis and therefore may aptly initiate life-saving treatments (Kissoon, 2014, Vousden et al., 2018).

Education about pathophysiology and indicators of sepsis using the Surviving Sepsis Campaign guidelines is crucial for nurses to understand the vital signs and laboratory changes as indicators for sepsis that help in accurately completing and using a screening tool to assess risk for sepsis as well as implementing lifesaving interventions (Dellinger et al., 2013, Olson, 2015).

When a nurse is unaware of the early signs of sepsis, treatment is delayed and multiple organ failure may progress quickly (Olson, 2015). Nurses' knowledge, behaviors, and attitudes about sepsis directly impact patient outcomes. Educational interventions about sepsis and implementation of the Surviving Sepsis Campaign guidelines have been reported to have raised nurses' confidence and ability to identify sepsis and initiate sepsis bundles for example one study

reported an improvement from less than 10% to greater than 90% in the nurses' level of confidence in the identification of sepsis (Olson, 2015, Lee, 2015).

The use of the systemic inflammatory response syndrome (SIRS) criteria from the Surviving Sepsis Campaign guidelines was able to diagnose maternal sepsis due to bacteremia more than other modified tools though its adoption in low-income countries is not widespread (Maguire et al., 2016).

Recommendations have been made regarding the modification of screening tools to meet the needs for low-resource settings. The recommendations in the low-resource settings are modified to define sepsis, severe sepsis, and septic shock in light of vital signs and other signs and symptoms that are indicators for sepsis rather than laboratory investigations that cannot be easily obtained due to high costs and lack of availability in low-resource settings (Dünser et al., 2012). Alternately, other researchers have reported that the ability of clinicians to accurately and efficiently recognize sepsis in its earlier stages remains inadequate, despite information concerning pathophysiology and management of sepsis being available in medical and nursing literature (Jeffery et al., 2014, Kissoon, 2014). The relevant evidence-based information regarding diagnosis and management of sepsis has been made available through the Surviving Sepsis Campaign guidelines though evidence of implementation of these guidelines in scarce for low-income countries (Aitken et al., 2011, Northridge et al., 2014). There is an apparent evidence-to-practice gap observed in low-resource countries including Uganda yet it has been reported that the use of maternity specific sepsis screening tools would prompt early recognition and treatment of sepsis and therefore reduce sepsis-related morbidity and mortality (Kissoon, 2014).

There is a paucity of data regarding knowledge, practice, and educational interventions about puerperal sepsis in low-income countries. There are no defined protocols for maternal sepsis identification and management in use by nurses and midwives in the obstetric wards of public Ugandan hospitals. There are limited reports in the literature of other similar settings employing such tools despite sepsis being a significant contributor to mortality in low-income countries. This aim of this study was to assess the outcome of an educational intervention regarding identification of puerperal sepsis using maternal sepsis screening tools on nurses' and midwives' knowledge about puerperal sepsis and practice in identification of sepsis in postpartum patients following cesarean section delivery.

Methods

This quasi experimental study that employed a pretest, intervention, and posttest design was done to evaluate the effect of an educational intervention on the nurses' and midwives' knowledge about puerperal sepsis and the effect of implementing a maternal sepsis screening tool on the practice of nurses and midwives in identification of puerperal sepsis in the low resourced setting of a South Western Ugandan RRH maternity ward.

Study Setting, Population, and Sample

A purposive sample of midwives and nurses working on the obstetrics, gynecology, and maternal-child health (MCH) wards comprised the population of interest for the quasi-experimental study because they all rotate to the assignment of post-partum care. The wards employed a total of twenty two certificate midwives, fourteen diploma midwives and two intern nurses. The average number of midwives on the maternity ward per shift was as follows; five midwives on the day shift (Three at certificate level, two at diploma level mostly for administrative work), three midwives at certificate level for the evening duty and three midwives

at certificate level for the night duty. The target sample size of nurse participants was derived from a calculation for a planned non-parametric dependent *t*-test analog, the Wilcoxon signed-rank test, where *a* priori power analysis indicated a total sample size of 15. (Buchner et al., 2009). To allow for an anticipated attrition rate of 10%, the researcher aimed for at least 18 participants in the study..

Instruments

Participants' knowledge about sepsis before and after the intervention was assessed using self-administered questionnaires. The questionnaires included multiple choice questions based on knowledge of sepsis from the Surviving Sepsis Campaign and hypothetical case studies that the participants had to respond to by indicating whether the patient had sepsis, severe sepsis, or was demonstrating signs of septic shock. A maximum score of 13 was possible on the knowledge assessment.

Based on the Surviving Sepsis Campaign Guidelines, the education intervention comprised of lecture notes designed to train the identified participants about sepsis definition as the two or more symptoms indicating systemic inflammatory syndrome (SIRS) and infection. Specific information about SIRS criteria included a temperature of equal to or greater than 38^{o} C or lower than 36^{o} C, a heart rate faster than 90 beats per minute, a respiratory rate faster than 20 breaths per minute, and altered mental status (Dellinger et al., 2013).

For the puerperal sepsis screening both retrospectively and prospectively, a maternal sepsis screening tool adopted and modified for the study site was used. The tool screened for indicators of the SIRS criteria which are changes in vital signs due to inflammatory response to infection (pulse, temperature, respiratory rate) signs of sepsis with evidence of malaise or body weakness, and apathy (which indicated altered mental status) , signs of septic shock as changes

in blood pressure and a source of infection. There were areas on the screening tool to indicate the risk for sepsis based on the vital sign and mental status and to record interventions implemented for mothers found with puerperal sepsis or risk of sepsis.

Along with the screening tool, instruments to measure the vital signs like sphygmomanometer and thermometers were provided on the ward.

Study Procedures

The study comprised 3 phases including pre-intervention, intervention, and post-intervention.

Pre- Intervention Phase

During the pre-intervention phase, the participants completed a pre-test to assess the level of knowledge regarding sepsis care bundles and the retrospective review of the randomly selected patients' records was completed.

Retrospective Patient chart review

From a total of 321 charts of mothers who had cesarean section deliveries at the RRH two months prior to the study and had been discharged, 50 charts were randomly selected for the review using the maternal sepsis screening tool that was designed for the study. Out of the 50 charts, 517 randomly selected observations according to the screening tool indicated parameters were recorded for the review based on the different nurses duty shifts (morning, evening and night duty) as measure for baseline screening prior to the intervention. The sample size for the retrospective chart review was derived from informal chart audits in quality improvement projects studies which report that 10% of the total number of charts is sufficient to provide strong evidence of practice (Etchells et al., 2010, Medicine, 2016).

Intervention Phase

In this phase, the nurses and midwives from the identified wards received an educational intervention regarding sepsis identification and management and were instructed on the use of the maternal-specific modified sepsis screening tool.

The educational intervention was comprised of teaching sessions about the epidemiology of puerperal sepsis, sepsis definitions, signs and symptoms for sepsis, sepsis bundles and use of the maternal sepsis screening tool. A total of three teaching sessions were conducted due to the busy working schedules of the midwives. Each session had a range of ten to thirteen participants. The majority of the participants (90%) attended at least twice in the whole training session. Two weeks after the education intervention, the modified maternal sepsis screening tool was introduced as part of the patient record and screening for sepsis was initiated from the time after the cesarean section was done to the day of discharge.

Prospective maternal screening

A total of 247 post caesarian section mothers had maternal sepsis screening tools attached to their files for the study. The evaluation of use of the screening tool was based on thrice daily completion of each assessment criteria on the tool, once per shift, for each eligible mother throughout the duration of each patient's stay on the post-partum unit. The number of times each parameter included in the screening tool was measured and recorded or missed was observed. The outcome of the screening to determine if a mother had sepsis or not and interventions thereof were recorded. To achieve a confidence interval of 95% and an expected proportion of screening tools completed of 30%, the exact binomial calculation determined a sample 341 observations was required (Hulley et al., 2013), prompting a final sample size of 350 observations for analysis.

Post Intervention Phase

In this phase, the participants completed the same knowledge assessment as a post-test after the training.

Evaluation of the use of the screening tool was based on: if the tools were filled for each mother who had delivered by cesarean section on that day (a mother was appropriately scored according to the sepsis screening parameters), if the mother met the SIRS, sepsis or septic shock criteria in the course of her monitoring and the steps taken by the midwife (the steps were indicated on the screening tool).

Data Analysis

The questionnaires and screening tools were scored before and after the intervention. These scores were analyzed using SPSS and descriptive statistics are presented. Paired *t* tests and Chi square tests were used to determine if there was a statistically significant change in sepsis knowledge among the nurses and midwives following education intervention based on the pre and post questionnaires. Chi square analysis compared the retrospective chart reviews and use of the prospective screening tools for differences in frequencies of completion of systematic inflammatory response syndrome (SIRS) criteria assessments.

Ethical Considerations

Approvals for conducting the study were obtained from the institutional Research Ethics Committee (REC) and the Regional Referral Hospital administration.

The midwives and nurses were subjected to a voluntary informed written consent. Owing to the fact that the screening done for the mothers was part of their routine care consent for use of the screening tool was not required from the mothers.

Results

A total of 16 midwives and 2 intern nurses participated in the study representing 47% of the 38 nurses and midwives who met inclusion criteria. The majority of the midwives were at certificate level of nursing and older than 40 years of age

Table 1. Demographic Characteristics of participants as per working station. (N = 18)

Demographic data	Frequency (percentage)
	n (%)
Age category	
Did not respond	2 (11.1)
18 to 28 years	3 (16.7)
29 to 39 years	5 (27.8)
40 or older	8 (44.4)
Years of work experience categorized	
Did not Respond	2 (11.1)
Fewer than 2 years	2 (11.1)
5 through to 10 years	4 (22.2)
Greater than 10 years	10 (55.6)
Nursing Education	
Certificate in Midwifery	11 (61.1)
Diploma in Midwifery	5 (27.8)
Bachelors in Nursing	2 (11.1)
Ward	
MCH	8 (44.4)
Gynecology	3 (16.7)
Maternity	7 (38.9)

Certificate midwife: completed the 2 year course after senior four (o-level) and are classified as technical nurses by the Uganda Nurses and Midwives Council (UNMC),
Diploma midwife: Registered Midwife who completed senior 6 (A-level) and 3 years professional training or advanced from Certificate level with additional 18 months professional training; the UNCM classifies the Registered Midwives as professional midwives.
Intern Nurse: Registered nurse with a bachelor's in nursing or midwifery serving a one-year government sponsored internship to qualify for licensure; the UNMC classifies nurse interns as professional nurses.

Knowledge Assessment

All participants (18) completed the pre-test knowledge assessment at the beginning of the first training session in 30 minutes. The pretest scores were normally distributed with a Shapiro-Wilk statistic as 0.95 *df* (15) *P* = 0.56. The pretest scores were low with a mean of 5.78 and the highest score was 8 out of 13 points. A total of 13 midwives and two intern nurses participated in the post test and were considered in the paired *t*-test to evaluate for knowledge changes. There was a mean improvement in the knowledge scores of 1.33, but the improvement was not statistically significant, t (14) = 1.98, p =.068 Cohen's d = 0.65

Table 2. Knowledge Assessment Results

	N	Mean	SD	Range	Minimum	Maximum
Pretest total score	18	5.78	1.39	5	3	8
Post test score	15	7.13	2.36	8	3	11

There were slightly more correct answers for particular items in after the educational intervention for particular questions in the questionnaire. For example, 27.8% of participants correctly identified heart rate of 95 and a respiratory rate of 24 as indictors of SIRS on the pretest, but the correct response rate improved to 55.6% and 72.2% respectively on the posttest. Some of the proportions of correct answers did not improve as seen in table 3, some items on the questionnaire received fewer correct responses on the post-test as compared to the pre-test.

Table 3. Correct Responses to pretest and post test Questions (*N* = 18)

	Pretest *n* = 18	Posttest *n* = 15
Frequency	*n* (%)	*n* (%)
Clinical manifestation suggestive for SIRS		
Temperature of 37.5^0 C	11 (61.1)	9 (50.0)
Heart rate of 95 beats/min	5 (27.8)	10 (55.6)
Respiratory rate of 24 breath/min	5 (27.8)	13 (72.2)
White blood cell count of 15,000cells/mm^3	14 (77.8)	8 (44.4)
Definition for Sepsis	13 (72.2)	12 (66.7)
Non indicators for sepsis	6 (33.3)	2 (11.1)
Principle for antibiotic therapy	13 (72.2)	11 (61.1)
Identification of septic shock	9 (50.0)	12 (66.7)
Case 1	7 (38.9)	6 (33.3)
Case 2	0	1 (5.6)
Case 3	10 (55.6)	12 (66.7)
Case 4	7 (38.9)	3 (16.7)
Case 5	4 (22.2)	8 (44.4)

Maternal Sepsis Screening

The frequency and proportions that vital signs were documented by the nurses and midwives increased in a statistically significant way when the screening tools were implemented. The proportions of completion on the screening form for all vital sign assessments were statistically significantly greater in the morning shift as compared with the evening and night shifts as determined by cross-tabulation chi-square analysis ($p \leq .001$). Based on the infrequent documentation of assessment criteria, 0.9% of the mothers met the SIRs criteria for sepsis in the prospective maternal sepsis screening. Documentation of assessment of surgical incisions and mental status was less frequent on the sepsis screening tool than found in the retrospective chart review (table 4).

Table 4. Documentation of Parameters: Retrospective and Prospective Reviews *N*=867

Item/shift	Pre-Intervention *n* = 517	Post-Intervention *n* = 350	Pre / post intervention Comparison		Post intervention between shift comparison	
	n (%)	*n* (%)	$\chi 2$	*p*	$\chi 2$	*p*
Temperature						
Morning	1 (0.6)	55 (41.7)				
Evening	0	19 (18.1)	133.7	< .001	38.8	< .001
Night	0	10 (8.8)				
Total	1 (0.2)	84 (24)				
Heart Rate						
Morning	9 (5.2)	53 (40.2)				
Evening	0	20 (19.0)	106.2	< .001	34.7	< 001
Night	0	10 (8.8)				
Total	9 (1.7)	83 (24)				
Respiratory Rate						
Morning	0	50 (37.9)				
Evening	0	19 (18.1)	119.4	< .001	37.1	< .001
Night	0	7 (6.2)				
Total	0	76 (21.7)				
Mental Status						
Morning	153(88.4)	50 (37.9)				
Evening	11 (6.4)	20 (19)	100.2	< .001	34.3	< .001
Night	10 (5.8)	8 (7.1)				
Total	174(33.7)	78 (22.4)				
2 or more signs and symptoms						
Morning	1 (0.6)	43 (32.6)				
Evening	0	17 (16.2)	100.2	< .001	32.5	< .001
Night	0	5 (4.4)				
Total	1 (0.2)	65 (18.6)				
Incision site status						
Morning	151(87.3)	43 (32.6)				
Evening	11 (6.4)	19 (18.1)	16.64	< .001	21.5	< .001
Night	10 (5.8)	10 (8.8)				
Total	172(33.3)	72 (20.6)				
Blood Pressure						
Morning	10 (5.8)	50(37.9)				
Evening	1(0.6)	24(22.9)	102.3	< .001	28.2	< .001
Night	0	10(8.8)				
Total	11(2.1)	84 (24)				

Retrospective review opportunities by shift: Morning: *n* = 173, Evening *n* = 173, Night *n* = 171.
Prospective Screening opportunities by shift: Morning *n* = 132, Evening *n* = 105, Night *n* = 113.

Discussion

Midwives in this sample had a low level of knowledge as evidenced by the low pretest scores. Possible explanations for low mean scores from this study were that there were no stipulated protocols from the surviving sepsis campaign guidelines in use at the RRH for maternal sepsis (Northridge et al., 2012). Unavailability of such guidelines presents a knowledge gap in the diagnosis and management of sepsis which is later translated into poor practices in terms of early identification and initiation of sepsis management. Item analyses of the knowledge assessment tool demonstrated nurses easily recognized septic shock, however they had difficulty recognizing patients in earlier stages of the sepsis (the SIRS/sepsis continuum). This finding was similar to other studies that showed that participants had deficits in identifying patients with the SIRS criteria yet they could confidently diagnose septic shock (Jeffery et al., 2014). The deficiency in recognizing earlier stages of sepsis can translate into delayed management and lead to devastating complications like septic shock.

The increase in the mean scores post intervention indicates an increased level of learning which was a similar finding to another study where increase in the mean scores of the participants pre and post the interventions by 64.5 to 85.2 in the test group was observed (Yousefi et al., 2012).

However, the statistically non-significant change in the scores post intervention can be explained by the possibility of low participant interest and motivation in the topic, owing to the great workload of caring for 40 to 50 postpartum patients at a time. Age could also have be considered as a contributor to the reduction of correct responses in the post-test, as content could have been too complicated for some of the different age groups as majority of the participants

were 40 years and above . This phenomenon is explained by weakening of some cognitive functions due to age (President and Fellows of Harvard College, 2022)

Maternal / Puerperal Sepsis Screening.

A number of difficulties have been met in implementing sepsis protocols, especially monitoring of the SIRS criteria due to low numbers in human resource in many developing countries leaving extremely high nurse to patient ratios. Though the protocols are important, low numbers in staffing have contributed to the slow progression in implementation (Kissoon, 2014).

There was a marked improvement in the documentation of the assessment of post-cesarean section mothers using vital signs and documentation of observed clinical signs improved using the maternal sepsis screening tool. The increased frequency of assessment and documentation of vital signs parameters following the intervention may indicate the education program affected the screening practice of the nurses and midwives, despite the midwives to patient ratio being very high i.e. 1:40 during the day and 1:50 during the night (Ngonzi et al., 2017). The majority of the assessment was done in the morning, most likely due to having a greater number of midwives in this shift. It is not clear what licensure level of the nurse is more frequently present in the morning versus other shifts.

Assessment of the incision site status and mental status were areas more commonly assessed by medical providers in the retrospective pre-intervention review of records. The study did not include examination of the patient files in the prospective arm to locate documentation by these providers that was not included on the sepsis screening worksheet. The decreased frequencies of assessment for these parameters in this study most likely does not represent an overall lower assessment, but it did highlight the infrequency with which the nurses assessed and

documented clinical assessments that require nursing judgment and clinical skill. This phenomenon may also relate to the preponderance of certificate nurses and midwives working at the RRH who may not perform at the same level of professional skills as nurses and midwives with higher levels of education. International studies have confirmed that the educational skill mix of nursing providers influences recognitions of deteriorating patient status (Massey et al., 2017, Sibandze and Scafide, 2018). Other studies also showed an increase in sepsis screening which in turn increased diagnosis of patients with sepsis whom the physicians did not diagnose early (Green et al., 2016, Yousefi et al., 2012).

The midwives in the study sample assessed and documented findings for fewer than one-quarter of the 350 observations allowing identification of only 0.9% of the mothers having two or more of the SIRS criteria. This level of screening was very low compared to another study where a total of 2,143 screening tests were completed in 245 patients and ICD-9 codes confirmed sepsis incidence was 9%, a ten-fold increase in recognition over the present study (Gyang et al., 2015). In the retrospective arm, there was no convenient or consistent form or place for nurses to document their assessment of vital signs or other findings. Placing a flowsheet screening tool in the file specifically for the nurses to use, prompted marked improvement in nursing documentation. It is not clear if an inter-professional review of the nurses' findings was performed by surgeons or other providers.

This shows that despite the lack of documented knowledge improvement from the educational intervention, implementing the screening tool and providing essential instruments to measure vital signs resulted in an improved rate of documentation of vital signs that are aimed at identifying early signs of sepsis. However, the overall rate of adherence to the guidelines was insufficient to identify the expected number of cases of sepsis for the study site based on prior

rates by prevalence studies conducted at the same institution (Ngonzi et al., 2018). The study was effective at finding a small, but significant increase in vital signs measurement, but it did not resolve the issues that prevent the nurses and midwives from documenting complete assessments on the patients and thereby identifying early signs of puerperal sepsis.

Limitations

Every study has limitations, and the results of this study should be cautiously considered in light of its limitations. The lack of statistical significance for the improvement in knowledge may be attributed to the sample size that was designed to detect a large effect (Cohen's $d = 0.7$). The post hoc power analysis revealed the effect size of the difference found was large (Cohen's $d = 0.65$ and the power to detect were marginal at 0.78 (Buchner et al., 2009). We cannot rule out a medium or smaller statistically significant effect of the educational intervention. Likewise, the small sample size does not allow for contrasts between educational levels of the participants; additional studies are required to determine if the predominant lowest (certificate) level of education affects overall care related to sepsis screening.

The low-resource setting frequently does not have sufficient equipment for the staff to measure vital signs; it is not possible to disentangle the effect of supplying the equipment from the effect of the screening tool or the education. The physician and surgeon staff were invited, though did not participate in the education or introduction of the screening tool. It is most likely these providers continued to document their assessments on traditional notes in the patient files. Evaluation of documentation of assessments in the post-intervention phase did not include a thorough file review; it is possible that further documentation of vital signs and other parameter assessments were completed in standard notes rather than specifically on the screening tool.

Conclusion

The study showed that training midwives about the maternal/ puerperal sepsis identification using the Surviving Sepsis Campaign guidelines and provision of a screening tool had a significant impact on the midwife's practice of screening mothers at risk for sepsis and documentation of findings though there was no statistically significant change in knowledge.

Recommendations

Based on the significant improvement in rates of documentation of vital signs demonstrated in this study, providing the essential tools for measurement is critical (blood pressure cuffs, stethoscopes, and thermometers). Additionally, the patient files in low-resourced countries frequently do not contain the designated forms or sections for nurses and midwives to document their assessment findings. Providing a specific location in this study facilitated such documentation. Hence, health ministries should urge public hospital administrators to implement these low-cost strategies tactics and provide access to procurement of the stationary and instruments to follow through with the implementation.

The low levels of knowledge and the limited uptake of the instruction presented to the midwife and nurse participants in this study may be related to the preponderance of technical nursing staff that provide care on the wards. The higher-ranked staff generally perform oversight and administrative duties. In light of evidence that supports professional and university-educated nursing staff is more likely to recognize patients who are becoming seriously ill, the referral hospital systems of low-income countries should study the impacts of providing and encouraging nursing educational advancement to publicly employed nurses and midwives.

Moving the primary certificate nurses to diploma level and then to bachelors level may improve clinical judgment and increase the rate of recognition of early sepsis to save mothers' lives.

The participants in this study improved the rates of documentation of vital signs but did not correspondingly document surgical site assessments or mental status assessments of their patients. In the retrospective review, this documentation was found to be completed by the surgeons. Interprofessional team-based care provided to the mothers in this post-partum ward was not evident in the patient records. Further research is required to examine how multidisciplinary teams approach patient care in low-resource settings to further the improvement of patient outcomes.

Further examination of barriers to measuring and documenting vital signs and assessing patients' surgical sites and mental status should be explored. The patient caseload must be a primary consideration as a barrier; a midwife caring for 40 to 50 patients during an 8-hour shift may face limits of time. Allowing five minutes per patient for a midwife to measure vital signs and assess post-partum status including mental status and document the findings would encompass up to half the allotted shift time for solely this task (3.5 to 4.2 hours). The development of strategies to facilitate overcoming this obvious barrier is paramount to improving the outcomes related to puerperal sepsis in developing countries.

Improvement in health outcomes like reducing maternal mortality from puerperal sepsis in low-resourced countries is a long-term goal that will require sequential and gradual strategies to realize achievement. This study demonstrated that provision of education and tools to complete the required assessments resulted in an incremental improvement that is a step toward the attainment of the goal. Each new tactic in this development should build on existing

knowledge as a translation of strong evidence into practice is adapted to the low-resourced settings of developing countries.

LIST OF ACRONYMS:

MAP: Mean Arterial Pressure

Mmol/L: Milli moles per Litre

RRH: Regional Referral Hospital

SSC: Surviving Sepsis Campaign

SIRS: Systematic inflammatory response

WHO: World Health Organization

MCH: Maternal Child Health

NRH: National Referral Hospital

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Providing Education and Tools Increases Nurses' and Midwives' Assessment for Puerperal Sepsis in a Regional Referral Hospital in South Western Uganda

ABSTRACT

Background: Puerperal sepsis causes at least 75,000 maternal deaths every year, mostly in low-income countries. Early identification of sepsis and initiation of sepsis care bundles are crucial the survival of patients. Education about the surviving sepsis campaign guidelines is critical for nurses to understand the indicators for sepsis that inform accurate screening and initiation of life-saving interventions. We sought to establish the effect of an education intervention and implementation of screening tools on maternal sepsis screening in a Regional Referral hospital in South Western Uganda

Methods: A pretest-posttest quasi-experimental study design was employed to determine the change in the level of knowledge regarding sepsis among a purposively selected sample of 16 midwives and 2 intern nurses. Translation of knowledge to practice was determined by pre-intervention retrospective chart review and post-intervention evaluation of the maternal sepsis screening.

The statistically significant change in knowledge and practice following the educational intervention was determined by Paired *t-tests* and Chi-square tests using SPSS version 16.

Results: There was an improvement in knowledge scores post the educational intervention from a mean score of 5.78 to 7.13. There was a statistically significant difference in the documentation of vital signs observed between the retrospective chart review and the screening done after the education intervention.

Conclusion: This study demonstrated that the provision of education and sepsis screening tools in an incremental improvement in puerperal sepsis screening which is an important step toward reducing maternal mortality.

Key Words: Maternal Sepsis, Puerperal sepsis. Sepsis, Sepsis bundles, Sepsis Screening, Surviving Sepsis Campaign

Introduction

Globally 11 women per 1,000 live births have been reported to have an infection that has caused or contributed to severe post-partum complications and death (World Health Organisation, 2020). Many of the sepsis deaths occur during the puerperal period (within six weeks of childbirth) (World Health Organisation, 2014, World Health Organisation, 2019).

In Uganda, a low-income country, sepsis presents a substantial risk to maternal health. Deaths due to puerperal sepsis in the national referral hospital account for 12.7% of the maternal mortality rate annually (Wandabwa et al., 2011). In a regional referral hospital (RRH) in southwest Uganda, deaths due to puerperal sepsis amounted to 30.9% of annual maternal mortality and sepsis was deemed the most common cause of maternal mortality at the hospital (Ngonzi et al., 2016).

Delivery by cesarean section was an important risk factor contributing to the development of puerperal sepsis in the RRH in southwest Uganda. Cesarean delivery complicated by surgical site and urinary tract infections increased the likelihood of mothers developing puerperal sepsis, emphasizing the importance of early recognition of complications to prevent and manage puerperal sepsis (Lamont et al., 2011, Ngonzi et al., 2018). The Ugandan cesarean section rate as of 2021 was projected to increase by 36% which greatly increases the risk for infection and in the long term sepsis. (Atuheire et al., 2019). Global experts recommend prophylactic antibiotic administration 20 to 60 minutes before skin incision and this intervention has been widely practiced in the clinical settings without significant reduction in the maternal mortality rate due to puerperal sepsis (van Schalkwyk et al., 2010) With the high rates of cesarean section, the rate of maternal mortality due to puerperal sepsis is bound to increase in

developing countries if nurses and midwives cannot identify sepsis early in its development and initiate effective management (Asiimwe et al., 2014, Giuliano, 2006).

The Global Sepsis Alliance stipulates that saving the lives of patients at risk for sepsis does not only depend on the treatment of a particular infection, but rather focuses on early recognition and awareness of sepsis, rapid antimicrobial therapy, fluid resuscitation, and vital organ support (Global Sepsis Alliance, 2010). With the increasing burden of sepsis in low-income countries, early identification of sepsis is key to the survival of patients. But, this early recognition remains the greatest challenge facing effective sepsis management (McClelland and Moxon, 2014, Kissoon, 2014). Nurses and midwives, by their having more contact with patients, are pivotal in identifying patients who are unwell or whose conditions are deteriorating. By undertaking routine clinical observations, including vital signs, they initiate the early identification of women at risk for sepsis and therefore may aptly initiate life-saving treatments (Kissoon, 2014, Vousden et al., 2018).

Education about pathophysiology and indicators of sepsis using the Surviving Sepsis Campaign guidelines is crucial for nurses to understand the vital signs and laboratory changes as indicators for sepsis that help in accurately completing and using a screening tool to assess risk for sepsis as well as implementing lifesaving interventions (Dellinger et al., 2013, Olson, 2015).

When a nurse is unaware of the early signs of sepsis, treatment is delayed and multiple organ failure may progress quickly (Olson, 2015). Nurses' knowledge, behaviors, and attitudes about sepsis directly impact patient outcomes. Educational interventions about sepsis and implementation of the Surviving Sepsis Campaign guidelines have been reported to have raised nurses' confidence and ability to identify sepsis and initiate sepsis bundles for example one study

reported an improvement from less than 10% to greater than 90% in the nurses' level of confidence in the identification of sepsis (Olson, 2015, Lee, 2015).

The use of the systemic inflammatory response syndrome (SIRS) criteria from the Surviving Sepsis Campaign guidelines was able to diagnose maternal sepsis due to bacteremia more than other modified tools though its adoption in low-income countries is not widespread (Maguire et al., 2016).

Recommendations have been made regarding the modification of screening tools to meet the needs for low-resource settings. The recommendations in the low-resource settings are modified to define sepsis, severe sepsis, and septic shock in light of vital signs and other signs and symptoms that are indicators for sepsis rather than laboratory investigations that cannot be easily obtained due to high costs and lack of availability in low-resource settings (Dünser et al., 2012). Alternately, other researchers have reported that the ability of clinicians to accurately and efficiently recognize sepsis in its earlier stages remains inadequate, despite information concerning pathophysiology and management of sepsis being available in medical and nursing literature (Jeffery et al., 2014, Kissoon, 2014). The relevant evidence-based information regarding diagnosis and management of sepsis has been made available through the Surviving Sepsis Campaign guidelines though evidence of implementation of these guidelines in scarce for low-income countries (Aitken et al., 2011, Northridge et al., 2014). There is an apparent evidence-to-practice gap observed in low-resource countries including Uganda yet it has been reported that the use of maternity specific sepsis screening tools would prompt early recognition and treatment of sepsis and therefore reduce sepsis-related morbidity and mortality (Kissoon, 2014).

There is a paucity of data regarding knowledge, practice, and educational interventions about puerperal sepsis in low-income countries. There are no defined protocols for maternal sepsis identification and management in use by nurses and midwives in the obstetric wards of public Ugandan hospitals. There are limited reports in the literature of other similar settings employing such tools despite sepsis being a significant contributor to mortality in low-income countries. This aim of this study was to assess the outcome of an educational intervention regarding identification of puerperal sepsis using maternal sepsis screening tools on nurses' and midwives' knowledge about puerperal sepsis and practice in identification of sepsis in postpartum patients following cesarean section delivery.

Methods

This quasi experimental study that employed a pretest, intervention, and posttest design was done to evaluate the effect of an educational intervention on the nurses' and midwives' knowledge about puerperal sepsis and the effect of implementing a maternal sepsis screening tool on the practice of nurses and midwives in identification of puerperal sepsis in the low resourced setting of a South Western Ugandan RRH maternity ward.

Study Setting, Population, and Sample

A purposive sample of midwives and nurses working on the obstetrics, gynecology, and maternal-child health (MCH) wards comprised the population of interest for the quasi-experimental study because they all rotate to the assignment of post-partum care. The wards employed a total of twenty two certificate midwives, fourteen diploma midwives and two intern nurses. The average number of midwives on the maternity ward per shift was as follows; five midwives on the day shift (Three at certificate level, two at diploma level mostly for administrative work), three midwives at certificate level for the evening duty and three midwives

at certificate level for the night duty. The target sample size of nurse participants was derived from a calculation for a planned non-parametric dependent *t*-test analog, the Wilcoxon signed-rank test, where *a* priori power analysis indicated a total sample size of 15. (Buchner et al., 2009). To allow for an anticipated attrition rate of 10%, the researcher aimed for at least 18 participants in the study..

Instruments

Participants' knowledge about sepsis before and after the intervention was assessed using self-administered questionnaires. The questionnaires included multiple choice questions based on knowledge of sepsis from the Surviving Sepsis Campaign and hypothetical case studies that the participants had to respond to by indicating whether the patient had sepsis, severe sepsis, or was demonstrating signs of septic shock. A maximum score of 13 was possible on the knowledge assessment.

Based on the Surviving Sepsis Campaign Guidelines, the education intervention comprised of lecture notes designed to train the identified participants about sepsis definition as the two or more symptoms indicating systemic inflammatory syndrome (SIRS) and infection. Specific information about SIRS criteria included a temperature of equal to or greater than 38^{o} C or lower than 36^{o} C, a heart rate faster than 90 beats per minute, a respiratory rate faster than 20 breaths per minute, and altered mental status (Dellinger et al., 2013).

For the puerperal sepsis screening both retrospectively and prospectively, a maternal sepsis screening tool adopted and modified for the study site was used. The tool screened for indicators of the SIRS criteria which are changes in vital signs due to inflammatory response to infection (pulse, temperature, respiratory rate) signs of sepsis with evidence of malaise or body weakness, and apathy (which indicated altered mental status) , signs of septic shock as changes

in blood pressure and a source of infection. There were areas on the screening tool to indicate the risk for sepsis based on the vital sign and mental status and to record interventions implemented for mothers found with puerperal sepsis or risk of sepsis.

Along with the screening tool, instruments to measure the vital signs like sphygmomanometer and thermometers were provided on the ward.

Study Procedures

The study comprised 3 phases including pre-intervention, intervention, and post-intervention.

Pre- Intervention Phase

During the pre-intervention phase, the participants completed a pre-test to assess the level of knowledge regarding sepsis care bundles and the retrospective review of the randomly selected patients' records was completed.

Retrospective Patient chart review

From a total of 321 charts of mothers who had cesarean section deliveries at the RRH two months prior to the study and had been discharged, 50 charts were randomly selected for the review using the maternal sepsis screening tool that was designed for the study. Out of the 50 charts, 517 randomly selected observations according to the screening tool indicated parameters were recorded for the review based on the different nurses duty shifts (morning, evening and night duty) as measure for baseline screening prior to the intervention. The sample size for the retrospective chart review was derived from informal chart audits in quality improvement projects studies which report that 10% of the total number of charts is sufficient to provide strong evidence of practice (Etchells et al., 2010, Medicine, 2016).

Intervention Phase

In this phase, the nurses and midwives from the identified wards received an educational intervention regarding sepsis identification and management and were instructed on the use of the maternal-specific modified sepsis screening tool.

The educational intervention was comprised of teaching sessions about the epidemiology of puerperal sepsis, sepsis definitions, signs and symptoms for sepsis, sepsis bundles and use of the maternal sepsis screening tool. A total of three teaching sessions were conducted due to the busy working schedules of the midwives. Each session had a range of ten to thirteen participants. The majority of the participants (90%) attended at least twice in the whole training session. Two weeks after the education intervention, the modified maternal sepsis screening tool was introduced as part of the patient record and screening for sepsis was initiated from the time after the cesarean section was done to the day of discharge.

Prospective maternal screening

A total of 247 post caesarian section mothers had maternal sepsis screening tools attached to their files for the study. The evaluation of use of the screening tool was based on thrice daily completion of each assessment criteria on the tool, once per shift, for each eligible mother throughout the duration of each patient's stay on the post-partum unit. The number of times each parameter included in the screening tool was measured and recorded or missed was observed. The outcome of the screening to determine if a mother had sepsis or not and interventions thereof were recorded. To achieve a confidence interval of 95% and an expected proportion of screening tools completed of 30%, the exact binomial calculation determined a sample 341 observations was required (Hulley et al., 2013), prompting a final sample size of 350 observations for analysis.

Post Intervention Phase

In this phase, the participants completed the same knowledge assessment as a post-test after the training.

Evaluation of the use of the screening tool was based on: if the tools were filled for each mother who had delivered by cesarean section on that day (a mother was appropriately scored according to the sepsis screening parameters), if the mother met the SIRS, sepsis or septic shock criteria in the course of her monitoring and the steps taken by the midwife (the steps were indicated on the screening tool).

Data Analysis

The questionnaires and screening tools were scored before and after the intervention. These scores were analyzed using SPSS and descriptive statistics are presented. Paired *t* tests and Chi square tests were used to determine if there was a statistically significant change in sepsis knowledge among the nurses and midwives following education intervention based on the pre and post questionnaires. Chi square analysis compared the retrospective chart reviews and use of the prospective screening tools for differences in frequencies of completion of systematic inflammatory response syndrome (SIRS) criteria assessments.

Ethical Considerations

Approvals for conducting the study were obtained from the institutional Research Ethics Committee (REC) and the Regional Referral Hospital administration.

The midwives and nurses were subjected to a voluntary informed written consent. Owing to the fact that the screening done for the mothers was part of their routine care consent for use of the screening tool was not required from the mothers.

Results

A total of 16 midwives and 2 intern nurses participated in the study representing 47% of the 38 nurses and midwives who met inclusion criteria. The majority of the midwives were at certificate level of nursing and older than 40 years of age

Table 5. Demographic Characteristics of participants as per working station. (N = 18)

Demographic data	Frequency (percentage)
	n (%)
Age category	
Did not respond	2 (11.1)
18 to 28 years	3 (16.7)
29 to 39 years	5 (27.8)
40 or older	8 (44.4)
Years of work experience categorized	
Did not Respond	2 (11.1)
Fewer than 2 years	2 (11.1)
5 through to 10 years	4 (22.2)
Greater than 10 years	10 (55.6)
Nursing Education	
Certificate in Midwifery	11 (61.1)
Diploma in Midwifery	5 (27.8)
Bachelors in Nursing	2 (11.1)
Ward	
MCH	8 (44.4)
Gynecology	3 (16.7)
Maternity	7 (38.9)

Certificate midwife: completed the 2 year course after senior four (o-level) and are classified as technical nurses by the Uganda Nurses and Midwives Council (UNMC),
Diploma midwife: Registered Midwife who completed senior 6 (A-level) and 3 years professional training or advanced from Certificate level with additional 18 months professional training; the UNCM classifies the Registered Midwives as professional midwives.
Intern Nurse: Registered nurse with a bachelor's in nursing or midwifery serving a one-year government sponsored internship to qualify for licensure; the UNMC classifies nurse interns as professional nurses.

Knowledge Assessment

All participants (18) completed the pre-test knowledge assessment at the beginning of the first training session in 30 minutes. The pretest scores were normally distributed with a Shapiro-Wilk statistic as 0.95 *df* (15) *P* = 0.56. The pretest scores were low with a mean of 5.78 and the highest score was 8 out of 13 points. A total of 13 midwives and two intern nurses participated in the post test and were considered in the paired *t*-test to evaluate for knowledge changes. There was a mean improvement in the knowledge scores of 1.33, but the improvement was not statistically significant, t (14) = 1.98, p =.068 Cohen's d = 0.65

Table 6. Knowledge Assessment Results

	N	Mean	SD	Range	Minimum	Maximum
Pretest total score	18	5.78	1.39	5	3	8
Post test score	15	7.13	2.36	8	3	11

There were slightly more correct answers for particular items in after the educational intervention for particular questions in the questionnaire. For example, 27.8% of participants correctly identified heart rate of 95 and a respiratory rate of 24 as indictors of SIRS on the pretest, but the correct response rate improved to 55.6% and 72.2% respectively on the posttest. Some of the proportions of correct answers did not improve as seen in table 3, some items on the questionnaire received fewer correct responses on the post-test as compared to the pre-test.

Table 7. Correct Responses to pretest and post test Questions (*N* = 18)

	Pretest *n* = 18	Posttest *n* = 15
Frequency	*n* (%)	*n* (%)
Clinical manifestation suggestive for SIRS		
Temperature of 37.5^0 C	11 (61.1)	9 (50.0)
Heart rate of 95 beats/min	5 (27.8)	10 (55.6)
Respiratory rate of 24 breath/min	5 (27.8)	13 (72.2)
White blood cell count of 15,000cells/mm^3	14 (77.8)	8 (44.4)
Definition for Sepsis	13 (72.2)	12 (66.7)
Non indicators for sepsis	6 (33.3)	2 (11.1)
Principle for antibiotic therapy	13 (72.2)	11 (61.1)
Identification of septic shock	9 (50.0)	12 (66.7)
Case 1	7 (38.9)	6 (33.3)
Case 2	0	1 (5.6)
Case 3	10 (55.6)	12 (66.7)
Case 4	7 (38.9)	3 (16.7)
Case 5	4 (22.2)	8 (44.4)

Maternal Sepsis Screening

The frequency and proportions that vital signs were documented by the nurses and midwives increased in a statistically significant way when the screening tools were implemented. The proportions of completion on the screening form for all vital sign assessments were statistically significantly greater in the morning shift as compared with the evening and night shifts as determined by cross-tabulation chi-square analysis ($p \leq .001$). Based on the infrequent documentation of assessment criteria, 0.9% of the mothers met the SIRs criteria for sepsis in the prospective maternal sepsis screening. Documentation of assessment of surgical incisions and mental status was less frequent on the sepsis screening tool than found in the retrospective chart review (table 4).

Table 8. Documentation of Parameters: Retrospective and Prospective Reviews *N*=867

Item/shift	Pre-Intervention *n* = 517	Post-Intervention *n* = 350	Pre / post intervention Comparison		Post intervention between shift comparison	
	n (%)	*n* (%)	$\chi 2$	*p*	$\chi 2$	*p*
Temperature						
Morning	1 (0.6)	55 (41.7)				
Evening	0	19 (18.1)	133.7	< .001	38.8	< .001
Night	0	10 (8.8)				
Total	1 (0.2)	84 (24)				
Heart Rate						
Morning	9 (5.2)	53 (40.2)				
Evening	0	20 (19.0)	106.2	< .001	34.7	< 001
Night	0	10 (8.8)				
Total	9 (1.7)	83 (24)				
Respiratory Rate						
Morning	0	50 (37.9)				
Evening	0	19 (18.1)	119.4	< .001	37.1	< .001
Night	0	7 (6.2)				
Total	0	76 (21.7)				
Mental Status						
Morning	153(88.4)	50 (37.9)				
Evening	11 (6.4)	20 (19)	100.2	< .001	34.3	< .001
Night	10 (5.8)	8 (7.1)				
Total	174(33.7)	78 (22.4)				
2 or more signs and symptoms						
Morning	1 (0.6)	43 (32.6)				
Evening	0	17 (16.2)	100.2	< .001	32.5	< .001
Night	0	5 (4.4)				
Total	1 (0.2)	65 (18.6)				
Incision site status						
Morning	151(87.3)	43 (32.6)				
Evening	11 (6.4)	19 (18.1)	16.64	< .001	21.5	< .001
Night	10 (5.8)	10 (8.8)				
Total	172(33.3)	72 (20.6)				
Blood Pressure						
Morning	10 (5.8)	50(37.9)				
Evening	1(0.6)	24(22.9)	102.3	< .001	28.2	< .001
Night	0	10(8.8)				
Total	11(2.1)	84 (24)				

Retrospective review opportunities by shift: Morning: *n* = 173, Evening *n* = 173, Night *n* = 171.
Prospective Screening opportunities by shift: Morning *n* = 132, Evening *n* = 105, Night *n* = 113.

Discussion

Midwives in this sample had a low level of knowledge as evidenced by the low pretest scores. Possible explanations for low mean scores from this study were that there were no stipulated protocols from the surviving sepsis campaign guidelines in use at the RRH for maternal sepsis (Northridge et al., 2012). Unavailability of such guidelines presents a knowledge gap in the diagnosis and management of sepsis which is later translated into poor practices in terms of early identification and initiation of sepsis management. Item analyses of the knowledge assessment tool demonstrated nurses easily recognized septic shock, however they had difficulty recognizing patients in earlier stages of the sepsis (the SIRS/sepsis continuum). This finding was similar to other studies that showed that participants had deficits in identifying patients with the SIRS criteria yet they could confidently diagnose septic shock (Jeffery et al., 2014). The deficiency in recognizing earlier stages of sepsis can translate into delayed management and lead to devastating complications like septic shock.

The increase in the mean scores post intervention indicates an increased level of learning which was a similar finding to another study where increase in the mean scores of the participants pre and post the interventions by 64.5 to 85.2 in the test group was observed (Yousefi et al., 2012).

However, the statistically non-significant change in the scores post intervention can be explained by the possibility of low participant interest and motivation in the topic, owing to the great workload of caring for 40 to 50 postpartum patients at a time. Age could also have be considered as a contributor to the reduction of correct responses in the post-test, as content could have been too complicated for some of the different age groups as majority of the participants

were 40 years and above . This phenomenon is explained by weakening of some cognitive functions due to age (President and Fellows of Harvard College, 2022)

Maternal / Puerperal Sepsis Screening.

A number of difficulties have been met in implementing sepsis protocols, especially monitoring of the SIRS criteria due to low numbers in human resource in many developing countries leaving extremely high nurse to patient ratios. Though the protocols are important, low numbers in staffing have contributed to the slow progression in implementation (Kissoon, 2014).

There was a marked improvement in the documentation of the assessment of post-cesarean section mothers using vital signs and documentation of observed clinical signs improved using the maternal sepsis screening tool. The increased frequency of assessment and documentation of vital signs parameters following the intervention may indicate the education program affected the screening practice of the nurses and midwives, despite the midwives to patient ratio being very high i.e. 1:40 during the day and 1:50 during the night (Ngonzi et al., 2017). The majority of the assessment was done in the morning, most likely due to having a greater number of midwives in this shift. It is not clear what licensure level of the nurse is more frequently present in the morning versus other shifts.

Assessment of the incision site status and mental status were areas more commonly assessed by medical providers in the retrospective pre-intervention review of records. The study did not include examination of the patient files in the prospective arm to locate documentation by these providers that was not included on the sepsis screening worksheet. The decreased frequencies of assessment for these parameters in this study most likely does not represent an overall lower assessment, but it did highlight the infrequency with which the nurses assessed and

documented clinical assessments that require nursing judgment and clinical skill. This phenomenon may also relate to the preponderance of certificate nurses and midwives working at the RRH who may not perform at the same level of professional skills as nurses and midwives with higher levels of education. International studies have confirmed that the educational skill mix of nursing providers influences recognitions of deteriorating patient status (Massey et al., 2017, Sibandze and Scafide, 2018). Other studies also showed an increase in sepsis screening which in turn increased diagnosis of patients with sepsis whom the physicians did not diagnose early (Green et al., 2016, Yousefi et al., 2012).

The midwives in the study sample assessed and documented findings for fewer than one-quarter of the 350 observations allowing identification of only 0.9% of the mothers having two or more of the SIRS criteria. This level of screening was very low compared to another study where a total of 2,143 screening tests were completed in 245 patients and ICD-9 codes confirmed sepsis incidence was 9%, a ten-fold increase in recognition over the present study (Gyang et al., 2015). In the retrospective arm, there was no convenient or consistent form or place for nurses to document their assessment of vital signs or other findings. Placing a flowsheet screening tool in the file specifically for the nurses to use, prompted marked improvement in nursing documentation. It is not clear if an inter-professional review of the nurses' findings was performed by surgeons or other providers.

This shows that despite the lack of documented knowledge improvement from the educational intervention, implementing the screening tool and providing essential instruments to measure vital signs resulted in an improved rate of documentation of vital signs that are aimed at identifying early signs of sepsis. However, the overall rate of adherence to the guidelines was insufficient to identify the expected number of cases of sepsis for the study site based on prior

rates by prevalence studies conducted at the same institution (Ngonzi et al., 2018). The study was effective at finding a small, but significant increase in vital signs measurement, but it did not resolve the issues that prevent the nurses and midwives from documenting complete assessments on the patients and thereby identifying early signs of puerperal sepsis.

Limitations

Every study has limitations, and the results of this study should be cautiously considered in light of its limitations. The lack of statistical significance for the improvement in knowledge may be attributed to the sample size that was designed to detect a large effect (Cohen's $d = 0.7$). The post hoc power analysis revealed the effect size of the difference found was large (Cohen's $d = 0.65$ and the power to detect were marginal at 0.78 (Buchner et al., 2009). We cannot rule out a medium or smaller statistically significant effect of the educational intervention. Likewise, the small sample size does not allow for contrasts between educational levels of the participants; additional studies are required to determine if the predominant lowest (certificate) level of education affects overall care related to sepsis screening.

The low-resource setting frequently does not have sufficient equipment for the staff to measure vital signs; it is not possible to disentangle the effect of supplying the equipment from the effect of the screening tool or the education. The physician and surgeon staff were invited, though did not participate in the education or introduction of the screening tool. It is most likely these providers continued to document their assessments on traditional notes in the patient files. Evaluation of documentation of assessments in the post-intervention phase did not include a thorough file review; it is possible that further documentation of vital signs and other parameter assessments were completed in standard notes rather than specifically on the screening tool.

Conclusion

The study showed that training midwives about the maternal/ puerperal sepsis identification using the Surviving Sepsis Campaign guidelines and provision of a screening tool had a significant impact on the midwife's practice of screening mothers at risk for sepsis and documentation of findings though there was no statistically significant change in knowledge.

Recommendations

Based on the significant improvement in rates of documentation of vital signs demonstrated in this study, providing the essential tools for measurement is critical (blood pressure cuffs, stethoscopes, and thermometers). Additionally, the patient files in low-resourced countries frequently do not contain the designated forms or sections for nurses and midwives to document their assessment findings. Providing a specific location in this study facilitated such documentation. Hence, health ministries should urge public hospital administrators to implement these low-cost strategies tactics and provide access to procurement of the stationary and instruments to follow through with the implementation.

The low levels of knowledge and the limited uptake of the instruction presented to the midwife and nurse participants in this study may be related to the preponderance of technical nursing staff that provide care on the wards. The higher-ranked staff generally perform oversight and administrative duties. In light of evidence that supports professional and university-educated nursing staff is more likely to recognize patients who are becoming seriously ill, the referral hospital systems of low-income countries should study the impacts of providing and encouraging nursing educational advancement to publicly employed nurses and midwives.

Moving the primary certificate nurses to diploma level and then to bachelors level may improve clinical judgment and increase the rate of recognition of early sepsis to save mothers' lives.

The participants in this study improved the rates of documentation of vital signs but did not correspondingly document surgical site assessments or mental status assessments of their patients. In the retrospective review, this documentation was found to be completed by the surgeons. Interprofessional team-based care provided to the mothers in this post-partum ward was not evident in the patient records. Further research is required to examine how multidisciplinary teams approach patient care in low-resource settings to further the improvement of patient outcomes.

Further examination of barriers to measuring and documenting vital signs and assessing patients' surgical sites and mental status should be explored. The patient caseload must be a primary consideration as a barrier; a midwife caring for 40 to 50 patients during an 8-hour shift may face limits of time. Allowing five minutes per patient for a midwife to measure vital signs and assess post-partum status including mental status and document the findings would encompass up to half the allotted shift time for solely this task (3.5 to 4.2 hours). The development of strategies to facilitate overcoming this obvious barrier is paramount to improving the outcomes related to puerperal sepsis in developing countries.

Improvement in health outcomes like reducing maternal mortality from puerperal sepsis in low-resourced countries is a long-term goal that will require sequential and gradual strategies to realize achievement. This study demonstrated that provision of education and tools to complete the required assessments resulted in an incremental improvement that is a step toward the attainment of the goal. Each new tactic in this development should build on existing

knowledge as a translation of strong evidence into practice is adapted to the low-resourced settings of developing countries.

LIST OF ACRONYMS:

MAP: Mean Arterial Pressure

Mmol/L: Milli moles per Litre

RRH: Regional Referral Hospital

SSC: Surviving Sepsis Campaign

SIRS: Systematic inflammatory response

WHO: World Health Organization

MCH: Maternal Child Health

NRH: National Referral Hospital

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