Quality improvement of the preoperative bathing practice before caesarean section in the Obstetrics-Gynaecology Unit of Cibitoke Hospital, North-Western Burundi.

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A research report submitted to the Faculty of Health Sciences in partial fulfilment of the requirements for the degree of Master of Science (MSc) in Epidemiology - Implementation Science.

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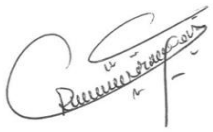
DECLARATION

I, Roger Ciza, declare that this thesis has been composed solely by myself and that it has not been submitted, in whole or in part, in any previous application for a degree. It is being submitted for the degree of Master of Science in Epidemiology in the field of Implementation Science at the University of the Witwatersrand, Johannesburg. Except where stated otherwise by reference or acknowledgment, the work presented is entirely my own.



5th day of February 2021 in Johannesburg, South Africa.

DEDICATION

I dedicate my dissertation work to my family and friends.

A special feeling of gratitude to my loving parents, Marcien Bazirutwiwe and Valerie Matama whose words of encouragement and push for tenacity ring in my ears.

My loving spouse Delphine Kaze, brothers and sisters have always been by my side. You are and will always be very special to me.

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ABSTRACT

Background

Surgical site infections (SSIs) are an important public health issue in both high (HIC) and low- and middle-income country (LMIC) settings. Having a caesarean section (C-section) may be associated with the risk of SSI. Preoperative bathing before C-section is recommended as a cost-effective intervention to prevent SSI. However, little is known of how health professionals in LMIC implement or improve this practice. This study aimed to improve the practice of preoperative bathing practices before C-section by using the model for improvement (MFI) in the Obstetrics-Gynaecology (OBGYN) Unit of Cibitoke hospital, Burundi which had previously reported SSI.

Methods

A quality improvement team (QIT) was assembled and trained on the use of MFI by the principal investigator (PI). A quasi-experimental study design based on the principles of MFI was conducted. The quasi-experimental study comprised pre-intervention (baseline), intervention and post-intervention (endline) phases to assess the preoperative bathing practices, identify factors leading to poor practices, identify test change ideas and evaluate the short-term impact of the implemented change ideas. Overall, four change ideas were identified and tested, each lasting one week. Three outcome indicators were employed to test for change in practice i.e. preoperative bath recommendation, baths taken and completion of recommended baths. Data were analysed using STATA 14.2, and presented using tables, bar graphs and run charts.

Results

At the baseline phase of the study only 44.44% (n=27) of women had been recommended by nurses to bath prior to their C-section. Of the women recommended to bath at the pre-operative stage, only 41.66% (i.e., n= 12) had bathed at least once and 25.00% (n = 12) had completed the number of recommended baths. All (100.00%) (n = 5) those who bathed once and/or completed recommended baths had used soap. By the intervention phase, 92.00% (n=23) of women had been recommended to perform preoperative bathing, 86.95% (n = 20) bathed at least once, and 73.91% (n =17) completed the number of recommended baths. Overall, by the endline phase, the proportion of women recommended to bath had increased from 44.44% to 85.18%. The proportion of women who bathed at least once increased from 41.66 % to 91.30% and the proportion of women who completed the number of recommended baths increased from 25.00% to 86.95%. Moreover, all women who bathed either once or completed baths recommended baths used soap.

Conclusion

By the endline phase, there was improvement in the three outcome indicators i.e., preoperative bath recommendation, baths taken and completion of recommended baths. Low awareness of

preoperative bathing advantages was associated with reduced recommendation of the practice. Recommendations include further research to examine the effects of preoperative bathing on SSI incidence. Such epidemiological research could be used to promote pre-operative bathing in low resource settings.

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ACRONYMS AND NOMENCLATURE

ANNT:	Aseptic Non-touch Technique
CDC:	Center for Disease Control and Prevention
CHG:	Chlorhexidine Gluconate
C-section:	Caesarean Section
CI:	Confidence Interval
DHS:	Demographic Health Survey
DRC:	Democratic Republic of Congo
DSA:	Diseases Society of America
ECDC:	European Center for Disease Control and Prevention
EEA:	European Economic Area
EU:	European Union
HAI:	Healthcare Associated Infection
HREC:	Human Research Ethics Committee
IHI:	Institute for Healthcare Improvement
ICU:	Intensive Care Unit
LLIN:	Long-lasting Insecticidal Net
LMIC:	Low- and middle-income country
MFI:	Model for Improvement
OBGYN:	Obstetrics and Gynaecology
PDSA:	Plan-Do-Study-Act
PCR:	Polymerase Chain Reaction
PI:	Principal Investigator

QI:	Quality Improvement
QIT:	Quality Improvement Team
RCT:	Randomized Controlled Trial
SHEA:	Society for Healthcare Epidemiology of America
SSI:	Surgical Site Infection
UK:	United Kingdom
US:	United States of America
WHO:	World Health Organization

STRUCTURE OF THE RESEARCH REPORT

Chapter 1:

In the first chapter, the Introduction, I present: 1.1. Key concepts used in the study. 1.2. prevalence and incidence of surgical site infection (SSI) in high income countries as well as in low- and middle- income countries (LMICs) 1.3. the SSI prevention. 1.4. a succinct description of the model for improvement (MFI), the theoretical framework employed in the study 1.5. literature review for the research report, 1.6 problem statement based on the gaps in the literature, 1.7 aims and objectives and 1.8 research question.

Chapter 2:

Chapter 2 presents: the methods employed in this study including the 2.1.study design, 2.2. study site 2.3. the overview of the study population and the sampling techniques.
2.4.The process of development and testing of change ideas is also presented. The chapter ends with the description of analysis techniques and the 2.5. ethical considerations.

Chapter 3:

Next, in the chapter of results, I summarise findings of the study from the baseline, intervention and endline phases. Results are presented as summary tables and graphically depicted using run charts.

Chapter 4:

In the final chapters, I discuss the study findings. In the discussion, I reflect on my findings, and compare my findings to previous literature. In the conclusion, I provide key learnings from my field experience and unpack what contributed to the success of the research.

CHAPTER 1. INTRODUCTION

This introduction chapter has several sections including 1.1. key definitions. 1.2. global prevalence and incidence estimate of surgical site infection (SSI) 1.3 the SSI prevention 1.4 model for improvement (MFI) 1.5. literature review for the research report, 1.6 problem statement based on the gaps in the literature, 1.7 research justification and 1.8 research question, aim and specific objectives.

1.1. Key definitions

Key definitions relating to what is examined in this study are: 1.1.1. SSI, 1.1.2. preoperative bathing and 1.1.3. C-section.

These are defined for ease of reference below:

1.1.1 Surgical site infection (SSI):

The term SSI refers to a postoperative infection at the incision site usually within 30 - 90 days after the said procedure (1,2). SSI contribute to the burden of nosocomial infections and are an economic burden to health systems. Patients who suffer from SSI are more likely to have increased hospital stays compared to patients who do not develop SSI (3).

As early as the 1990s, Kirkland and colleagues estimated the prevalence of SSI, SSI and their relationship to mortality and morbidity and excess length of stay in a community hospital in Durham, North Carolina, United States of America (USA). Though their data can be considered

dated, their results are still valuable to my research investigation. They found that the median length of excess hospital stay for patients with SSI was 11 days compared to patients without SSI whose median length of stay was approximately 6 days. Several excess costs were thus associated with SSI including the excess stay in hospital and the need for costly treatments (4). In a 2017 meta-analysis conducted by Badia and colleagues, the main findings corroborated previous studies that had found that SSI were related to poor health related quality of life (5).

With regard to the main exposures related to the onset of SSI, literature suggests that the risk of SSI can increase in relation to the type of surgery (5). A number of studies conducted over nearly four decades for example suggest that colorectal surgery may increase risk of SSI (6–11). These studies will be elaborated further in the literature review.

1.1.2 Preoperative bathing

Preoperative bathing is a bath or shower before surgery to ensure that the skin is as clean as possible and to reduce the bacterial load, especially at the site of incision. Preoperative bathing generally entails using either plain or antimicrobial soap containing chlorhexidine gluconate (CHG) (12). In my study, preoperative bathing was defined as the bath or shower performed before C-section to ensure that the skin is as clean as possible and to reduce the bacterial load, especially at the site of incision.

1.1.3 C-section

C-section is defined by the US Department of Health and Human Services as a procedure where the baby is delivered through an abdominal incision and not through the vagina. C-section is

usually suggested when vaginal delivery is risky to the mother, the baby or both but can also be requested by the mother (13,14).

1.2 Global prevalence and incidence estimates of SSI

There are prevalence and incidence data of SSI available from various studies with data from the World Health Organization (WHO) suggest that SSIs are prevalent in both HIC and LMIC (12). SSIs are highly prevalent in Europe where during the period of 2011-2012, SSI contributed 19.6% of the total burden of hospital acquired infections in the European region (15). The high prevalence of SSI in the European region is further illustrated by 2016 statistics from Germany which suggest that 22,4% of health care infections were SSIs (16).

With regard to incidence data there are data available from a high-income setting, the United Kingdom (UK). In the UK, cumulative incidence of inpatient and readmission-detected SSI has been found to range from 8.7% for large bowel surgery to <1.0% for hip and knee replacement surgery from April 2013 to March 2018 (17).

Furthermore, data from Singapore showed an overall SSI incidence of 7.8% in 2010. Likewise, Korea reported incidence ranging from 2.0% to 9.7% between 1995 and 2010 (12). In Uruguay, SSI incidence for the 2012-2013 period varied between 2.5% and 15.4% depending on the type of surgery (12).

With regards to LMIC, there are prevalence and incidence data available that give us an idea of the global picture of SSI. A meta-analysis by Fan and colleagues examined pooled incidence

yielded by prospective observational epidemiological studies across China. Interestingly, despite finding a pooled average incidence of 4.5 % of SSI in Mainland China from 2001 - 2012, there appeared to be decrease in incident cases over subsequent years. This meta-analysis draws on nuanced differences between more remote Western regions of China which have an incidence rate of 4.6%, the midlands which has an incidence rate of (3.8%) and the eastern coastal regions of 3.0%, suggesting that socio economic status which is disparate between the regions may impact on SSI incidence. The authors suggest that with the advent of the severe acute respiratory syndrome (SARS) epidemic, hospitals had given renewed attention to control of infection. Although the authors are not certain, this renewed attention after SARS may be related to the overall decrease in incidence mentioned above (18).

Data available from Brazil suggests that SSI prevalence had increased from 9.6% in 1998 to 23.5% in 2010 (12,19,20). A recent study conducted by de Carvalho and colleagues, a retrospective cohort study of nearly 17000 participants suggested that incidence rates of SSI were lower than national comparisons and that decreases in incidence of SSI in Brazil may be related to post discharge surveillance (21,22).

In most parts of Africa, SSI incidence can range between 2.5 and 30.9% (23). A recent meta-analysis conducted by Birhanua and Endalamaw of studies of SSI in Ethiopia suggested that pooled prevalence of SSI in this country ranged widely between 6.4 to 75.5% (24), higher than previous estimates in Burundi and the Democratic Republic of Congo (25). Further prevalence estimates tended to differ between different regions of Ethiopia (24) .

Studies suggest that types of surgery are associated with potential onset of SSI (18,26–28). Abdominal surgical intervention seems to be strongly associated with SSI. However the rates are significantly lower after orthopaedic surgical interventions (18,27–29). For example, SSI incidence in Colombia varied between 2.54% after hip arthroplasty and 46.2% after pancreas and kidney transplant (26). Two Canadian hospitals reported overall incidences of SSI 16.3% and 0.91% respectively for abdominal and orthopaedic interventions (30,31). In Europe, the 2016 annual epidemiological report on SSIs in the EU/EEA zones indicates that the percentage of SSIs varied from 0.5% to 9.0% in knee prosthesis and colon surgical operations (27,32). In China, a meta-analysis found an SSI incidence rate of 8.3% and 1.0% for abdominal and orthopaedic surgeries, respectively (18). In sub-Saharan Africa, a systematic review revealed a significant heterogeneity of SSI incidence according to the type of surgery with an SSI incidence of 19.1% in general and visceral surgery, 14.8% in orthopaedics and 8.6% in Obstetrics and Gynaecology (OBGYN) (33). In Nigeria, a recent meta-analysis found out that SSIs are most commonly encountered following colorectal and abdominal surgeries at the respective rates of 29.2% and 20% (29). Studies examining the relationship between SSI and type of surgery will be expanded in the literature review below.

1.3 SSI Prevention

Prevention of SSI is a public health concern. Several evidence-based interventions have been proposed to prevent or reduce SSI including the comprehensive Global Guidelines for the Prevention of SSI by the WHO (12). In 2017, the American college of surgeons suggested that prevention interventions of SSI could incorporate both pre- and post-hospital interventions. An example of a prehospital intervention could be a behavioural intervention e.g. smoking cessation,

encouragement of food security or nutrition or prophylactic antibiotics (34,35). Indeed, Skeie and colleagues found a significantly higher incidence of SSIs among patients at nutritional risk, i.e. sub-optimal food intake, weight loss and/or low body mass index as compared to those who were not at nutritional risk11.8% vs 7% (36).

Moreover, Sidhwa and Itani report that preparing the surgical site with alcoholic 2% CHG was associated with significant reductions in the risk of SSI when compared to aqueous-based preparations (37). In a multi-centre study, alcoholic-CHG has been shown to be superior to aqueous 10% povidone-iodine. The overall rate of SSI was significantly lower in the alcoholic-CHG group, 9.5% vs. 16.1%. Again, alcoholic CHG was significantly more protective against both superficial (4.2% vs. 8.6%), and deep incisional infections (1% vs. 3%) (6). Furthermore, a systematic review conducted in 2015 suggested that the SSI rate in the CHG and aqueous povidone-iodine groups were 6.3% and 13%, respectively. There was a 53% reduction of SSI risk in the CHG group compared to the aqueous povidone-iodine group (38).

On the other hand, examples of hospital preventive measures could include blood glucose control, surgeons wearing double gloves and clean instrument trays. In a meta-analysis published by Zywot and colleagues in 2017, studies suggested an overwhelming reduction in SSI when bundles with sterile closure trays were used (39). In a study of the risk of incidence of SSIs in diabetic patients who had had surgery for orthopaedic trauma, Reich and colleagues noted an SSI incidence rate of 32% and 14.2% for poorly controlled diabetic and controlled diabetic patients

respectively (40). In addition there are also post-operative interventions to reduce the risk of SSI (1). They include wound dressings and optimal timing for wound drain removal (1).

As a focus of this research report, cost –effective preventive strategies have been considered including pre-operative antibiotics or pre-operative bathing. The former's cost effectiveness potential was the focus of a systematic review by Allen and colleagues. Their findings suggest that although administering pre-operative antibiotics may be cost-effective, most randomized controlled trials (RCT) do not include a cost effectiveness component (42). Another prophylactic strategy in relation to SSI is that of preoperative bathing. Preoperative bathing decreases the bacterial load on the skin prior to incision and ultimately decreases the risk of SSI occurrence (12,43–46). The recommendation is that a patient takes at least two baths or showers a day prior to surgery; the first bath/shower the evening before the scheduled surgery and the second in the morning of the day the surgery is to be performed (12). Therefore, preoperative bathing is one of the interventions in which patients play a key role, guided by health professionals who give them procedural instructions.

Generally, preoperative bathing can be performed using either an antimicrobial soap or plain soap (12,47). However, countries can adopt national policies that are specific to either using antimicrobial (also known as 4% CHG) or plain soaps. An illustration is the United Kingdom (UK) where policies recommend the use of plain soap prior to surgery (12). In the US, while the Institute of Healthcare Improvement (IHI) bundle for hip and knee arthroplasty recommends CHG soap for preoperative bathing, both the Society for Healthcare Epidemiology of America (SHEA) and the Infectious Diseases Society of America (DSA) do not give particular

recommendations for which one to choose (12). With respect to developing countries, WHO recommends the use of plain soap, partly because it is cheap and widely available (12). In their study to examine the association between bathing and SSIs in the US, Colling and colleagues found that a bath policy associated with a pre-operative antiseptic shower was associated with a significant SSI decrease (48). Epidemiological studies of the effectiveness of preoperative bathing for SSI are elaborated in the literature review.

1.4 The Model for Improvement

I now move onto the Model for Improvement (MFI). The most common quality improvement (QI) methodologies used in health care are six-sigma, lean and the MFI. Each method has a common goal of improving delivery and support processes (49).

I describe each below.

Six-sigma is a rigorous statistical measurement methodology designed to reduce cost, decrease process variation, and eliminate defects. It reflects the number of standard deviations a given process is from perfection and is achieved through a series of five steps that are define, measure, analyse, improve and control (50).

Lean methodology is driven by the identified needs of the customer and aims to improve processes through removing non–value-added activities, also called waste, which add to cost, or affect the patient experience (50). Lean and six-sigma are often used together in an integrated approach called Lean-sigma through which a testing phase during the sigma's fourth step

"improve" is incorporated. In this step, solutions are created, and tests of change developed. Also, the change team learn from the test, improve the change, and then test again, eventually find the best-fit solution (50).

The MFI is the most commonly used approach for rapid cycle improvement in health care and has been successfully used by many health care organizations to improve health care processes and outcomes. It comprises two main parts namely thinking and doing parts respectively. The thinking part is made of three fundamental questions whereas the doing part consists of a series of iterative cycles labelled Plan-Do-Study-Act (PDSA) cycles aimed at testing changes in real world settings (51) [Appendix 1].

Based on successful examples where the MFI has been implemented and its feasibility to be tested in the developing countries(52), the MFI was chosen to guide improvement of preoperative bathing processes and outcomes.

1.5. Literature review

Several online databases including PUBMED, the Cochrane Library and Global Health were searched for literature to inform this literature review and this quasi-experimental study design. The following search terms were employed: SSI, risk, intervention, preoperative bathing, and MFI. Reference lists were scanned of all relevant papers to ensure that important literature was not missed. A plethora of literature emerged and builds a rationale for the research question suggesting that SSI is an important public health issue and requires low-cost interventions. The literature is therefore presented and synthesized under the following themes:

1. Risk factors for SSI. 2. The relationship between SSI and C-section. 3. Pre-operative bathing. 4. Public health studies using the MFI.

1.5.1. Risk factors for SSI

As mentioned earlier in the chapter's introduction section, there are several risk factors for SSI suggested by meta-analyses, systematic reviews and observational epidemiological studies from both high and low to middle income country settings (25,53–58). Studies suggest that despite improvements in sterilization of operating rooms and instruments, advance of surgical techniques, basic operations such as the removal of the appendix and C-sections may lead to the onset of SSI (59). Risk factors include types of surgery associated with potential higher risk as well as additional risk factors. Pre-existing morbidities known to be associated with SSIs are elevated BMI (obesity), smoking, older age, nutritional status, low immunity, being on immunosuppressive therapy, longer preoperative hospitalization period and having diabetes (60). These risk factors are elaborated below, mainly from studies conducted in LMIC, relevant to the present study setting:

Da Costa and colleagues who work in Brazil aimed to estimate prevalence of SSI following hydrocelectomy, where surgery is used to reduce excessive fluid in the testes, among a sample of adult patients. They also aimed to examine risk factors for the onset of SSI after this procedure. They found that being a chronic smoker was a risk factor for SSI. Smokers were almost three times at risk of SSI after hydrocelectomy when compared to non- smokers. Neither antibiotic

prophylaxis nor post-operative variables (e.g. the length of the hospital stay nor the operation time) were found to have a statistically significant relationship with SSI (61).

In another LMIC setting, a trauma Centre in Southern Thailand, Tunthanathip and Tepaamondej examined risk factors associated with the onset of SSI after neurosurgery finding that brain shift, the actual operative procedure was associated with the onset of SSI (62).

Yang and colleagues who work in China published a study in 2020 focusing on SSI in orthopaedic patients. They suggest that orthopaedic surgery has evolved significantly over time and postulated that as a result of extensive procedures, there might be higher risk of SSI. Their study found through retrospective record review that 3.1 % of their patients had SSI. Further, older age, diabetes and hypertension were associated with the onset of SSI in this sample (63).

Another study published very recently in 2020 by Chong and colleagues investigated incidence and the risk of onset of post-operative complications including SSI after recto-vaginal fistula repair surgery. This study which was conducted in the United States of America (USA), a higher income setting suggested that the group who had the procedure transabdominally was more likely to experience post-operative complications including SSI. However additional variables including comorbid conditions and pre-operative infection also seemed to be predictive of post-operative complications (64). In Burundi, a recent study reported that SSIs were associated with 20% of laparotomies (abdomen surgical interventions) whereas only 4% of external fixation surgical wounds (part of orthopaedic interventions) were found to be associated with SSI (65).

1.5. 2. The relationship between SSI and C-section

First, I provide prevalence estimates of C-section procedure to give some context. Prevalence of C-section has increased substantially across the world over the last three decades. In 1990, the global prevalence of C-section was 6.7%. By 2014 the prevalence of C-section was estimated to be 19.1%. increased to 19.1% by 2014, and is annually increasing by 4.4% (66).

The Latin American and the Caribbean regions currently have the highest C-section prevalence, combined estimated figure of 40.5%. With a C-section prevalence estimate of 55.6% and 56.4% respectively for Brazil and the Dominican Republic, the two aforementioned countries record the highest rates in the region and the world (66). Higher prevalence of C-section are also noted across the North America, 32.3%; followed by Oceania with 31.1%; Europe with 25% and Asia 19.2% (66,67). Armenia reported an increase of C-section rate, ranging from 7.2% in 2000 to 31.0% in 2017 due to financial incentives, lack of regulations and maternal requests. More specifically, higher reimbursement for C-section was a reason for OBGYNs to perform more C-sections, even without medical necessity (68).

In addition to the disparities between countries described above, a recent study suggested that there are within-countries disparities regarding C-section access. Firstly, women from the richest quintiles preferred C-section almost five times more than those from poorest quintiles. Secondly, a high rate of C-section use was noticed among highly educated women from Brazil and China. Thirdly, Brazilian private facilities used C-section 1.6 times more frequent than public facilities (69).

Africa has the low C-section prevalence of 7.3%, but there still are significant variations between African regions (67). The C-section prevalence estimates were 29.6%; 6.2% and 4.1% in North Africa, Eastern and Southern Africa and West and Central Africa respectively. Between countries, variations are also noted and overall, countries like South Sudan with 0.6%; Niger 1.4%; Burkina Faso 1.9% and Zambia 3% have the lowest C-section prevalence while Egypt record 51.8%, the highest C-section rate (66).

In Burundi, reports suggest that C-section was performed for about 6.9% of deliveries in 2005 and 5.8% in 2008 with a C-section average rate of 4% between 2008 and 2012 (70). According to the 2017 Demographic Health Survey (DHS), only 5% of births are caesarean deliveries and some particularities are to be highlighted. C-section prevalence estimates are about four times higher in urban areas, 16% than rural areas 4%. Also, C-section rates vary between lowest and highest quintile, from 3% to 13%. Moreover, the 2017 DHS reported that 14% of women with secondary or higher education deliver by C-section whereas the rate is only 4% among women with primary or no level of education (71).

As with any surgical procedure, C-section can be associated with a number of complications, SSIs being one of them. The rate of SSIs following C-section ranges from 3% to 15% worldwide (72).

Worldwide, the SSIs are the most frequent infectious complication following C-section contributing to maternal morbidity and mortality (72,73). Recent studies found that women undergoing C-section are five times more likely to develop a postpartum infection after delivery

than women who undergo vaginal delivery (74–76). In the literature, the reported SSI rates following C-section range from 3% to 15%, depending on factors like the surveillance methods used to detect infections, the population characteristics, the antimicrobial prophylaxis among others (72). However, lower rates are found in developed countries whereas developing countries report much higher rates of SSIs following C-section (73,77).

Kawakita and colleagues suggest risk factors for the onset of SSI after C-section include maternal intrapartum and operative factors. Examples of maternal factors include maternal smoking, sub-optimal care during pregnancy obesity, corticosteroid use, twin pregnancies, anaemia, and previous C-section. They further suggest that delivery factors including rupture of membranes and lack of antibiotic administration during delivery may also be predictors of SSI after C-section (78).

Regarding intrapartum and operative factors, several conditions are recognized to be factors triggering SSIs. They include premature rupture of membranes, chorioamnionitis, prolonged rupture of membranes, prolonged labour, large incision, subcutaneous tissue thickness >3 cm, lack of antibiotic prophylaxis, subcutaneous hematoma, emergency delivery, and excessive blood loss (78,79). Repeated digital vaginal examinations (≥5 times), prolonged duration of surgery, wound contamination class III and C-section performed by less experienced practitioners have also been identified as risks which increase odds of SSIs (79–81).

Zejnullahu and colleagues suggest from prospective cohort data in a hospital in Kosovo that 9.85% of their sample developed SSI. Their sample comprised 25 women who underwent labour

and scheduled C-sections between January and September 2018. Each woman was followed for 30-postoperative days. They found that being younger i.e., less than the age of 35 years, preoperative use of antibiotic prophylaxis and ensuring that the operation duration was less than one hour. Having had a C-section before and having a comorbid condition (e.g. diabetes or anaemia) increased risk of SSI, respectively (73).

With regards to developed countries, the rate of SSI was 5.5% at one university based US hospital (82). In Canada, a community hospital reported a crude SSI rate of 5.9% whilst the province of Saskatchewan reported an SSI rate of 3.5% for the period of 2015-2016(83,84). In Europe, ECDC reported an average SSI rate of 2.9% for C-section in 2016 (12,32).

With regards to LMICs, WHO reports indicate that up to 20% of women having a C-section contract a wound infection and more examples of high rates of SSI following C-section are reported (12). Two Brazilian studies reported SSI rates of 9.6% and 23.5% respectively for the first and second (12).

In 2005, a Kenyan Hospital reported an SSI rate of 19% among women who underwent C-section (85). A recent multi-site study conducted by Médecins Sans Frontières in Burundi, the Democratic Republic of Congo (DRC) alongside Sierra Leone reported a post C-section SSI rate of 10,4%, 10% and 7% respectively (25). In Ethiopia, SSI prevalence of 8.4% and 11% respectively was reported at two hospitals (79,86), whilst the Bugando Medical Centre and Dodoma Regional Referral Hospital in Tanzania reported an SSI incidence of 10.9% and 48%

respectively (87,88). In Nigeria, studies carried out at Kano and Ibadan Hospitals reported an SSI prevalence of 9.1% and 16.2% respectively (89,90).

In Burundi, Cibitoke Hospital is one of the hospitals that has high rates of SSIs following C-section. In 2015, C-section accounted for 643 out of 2569 deliveries with 46 SSIs identified, making an incidence of 7.15%; whilst during the only month of December 2017, 11 SSIs were reported over 54 C-section performed, which made an incidence of 20.3% (91).

1.5.3. Pre-operative bathing and its effects

The 2016 WHO SSI prevention guidelines include a number of strategies to alleviate SSIs occurrence [Appendix3]. They comprise measures to apply pre-operatively, intraoperatively and postoperatively (1).

Regarding preoperative measures, some of the most important strategies are the preoperative bathing, hair removal, surgical site preparation and surgical hand preparation (1).

A number of studies have examined the relationship between preoperative bathing and reduction of risk of SSI. For example, de Castro Franco and colleagues conducted a systematic review with a meta-analysis that examined the effect of bathing with 4% chlorhexidine on the prevention of SSIs in clean surgeries compared to bathing with placebo solution or soap. The findings of their systematic review suggested no significant difference in reduction in infection between

intervention (i.e. bathing with 4% chlorhexidine) and placebo solution (92). However, the authors did recommend further RCTs to examine the effects of pre-operative bathing on reducing SSI.

Further studies including RCTs that examined interventions for infection control showed effectiveness of outpatient preoperative bathing in reducing the occurrence of SSIs (44–46). Kline and colleagues found that an outpatient preoperative antiseptic decolonization bundle was more effective to eradicate bacteria colonization at all target body sites in 71.9% of participants when compared to the standard disinfectant showers. The latter seemed to succeed in reducing risk of SSI in only 24.5% of their participants (45). Wang Z and colleagues demonstrated that preoperative bathing with CHG was associated with a 1.69% reduction of total SSI incidence as well as a reduction in the incidence of infection among patients in the moderate-risk and high-risk categories (46).

In addition to the RCT described above, observational epidemiological data have also suggested conflicting results. For example, one study suggested that pre-operative bathing might be worth examining in different settings as a means to reduce risk of SSI. This study conducted in the USA compared total body showering and scrubbing incision site with disinfectant agents in a prospective cohort of patients undergoing selected surgical procedures. Patients who showered twice with 4% CHG had lower mean colony counts of skin bacteria at the surgical incision site in the operating room prior to the final scrub when compared to patients who showered twice with povidone-iodine solution or medicated bar soap. Also, patients in the CHG group had no growth on 43% of the incision site skin cultures compared with 16% in the povidone-iodine group and

6% in the soap and water group. Moreover, patients who were scrubbed with CHG had lower rates of intraoperative wound contamination (93). However, another USA based study, a retrospective cohort, conducted among paediatric surgical patients suggested that pre-operative antisepsis with CHG baths/wipes did not reduce the risk of SSI. Furthermore, the authors suggest that use of baths and wipes was adding an unnecessary cost (94).

In a study conducted by Keenan at Duke University Medical Center, North Carolina, USA, a multidisciplinary bundle including education materials, disinfecting showers prior to surgery, antibiotics and wound care was implemented in 2011. The impact evaluation stretched from 2008 through 2012 to allow assessment of before and after outcomes in patients undergoing colorectal surgery. The bundle was associated with reduction in both superficial SSIs, from 19.3% to 5.7%, and post-operative sepsis from 8.5% to 2.4% for the pre– and post-bundle groups respectively (95).

Similar initiatives have made their way to the African continent. An interventional study, a quasi-experimental study design carried out at Mulago Hospital, Uganda compared preoperative bathing and adequate alcohol-based skin preparation. The results suggest a significant correlation between the increase in preoperative bathing; adequate alcohol based skin preparation and the decrease in SSIs rate, from 54% to 14% (96).

Another study recently conducted at Mbarara Regional Referral Hospital in Uganda examine the relationship between preoperative bathing and reduction of incidence of post emergency C-

section SSIs. In their RCT, Lukabwe and colleagues suggested that a preoperative chloroxylenol bath reduced SSI by 90% (97).

In Burundi, despite all the above effective interventions including the preoperative bathing, SSIs prevalence and occurrence remain unacceptably high and to our best knowledge, fewer are initiatives to reduce their occurrence or implement the above interventions.

1.5. 4. Public health studies using the MFI

Given the burden of SSIs, both developed and developing countries continuously work to find cost-effective strategies aimed at decreasing the SSI incidence. Among these are quality improvement (QI) studies examining a potentially cost-effective strategies to reduce SSIs. Among these is the use of MFI to improve practices of preoperative bathing.

A QI study was conducted at two hospitals in the USA aimed to increase adherence to preoperative CHG bathing, targeting patients scheduled for colorectal surgery. Patients were given CHG bathing instructions along with a standard preoperative bathing kit prior to surgery. At the 18 months follow-up, the first hospital reported an adherence of 58%, which improved to 75% after a further 12 months. At the second hospital, the adherence was 92% at 18 months, which was maintained for a further 12 months (98).

Another study also in the USA compared two groups of patients who were to undergo surgical intervention. The first group was offered an educational class on the proper use of CHG in addition to the standard preoperative protocol, whereas the second group received only the standard preoperative protocol. The resultant patient compliance was 95.8% and 77.8% for the first and second groups respectively (99).

Furthermore, Schaffzin and colleagues aimed to reduce SSI-related harm by implementing a prevention bundle through the Solutions for Patient Safety national hospital engagement network. The recommended bundle comprised three measures including preoperative bathing,

intraoperative skin antisepsis, and antibiotic delivery. The initiative resulted in 96.7% adherence to the intervention along with a 21% reduction in SSI rate across network hospitals, from a mean baseline rate of 2.5% to 1.8% (100).

Delgado-Corcoran C. and colleagues employed a QI approach to reduce paediatric sternal wound infections. For the preoperative period, the recommended bundle consisted in CHG baths and mupirocin nasal ointment twice a day for 2– 5 days prior to surgery. Consequently, pre-operative CHG compliance reached 70% in the post-intervention group as documented by the bedside nursing flowsheet (101).

In Ireland, a QI study used iterative PDSA cycles in testing a series of change ideas to decrease the C-section SSI rate. Significant decrease of SSI rate between the baseline and endline was noted, from 14.7% to 7.5% and went along with introduction of CHG for skin antisepsis and increased compliance with choice of antibiotic prophylaxis from 89.6% to 98.5% (102).

In Pakistan, a LMIC settings, Pervaiz and colleagues implemented an improvement approach to establish the adult cardiothoracic SSIs registry to determine adult SSI rates and study impact of QI initiatives on SSI rates between July 2016 and July 2018. After investigation of a high SSI rate, multi-modal process improvements and infection control measures were implemented, leading to a decrease in SSI rate from 4.0% to 2.0% (103).

In African countries to my knowledge, there are few QI studies conducted to improve the preoperative bathing practice in order to decrease SSIs. However, QI approaches using PDSA

have been conducted in other public health domains and led to significant health outcomes improvement.

I.5.4.1 Examples of other public health studies using the MFI

QI projects have also been implemented in Africa in relation to various health outcomes. Data suggests that these have potential to lead to significant improvement of health outcomes.

In Ghana, the "Project Fives Alive" was an outstanding QI initiative that consisted of working closely with communities, frontline workers, and health system leadership to improve performance of maternal and child health programs across Ghana. It resulted in a considerable improvement of maternal and child health materialized by a considerable reduction of morbidity and mortality in under five years old children (104).

In KwaZulu Natal, South Africa, a Prevention of Mother-To-Child Transmission of HIV QI project that was conducted on a health district level resulted in considerable improvement of health outcome indicators in the year following the intervention. The coverage of cluster of differentiation 4 (CD4) testing increased by 142.5%; the uptake of maternal and infant nevirapine increased by 68, 5% and 353, 3% respectively and the Polymerase Chain Reaction (PCR) testing at six weeks in post-natal increased by 183,3% (105).

In Burundi, a QI study using PDSA iterative cycles has been recently carried out to improve long-lasting insecticidal nets (LLINs) use in Kayange community of north-western Burundi. The

study resulted in significant increase of the number of LLINs used, from 32% to 75% and the number of persons (general population) sleeping under LLINs, from 35% to 73%. Also, the number of children under 5 years and pregnant women sleeping under LLINs increased from 31% to 76% and 43% to 73%, respectively (106).

These studies illustrate the role of improvement efforts in implementing the preoperative bathing practice and other initiatives to improve public health outcomes. Such initiatives are even more valuable in developing countries, where implementation of recommended guidelines is frequently delayed, resulting in heavy burdens on health systems. Recent studies attest that preoperative bathing is neglected to a greater degree in developing countries, therefore improvement initiatives would be more helpful (107).

1.6 Problem statement

SSIs represent an immense burden on people's health and health systems as whole (3,12,95). Firstly, 25% of patients with SSIs progress to severe sepsis/shock and are admitted to the Intensive Care Unit (ICU) (108). Secondly, death risk is 2 to 11 times higher for patients with SSIs (109). Thirdly, patients with SSIs require prolonged hospitalizations, reoperations and or readmissions, which imply a considerable cost burden on the side of patients and the health systems (3). The persistent increase of SSIs results from the failure to implement WHO guidelines and recommendations. Despite the lack of data, Burundi is a typical illustration of such a failure. In fact, high rates of SSIs following C-section SSIs are reported across health care settings with some settings reporting up to 20.3% (91) ; which is among the highest rates in the region second to Tanzania.

However, the drivers and facilitators of the persistent occurrence of SSIs and the extent to which the WHO guidelines are implemented are not yet known. Despite governmental efforts to improve maternal, neonatal and children's health which led to significant outcomes including an increase in antenatal care attendance, less have been done to improve maternal outcomes after C-section (71). Namely, practical initiatives to improve preoperative bathing before elective C-section are lacking.

Therefore, our study, which employed the MFI framework, sought to improve preoperative bathing before elective C-section with an ultimate goal of reducing SSIs in the OBGYN unit in Cibitoke hospital in north-western Burundi. Specifically, our study examined the preoperative bathing practices, identified, and tested four improvement ideas, and assessed the short-term impact of the tested improvement ideas.

1.7 Justification

There has been an increase in the use of QI methods in healthcare and services provision across the world. A mounting evidence showed an association of QI methods with better patient and health outcomes. For instance, the QI in Postoperative Pain Management (QUIPS) project consisted of standardized data acquisition and analysis of quality and process indicators. The QUIPS project led to improved care with regards to postoperative pain management (110). The QI researches carried out on preoperative bathing indicated that increase of adherence to preoperative bathing was coupled to SSIs rate decrease (111).

This research sought to meet the need of using QI in SSIs prevention by implementing evidence-based strategies aiming to improve preoperative bathing practices at a hospital unit level,

especially the OBGYN Unit of Cibitoke Hospital characterized by high SSI rates. The study estimated the level of recommended and taken preoperative baths prior to elective C-section and exposed strategies that can improve preoperative bathing practices at a Hospital Unit level. Improving preoperative bathing prior to C-section improved community health by contributing to the reduction of maternal and child morbidity caused by SSIs potentially triggered by low levels of preoperative asepsis. Moreover, the effective and systematic preoperative bathing contributed to decrease wastage of hospital and governmental scarce resources that would have been spent while managing SSIs.

1.8. Research question, research aim and research specific objectives

Research question

Can small tests of change, a central characteristic of the field of implementation science improve the adherence of nurses to encouraging preoperative bathing protocols prior to a C-section procedure in an OBGYN Unit of a rural Hospital in Cibitoke, Burundi?

Research Aim

Ultimately, we hope to increase the proportion of women (when encouraged by nurses) to perform preoperative bathing prior to elective C-section by 50%. Although we hope to see change in practice on a small scale in the study site, we hope that the results will translate into using the information from this study to conduct similar researches in other facilities in the region to determine whether this has broader implication for maternal health in reducing maternal morbidity and mortality in other areas of Burundi.

Specific objectives:

1. To examine the preoperative bathing practices conducted by nurses with women prior to C-section in the OBGYN unit of Cibitoke hospital between August and October 2018.
2. To identify and test improvement strategies, from the field of implementation science, aimed at increasing adherence of nurses to preoperative bathing protocols prior to C-section in the OBGYN unit of Cibitoke hospital between August and October 2018.
3. To assess the short-term impact of improvement strategies by increasing the proportion of women who are encouraged by nurses to perform preoperative bathing prior to elective C-section in the OBGYN unit of Cibitoke hospital between August and October 2018.

CHAPTER 2. METHODOLOGY

This chapter presents the methods employed in this study. The chapter presents details on the study design, population and sample, components of the intervention and procedures. The analytical techniques employed, and ethical considerations taken into account are also presented in this chapter.

2.1 Study design

The study employed a before and after quasi-experimental study design entailing three components: 2.1.1. a baseline. 2.1.2. an intervention and 2.1.3. an endline (post intervention) stages. Each of the components lasted four weeks. The before/after design is one of the most popular in the domain of improvement and once the change is made, circumstances after the change are compared to the circumstances before the change (112).

2.1.1 Baseline

The baseline component was formative and aimed at identifying gaps in current practice in the health facilities. The literature suggests that the baseline component has potential to improve the outcome in both quasi experimental study designs and randomized controlled trials. The design of this component was linked to the recommendations of Grimshaw et al. according to which the baseline provides an overall, initial estimate of a magnitude of a problem (113). Grimshaw et al. further recommended that for a robust evaluation of guideline implementation strategies,

researchers should prioritize study designs that allow comparison between baseline, intervention and final results (113).

This phase entailed quantitative data collection of the current pre-operative bathing practices performed by the nurse participants.

Collected data included:

a. the number of women who came for elective C-section
b. whether or not the women had been systematically recommended to bath before C-section
c. the source of soap used and whether soap was provided by the hospital or not
d. the nurses' reports of whether or not there had been verification that women bathed
e. the number of women who bathed at least once with or without soap
f. and the number of women who completed the number of daily recommended baths with or without soap

In the baseline, we assessed five outcome indicators (Table 1). For each outcome indicator, a target value was agreed upon by the QI Team (QIT). Weekly datapoints were plotted using run charts (figures 3,4,5,6 and 7).

Table 1. Outcome indicators

Indicator	Measurement
1. The proportion of women to whom the nurse has recommended to bath	This was calculated by dividing the total number of women who were recommended to bath over the total number of women who came for elective C-section.
2. The proportion of women who have bathed	This was obtained by diving the total number of women who bathed at least once over the total number of women who were recommended to bath.
3. The proportion of women who have bathed with soap	This was calculated by dividing the number of women who bathed with a soap divided by the total number of women who bathed.
4. The proportion of women who completed recommended baths prior to C-section	This was calculated by dividing the number of women who took at least two baths per day over the total number of women who were recommended to bath at least twice a day.
5. The proportion of women completing recommended baths with soap	This was calculated by dividing the number of women who took at least two baths per day using a soap over the number of women who bathed at least twice a day

The above five outcome indicators can be grouped into three categories as below described (Figure 1).

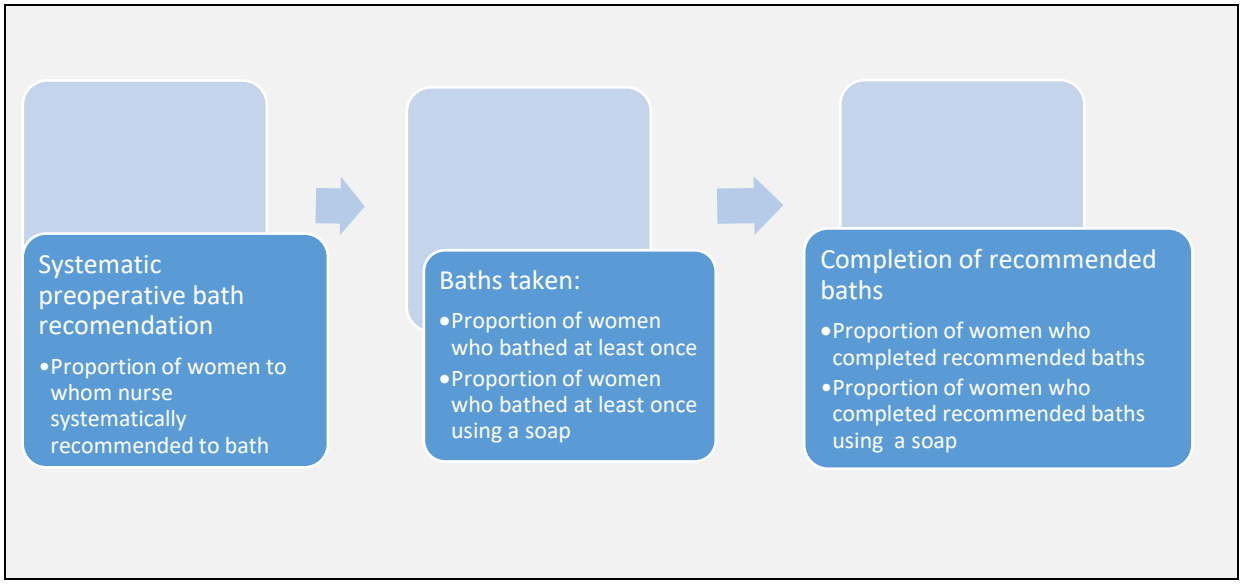

Figure 1: Schematic representation of outcome measures and indicators

In addition, we collected data of socio-demographic characteristics of nurses such as the level of education and the number of years of work experience because they have been found to impact a nurse's routine practices (114,115). In the same wave, a couple of studies conducted in the Middle East found the impact of age, educational level, the number of years of work experience, gender, and marital status on a nurse's practices (114,115). Also, factors including the workload, availability of resources and the managerial support can significantly affect the practice of nurses (114).

2.1.2 Intervention

The intervention consisted of four different PDSA cycles each tested on a period of one week. The thinking component of the MFI framework consisted of responding to the following three fundamental questions; 1) what are we trying to accomplish? 2) How will we know that a change is an improvement and 3) what changes can we make that will result in improvement? The doing part involved the PDSA cycles each of which tested and implemented one change in real-work settings. Results from each PDSA cycle informed the next change idea like it is the case in the improvement process using PDSA cycles (116).

In the beginning, we created a QIT composed of seven members of whom the Principal Investigator (PI) and six staff members from the OBGYN Unit and general hospital personnel. Namely, the QIT comprised the Hospital Director, the Deputy Hospital Director, the OBGYN Unit's Director, the General Hospital's Nursing Chief, the OBGYN Unit Nursing Chief and the Deputy OBGYN Nurse.

The PI trained the QIT on the MFI and regularly held QIT meetings before each PDSA cycle. The QIT agreed to continuously participate in the data collection (through supervising data collectors) and analysis processes with an aim of sparking new and innovative change ideas. The PI supervised the data collection and analysis. As for the baseline, we collected data on the outcome indicators (Table 1). The intervention was tested on a period of four weeks and weekly datapoints were plotted on the run chart. They correspond to the fifth to eighth datapoints (figures 3,4,5,6 and 7).

Third, the nurses recruited to the intervention received the women coming for elective C-section and captured whether these women had bathed or not before the surgery. Alternatively, they recommended that women bath prior to the surgery either 24 or less hours. The intervention then entailed change strategies aimed at closing the gaps between the baseline and the target situation. The target situation as mentioned above is where at least 50% of women are encouraged by nurses to perform preoperative bathing prior to elective C-section.

Before each test of change, the QIT reconvened regularly to learn the results from the previous change and then would identify the new change to be tested. For example, if nurses were omitting to recommend pre-operative bathing prior to C-section, then written reminders were disseminated.

The QIT then assisted the PI in describing what was expected of the intervention to participants. Several face-to-face meetings (four, each lasting approximately 45min) were convened at the health facility to achieve this goal.

Figure 2 below depicts the sequence of the development and testing of PDSA cycles.

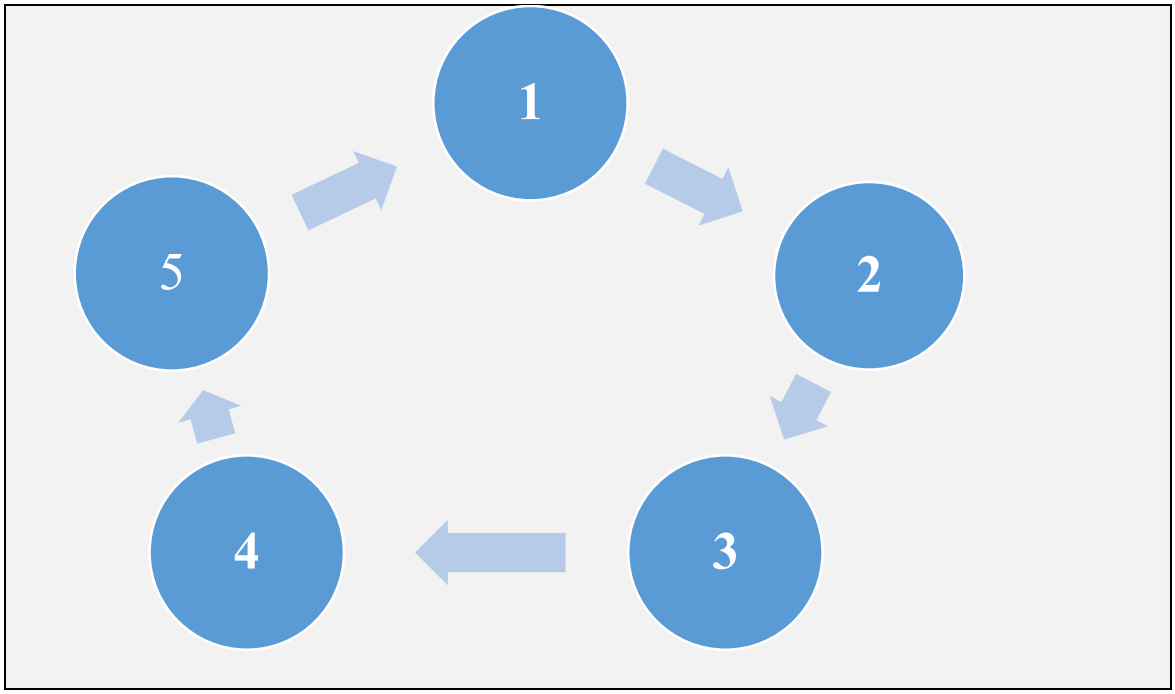

Figure 2: Sequence of events in the improvement process

Step one: Creation and training of the QIT. The PI assembled and trained the QIT on the use of the MFI. Led by the PI, the QIT piloted the QI process through planning, doing, studying and acting on changes.

Step two: Setting an improvement aim statement. With the QIT, an aim consisting in "increasing the proportion of women encouraged by nurses to perform preoperative bathing prior to elective C-section by 50%" was set. Setting an aim answered the MFI thinking part's question *"What are we trying to accomplish?"*.

Step three: Establishing improvement measures. By establishing measures, we sought to respond to the question "How *will we know that a change is an improvement?"*. Thus,

established improvement measures were grouped into three categories i.e., outcome, process, and balancing measures, and have helped identify whether or not a "change was an improvement". Improvement measures are detailed in the appendices [**Appendix 2**].

Steps four and five: Identifying and testing change ideas. By selecting change actions, we sought to answer the question *"What change can we make that will result in improvement?"*. Thus, the QIT convened to select, validate and test four change actions. For each change action, a PDSA cycle was run and the QIT met to critically analyze data on major factors affecting preoperative bath and get key learnings which would later inform the next change action and PDSA cycle.

The Summary of all PDSA Cycles is presented in the Table 2

First PDSA cycle: Sensitization of nurses on the preoperative bathing advantages. Information from the baseline analysis was that nurses do not recommend preoperative bathing because they are not aware of its advantages. Therefore, the QIT hypothesized that sensitizing nurses on advantages of preoperative bathing would result in a change.

Step one: Plan

During this stage, the QIT wanted to find a way to increase the number of women recommended to perform the preoperative bath. The main reason for not systematically recommend preoperative bathing was that nurses were unaware of its advantages. The QIT decided to sensitize nurses on the advantages of preoperative bathing.

Step Two: Do

The sensitization on preoperative bathing advantages was done by inviting nurses and OBGYN Unit staff to the sensitization session. The session was held on Monday 10th September 2018 just after the usual morning staff meeting; a usual time nurses were more likely to be around.

The sensitization session was conducted by the PI assisted by the OBGYN Unit Director. Mainly, the presentation focused on the preoperative bathing, its advantages and necessity to systematically recommend it, especially in a hospital where most of the patients come from rural villages with sometimes poor body hygiene. The presentation further focused on the role played by nurses receiving women coming for elective C-section.

Step Three: Study

Following nurses' sensitization, daily data on systematic preoperative bathing and factors stirring its absence were collected, grouped and summarized into weekly datasets and plotted on run charts. The QIT aimed to observe results and compare them to the predictions. Further, the QIT met upon the first PSDA completion to learn from its results and develop the next change action.

Step four: Act

Following the completion of the "Study" step and based on the lessons learnt from the first PDSA cycle, the QIT met for another time to develop another change idea and ultimately planning the second PDSA cycle.

Second PDSA cycle: Reminders to request preoperative bathing for all women scheduled for an elective C-section. After the first PDSA cycle, findings showed nurses often forgot to systematically recommend women for bathing before elective C-section.

Step one: Plan

In the first PDSA cycle, it emerged that nurses often forgot to recommend women for bathing before C-section. The QIT wanted to find a way to keep higher the proportion of preoperative bathing recommendation. Therefore, the QIT resolved to implement written reminders **"Memo"** that would be displayed in OBGYN nurses' rooms. The developed notice reads "*Chaque femme venant pour la césarienne programmée doit être recommandée à prendre la douche au moins deux fois par jour. Rappelez-vous donc de recommander la douche préopératoire*" which is translated into English as "Every *woman coming for elective C-section must be recommended to bath at least twice a day. You are kindly reminded to recommend preoperative bathing*".

Step two: Do

In this step, the QIT printed and displayed the memo in the OBGYN Unit' nurses stations. At the first day, the QIT ensured that all nurses have seen the notice to recommend women to perform the preoperative bathing as done in the previous week.

Step three: Study

After the reminders were displayed, daily data on systematic preoperative bathing and factors stirring its absence were collected and summarized. Data-points were also plotted on run charts. The aim was to look at the impact of the change idea implementation through observing the new patterns and comparing them to the previous ones.

Step Four: Act

Following the completion of the "Study" step, the QIT met again to learn from the new findings. The later informed the development of the third PDSA cycle.

Third PDSA cycle: Bathroom renovation: From the previous change actions, it emerged that bathroom was dirty and in bad state, and women did not want to enter it twice. Therefore, the QIT suggested that bathroom be renovated and maintained, which was done within two days.

Step one: Plan

In this step, the QIT and the hospital administration discussed on the bathrooms state and the way to make them cleaner. With full cooperation of the hospital administration, it was agreed that the OBGYN Unit' bathrooms would be renovated.

Step two: Do

OBGYN bathroom was maintained and made cleaner. The QIT visited how activities were going on and insisted on the necessity to regularly keep bathroom cleaner.

Step three: Study

Daily data were summarized into weekly datasets and datapoints plotted on run charts. The QIT met to observe the new patterns and results to identify the next change action.

Step four: Act

The QIT realized that the three change ideas resulted in ongoing improvement and sought to find further change idea that would be able to sustain recent and ongoing improvements.

Fourth PDSA cycle: Combining/sustaining the first three change actions: the change actions previously implemented showed a significant improvement in both bath recommendation and bath completion. Thus, the QIT decided to combine and implement them simultaneously.

Step one: Plan

The QIT decided to maintain and implement the last three change ideas in one package bundle. Thus, nurses kept recommending preoperative bathing, the reminders were still displayed and the bathroom kept cleaner.

Step two: Do

During the step "Do", nurses kept recommending preoperative bathing; the reminders were maintained on their usual places and bathroom was made cleaner.

Step three: Study

Daily data were summarized into weekly datasets and datapoints plotted on run charts.

Step four: Act

The QIT realized that combination of the three change ideas resulted in ongoing improvement. The QIT then decided that data should be collected for four weeks in order to observe endline patterns, and there was no further change idea to be implemented.

2.1.3 Endline

The endline component consisted of a follow-up period after the intervention. Similar to the baseline and intervention periods, outcome indicators (Table 1) were weekly monitored to observe the post-intervention trends in preoperative bathing. The endline phase lasted four weeks and collected data were plotted on the run chart to correspond to the ninth, tenth, eleventh and twelfth datapoints (figures 3,4,5,6 and 7).

Table 2: Summary of PDSA Cycles

PDSA number and change idea	**Plan Step**	**Do Step**	**Study Step**	**Act Step**
1st PDSA: Sensitization of nurses on the preoperative bathing advantages: nurses did not recommend preoperative because of lack of awareness of its advantages.	The QIT decided to sensitize nurses on the advantages of preoperative bathing.	• Nurses were invited to the sensitization session, held on **Monday 10th September 2018**, and conducted by the PI assisted by the OBGYN Unit Director. • The session focused on preoperative bathing advantages, the necessity to systematically recommend it and role played by nurses.	• Daily data collection on systematic preoperative bathing and factors stirring its absence. • Collected data were grouped and summarized into weekly datasets and plotted on run charts. • Upon completion of the first PSDA cycle, the QIT met to learn from results and develop the next change action.	Following the completion of the "Study" step and based on the lessons learnt from the first PDSA cycle, the QIT met for to develop another change idea and ultimately planning the second PDSA cycle.
2nd **PDSA cycle**: Reminders to request preoperative bathing for all women scheduled for an elective C-section.	In the 1st PDSA, nurses often forgot to recommend women for bathing. Written reminders **"Memo"** were displayed in OBGYN nurses' rooms and read : "*Chaque femme venant pour la césarienne programmée doit être recommandée à prendre la douche au moins deux fois par jour. Rappelez-vous donc de*	• The QIT printed and displayed the memo in the OBGYN Unit' nurses stations. • At the first day, the QIT ensured that all nurses have seen the notice	• Collected daily data were summarized and data-points plotted on run charts. • The aim was to look at the impact of the change idea.	The QIT met again to learn from the new findings. The later informed the development of the third PDSA cycle.

	recommander la douche préopératoire" which means "Every *woman coming for elective C-section must be recommended to bath at least twice a day. You are kindly reminded to recommend preoperative bathing*".			
3rd **PDSA:** Bathroom renovation: From the previous PDSA, it emerged that bathrooms were dirty and in bad state, and women did not want to enter it twice. The QIT suggested that bathroom be renovated and maintained.	The QIT and the hospital administration discussed on the way to make bathrooms cleaner. Thus, it was agreed that the OBGYN Unit' bathrooms would be renovated.	The bathroom was made cleaner. The QIT visited how activities were going on and insisted on the necessity to regularly keep bathroom cleaner.	Daily data were summarized into weekly datasets and datapoints plotted on run charts. The QIT met to observe the new patterns and results to identify the next change action.	The QIT realized that the three change ideas resulted in ongoing improvement and sought to find further change idea that would be able to sustain recent and ongoing improvements.
4th **PDSA cycle:** Combining/sustaining the first three change actions. The QIT decided to combine the first there change action because they showed a significant improvement in all outcomes.	The QIT decided to implement the last three change ideas in one package bundle: nurses kept recommending preoperative bathing, the reminders were displayed, and the bathroom kept cleaner.	Nurses kept recommending preoperative bathing; the reminders were maintained on their usual places and bathroom was made cleaner.	Daily data were summarized into weekly datasets and datapoints plotted on run charts	The QIT noted that combination of the three change ideas resulted in ongoing improvement. Thus, data were collected for four weeks in order to observe endline patterns. It was the end of improvement process.

2.2 Study site

The study was conducted in the OBGYN Unit of Cibitoke Hospital, in the North-Western region of Burundi. The Cibitoke Hospital is a district hospital that serves as a referral hospital for over 27 Health Centres. The hospital provides preventive and curative care through four main units which are the OBGYN, Paediatrics and Neonatology, Internal medicine, and Surgery Units. The hospital receives both outpatients and inpatients and has the capacity to accommodate 230 inpatients. The OBGYN Unit is equipped with 53 beds for inpatient care. Also, the unit offers general preventive and curative services of OBGYN, obstetric ultrasound and family planning and reproductive health among others.

2.3 Population and sample

The study population consisted of nurses who were involved in care delivery for women who undergo C-section.

2.3.1 Variables

Collected data included variables to capture if: nurses received women coming for elective C-section; nurses have recommended women coming for elective C-section to bath prior surgery; nurses verified that women have bathed; women who bathed have used soap; nurses verified that women have completed recommended baths.

Data collection form provides in detail the type of collected data [**Appendix 5**].

2.3.2 Sampling strategy

The study employed a convenient sampling method. This is a non-probabilistic sampling method in which any member of the target population who meet inclusion and practical criteria such as accessibility, geographical proximity or availability at a given time are included in the study population provided that they consent to participate in the research (117). In our study, we included all nurses who were receiving women prior to C-section (n=16). Routinely, there were two nurses on duty each day: one in the morning and the other in the evening. Among their role include receiving and preparing women scheduled for an elective C-section.

2.4 Study techniques

2.4 1 Data collection

Weekly data were collected using a semi-structured questionnaire which was developed using the WHO guidelines for SSIs prevention (107) **[Appendix 3].** French is the primary language in Burundi, the questionnaire was therefore translated in French to allow better comprehension and administration [**Appendix 7**]. Again, the questionnaire was pre-tested from 25-27 July 2018 on 10 nurses of the OBGYN Unit of Kamenge People's Hospital, Bujumbura. During the pre-test, nurses struggled to answer to the French version of the fourth question pertaining to whether nurses verified that women had bathed. The question was rephrased and thereafter, the questionnaire was adopted and validated. Collected data were back translated into English for analysis and reporting. The questionnaire was paper-based and administered by the data collectors. Seven data collectors were identified from other hospital Units and trained on the use of the questionnaire for data collection. Data

collectors visited the OBGYN Unit on a daily basis, each one had his or her specific day in a week. The PI or another QIT member supervised each of the data collectors during data collection to ensure the accuracy of collected data.

2.4.2. Data management and analysis

Collected data were entered into an Excel spreadsheet the day after collection. The PI and one or two QIT members did the task. Inconsistent or missing values were highlighted and collected once again the same day of data entry. Data and other confidential research documents were saved on a password-protected laptop. Access to the data were only limited to the primary investigator and the research supervisors.

Weekly datasets were analysed to yield a weekly datapoint as described in **Table 1**. We used Excel to generate run charts on which each weekly datapoint was plotted. The run chart has a target line of 50% increase of the proportion of women encouraged by nurses to perform preoperative bathing prior to elective C-section.

Descriptive analysis was conducted to examine socio-demographic characteristics of the study participants. Factors explaining the absence of a recommendation by a nurse to a woman to bath before intervention and those explaining the omission of preoperative bath practice despite a nurse's recommendation were analysed and summarised using frequency tables or graphically depicted using histograms. Each outcome indicator was calculated (Table 3) and plotted on run chart.

2.4.3 Ethical considerations

Before the beginning of the study, research authorization **[Appendix 8]** was obtained from the General Director of Health Services and Fight against HIV who is in responsible for health services delivery and QI at the Ministry of Public Health. The research authorization was submitted with the research protocol to the Human Research Ethics Committee-HREC (Medical) of the University of the Witwatersrand for ethical clearance and approval. The study was issued the Wits HREC number **M108242** [**Appendix 9**]. Moreover, study participants signed an informed consent form [**Appendix 4**]. A serial number was assigned to each participant to ensure anonymity and confidentiality. Data were exclusively used for the research purpose and kept under password protection. Only the researcher and the supervisors had access to the data.

CHAPTER 3. RESULTS

This chapter presents the study's most salient findings from analysed data both at baseline, intervention and endline phases of the study.

3. 1 Baseline results

3.1 1. Socio-demographic characteristics of the study participants

The sample comprised 16 nurses who work in the OBGYN Unit of the Cibitoke Hospital. The sociodemographic characteristics of participants are presented in Table 2 below. The age of participants ranged from 25 to 36 years and the average age was 31.25 years.

The majority of the study participants were female (87.50%) and had completed secondary school (81.25%). A minority of participants (18.75%) had reached university level education. In Burundi, nurses can complete a diploma through a nursing college and work after completion (they do not necessarily need a university level degree).

With regards to work experience, 56.25% had been working in the Unit for a period of less or equal to one year; 31.25% had worked in the unit for one to four years and 12.50% had worked in the Unit for a period of more than four years.

Table 2: Socio-demographic characteristics of participants

Socio-demographic characteristic	**Number (N)**	
Age range	**Number**	**Average**
25-36	16	31.25
Gender	**Number**	**Percent**
Female	14	87.50
Male	2	12.50
Level of education		
Secondary	14	87.50
Tertiary (University)	2	12.50
Years of Experience		
<=1year	9	56.25
1-4 year	5	31.25
>4years	2	12.50

3.1.2 Baseline results

As can be seen in Table 3, of 27 women who came for C-section, on average, 44.44% (12 women) of them were recommended to bath; of the 12 women who were recommended to bath, only 41.66 % (n=5) of them bathed at least once and only 25.00% (n=3) completed the number of recommended baths before undergoing C-section. 100.00% of those who bathed once and/or completed recommended baths have used a soap.

Table 3: Baseline follow-up: outcome indicators

Outcome Indicator	**Week 1**	**Week 2**	**Week 3**	**Week 4**	**Average**
Women recommended to bath (%)	37.50	50.00	40.00	50.00	44.44
Women who bathed at least once (%)	33.33	25.00	50.00	33.33	41.66
Women who bathed at least once with soap (%)	100.00	100.00	100.00	100.00	100.00
Women who completed recommended baths (%)	33.33	00.00	50.00	33.33	25.00
Women who completed recommended baths with soap (%)	100.00	100.00	100.00	100.00	100.00

3.1.3 Reasons for not bathing

Baseline findings suggested that the main reason that explains the non-bathing practice is because nearly two-thirds of nurses are unaware of the benefits of preoperative bathing (Table 4).

Regarding the verification of whether or not women had bathed; this was not done by nurses in 61.54% of cases. The main reason for this to happen was the absence of bath recommendation (93.33%) by nurses.

Table 4: Drivers of non-preoperative bathing recommendation

Reasons for not recommending pre-operative bath	**Total count (four weeks)**	**Percentage**
Don't know it is a good practice	14	63.64
Have never recommended it before	5	22.73
Forgot	2	9.09
No water in the facility	1	4.55
Other	0	0.00
Grand total	**22**	**100**

3.2. Intervention results

On the 25 who come for C-section in the intervention phase, 92.00% (n=23) women were recommended to perform preoperative bathing, 86.95% (n=20) of those who were recommended to bath had bathed at least once, and 73.91% (n=17) of them completed the number of recommended baths. Regarding the use of soap, 100% of women who had bathed (either once or completing recommended baths) had used a soap. Details are presented in **Table 5** below.

Table 5: Intervention phase: Outcome indicators

Outcome Indicator	Week 5 (PDSA1)	Week 6 (PDSA2)	Week 7 (PDSA3)	Week 8 (PDSA4)	Phase average
Women recommended to bath (%)	83.33	100.00	87.50	100.00	92.00
Women who bathed at least once (%)	80.00	66.66	100.00	100	86.95
Women who bathed at least once with soap (%)	100.00	100.00	100.00	100.00	100.00
Women who completed recommended baths (%)	40.00	50.00	100.00	100.00	73.91
Women who completed recommended baths with soap (%)	100.00	100.00	100.00	100.00	100.00

Table 5 shows that the vast majority of women coming for elective C-section (92.00%, n=23) were recommended to bath before the intervention. More than three quarters of women (n=20) recommended to bath have performed preoperative bathing at least once and nearly three quarters of women (n=17) who were recommended to bath have completed recommended baths. Moreover, the soap was used by all the women who either bathed once or completed recommended baths.

3. 3. Endline results

Improvements were noted in three outcomes indicators (see figures 3,4,5,6 and 7) baseline performances were sustained in two outcome indicators (see figure 5); figure 7 depicts both outcomes indicators (with improvements and sustained baseline performances).

The proportion of women who were recommended to bath before C-section increased from 44.44% before intervention to 85.18% after intervention (91.67% increase). Figure 3 depicts the percent of bath recommendation before and after interventions.

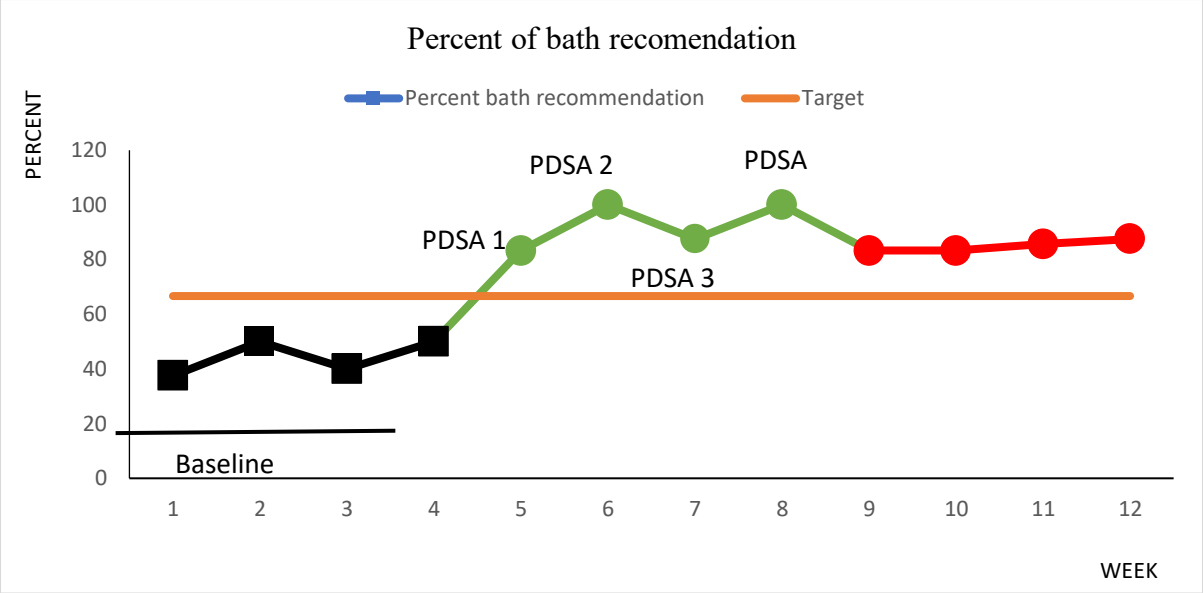

Figure 3: Percent of bath recommendations before and after interventions

The proportion of women who bathed at least once before C-section increased from 41.66 % before intervention to 91.30 % after intervention (111.70% increase).

The increase is presented in figure 4 which depicts the percent of women who bathed at least once, both before and after interventions.

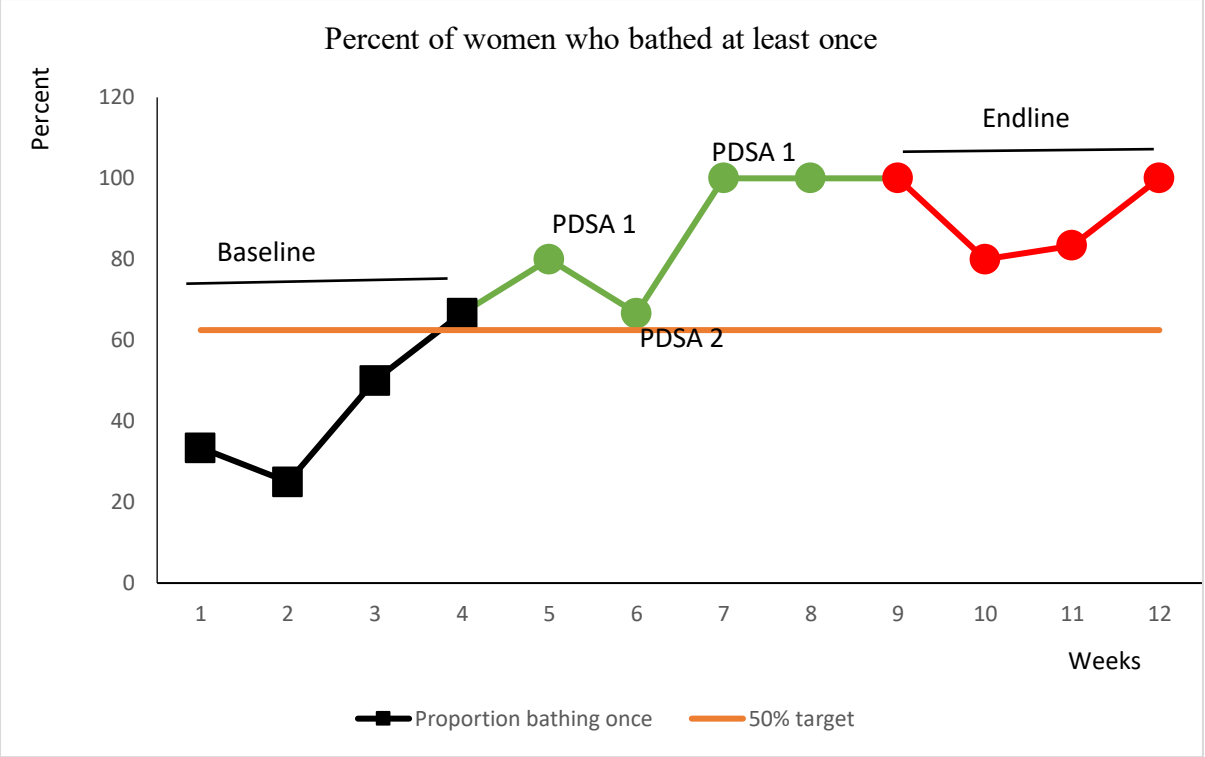

Figure 4: Percent of women who bathed at least once

The proportion of women who completed recommended baths before C-section increased from 25.00 % before intervention to 86.95% after intervention (139.40% increase). Figure 6 depicts the percentage of women who completed the number of recommended baths before an elective C-section, both before and after the interventions.

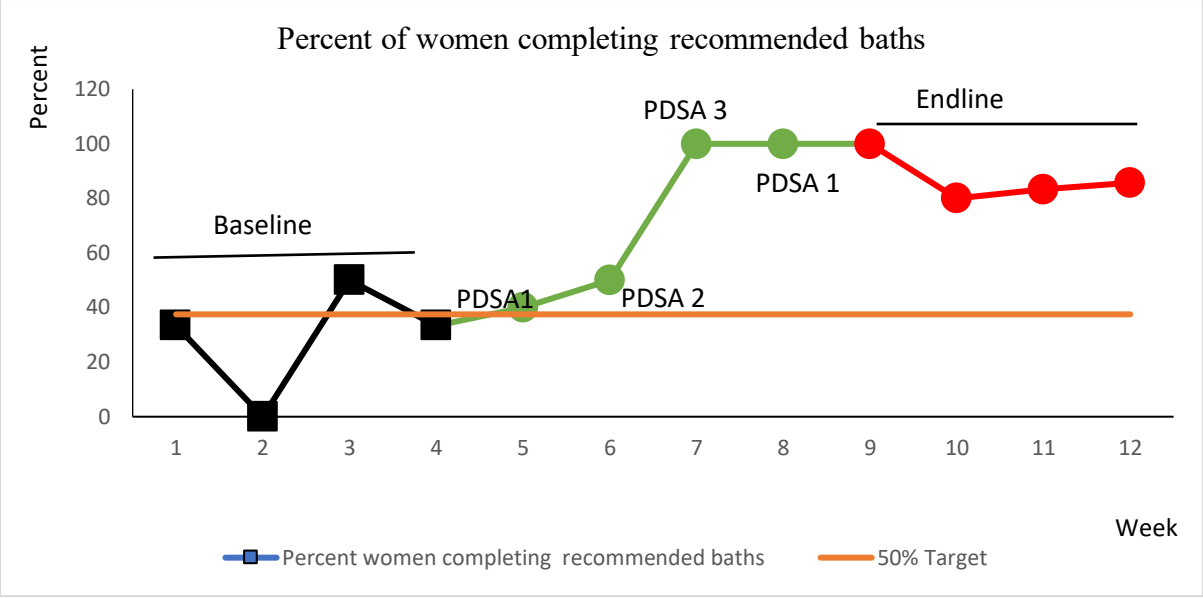

Figure 6: Percent of women completing recommended baths before C-section

Moreover, the proportions of women who bathed at least once using a soap and women who completed recommended bath with soap before C-section remained constant from the baseline to the endline (100.00%). In other words, baseline performances were sustained in the two outcomes indicators as it is represented by the figure 5 which depicts the percent of women who bathed at least once with a soap. Furthermore, all patients (100.00%) who bathed used their own soaps as the hospital does not provide patients with bathing soaps.

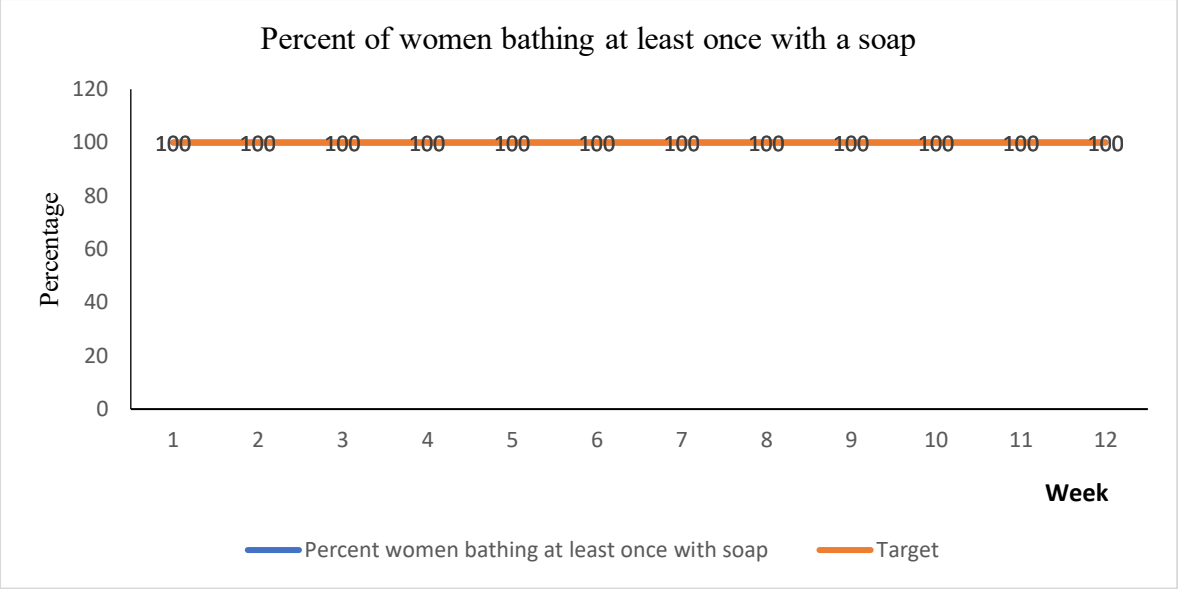

Figure 5: Percent of women who bathed at least once with a soap

Overall, implemented interventions have been translated into improvements in three outcomes indicators, namely the bath recommendation, bath realization and bath completion. Regarding the use of soap, baseline performances were sustained in two outcomes indicators that are bathing with soap and completing recommended baths.

Figure 7 depicts outcome indicators with improvements and those with sustained baseline performances.

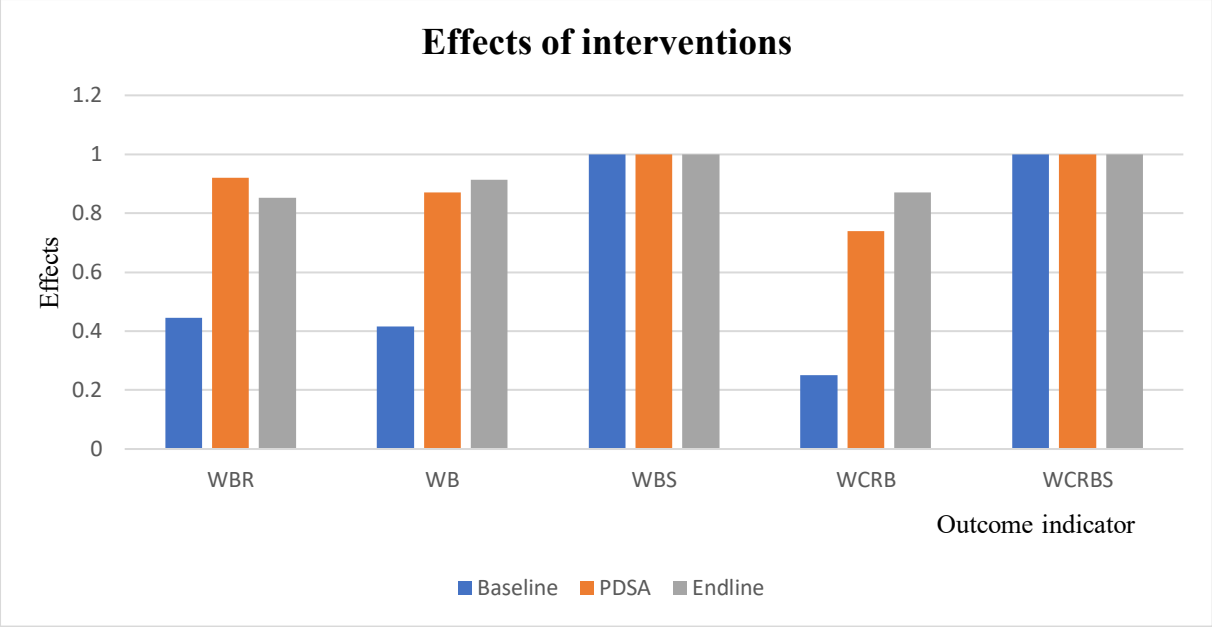

Figure 7: Effects of interventions

(1) WBR= Women recommended to bath

(2) WB= Women who bathed at least once

(3) WBS= Women who bathed at least once with a soap

(4) WCRB= Women who completed recommended baths

(5) WCRBS= Women who completed recommended baths with a soap.

CHAPTER 4. DISCUSSION

In this study conducted in one OBGYN Unit in Burundi, change actions were developed and implemented using the MFI framework to improve preoperative bathing prior to elective C-section. The study results suggest that significant improvements obtained in the intervention period were sustained over the entire study period. Specifically, these outcomes are the number of women recommended to bath, women who bathed and completed recommended baths all of which increased. This chapter presents and reflects on the study's most salient findings both at baseline, intervention and endline phases with comparison to previous literature.

4. 1 BASELINE FINDINGS

4.1.1 Women recommended to bath

In our study, 12 women out of a sample of 27 (44.44 %) coming for elective C-section were recommended to bath before the intervention.

Our baseline findings were lower than those found in previous similar studies. For example, Schaffzin and colleagues in the USA used the MFI to implement a preoperative SSI prevention protocol (including a preoperative bathing with chlorhexidine gluconate) for paediatric neurosurgical patients. The staff (nurse) adherence at the baseline phase of the study was 92.9% and the overall (nurse, patient/family) adherence 51.3%. A possible explanation for this high adherence to protocol is that incentives were offered to those participating in the intervention (111). Our baseline results are also lower than those reported in another QI study that aimed at reducing healthcare associated infections in Kuwait. This particular study conducted by Ramadan and colleagues noted an overall baseline compliance

to hand hygiene in surgical Paediatric Intensive Care Units (ICU) that of 62.2% and 76.1% respectively (118). We suspect that low baseline compliance with recommendations of pre-operative bathing may be due to low resources and sheer patient burden as suggested by previous studies (119,120).

However, our results are comparable with those reported by Khurana and colleagues who applied the MFI to reduce healthcare associated infections in neonates by standardizing and improving compliance to Aseptic Non-touch Techniques (ANNT) for commonly performed procedures in the Neonatal Intensive Care Unit. Compliance to aseptic non-touch techniques practices (procedure tray/trolley), cleaning, personal protective equipment use and use of non-touch technique was respectively 16%, 33%, 55% and 50%. Also, the rate in key part contamination was 45% (121).

4.1.2 Percent of women who bathed at least once before and or completed recommended baths.

In our study, 41.66 % of women who were recommended to bath bathed at least once and a quarter (25.00%) completed the number of recommended baths before C-section in the baseline.

With regards to this particular outcome, previous research has yielded contrasting results. Some studies have reported lower prevalence at the baseline stage compared to others which suggest higher compliance. On the one hand, our baseline preoperative proportion is lower than that of Elobu and colleagues in Uganda which was of 72% (96) and that of Allegranzi and colleagues who examined data from a multicentre study in Africa. Allegranzi and colleagues found the compliance with preoperative patient bathing was 77.2% in the

baseline (122). In the USA, Leeds and colleagues in their comparative QI study to improve patient adherence with preoperative chlorhexidine gluconate bathing for elective patients undergoing colorectal surgery reported a patient adherence of 58% and 92% at the first and second hospitals respectively (98). Moreover, our results baseline findings are also lower than those of Schaffzin and colleagues in the USA who found a patients' adherence to the preoperative protocol of 83.8% at the preliminary phase (111). The development level of the USA in the study of Schaffzin and colleagues would explicate the high adherence to bathing protocols as body hygiene can mostly be influenced by socioeconomic status. Also, given that incentives have been associated with reinforced medication adherence (123), we can suspect that offering the soap for free of charge can be one of the reasons explicating the higher adherence to preoperative protocol in the study conducted by Schaffzin and colleagues. Similarly, the consistent supply of CHG soap has been reported as a facilitator influencing the bathing process in the study of Musuuza and colleagues (124).

On the other hand, our baseline findings are comparable with those of Wick and colleagues who reported that 33% of patients were compliant with preoperative bathing protocols (125). Interestingly our baseline findings are higher than those of Kong K. and colleagues and Hekman and her colleagues. Kong K. and colleagues reported a patient compliance to appropriate hand hygiene practices that was as lower as 13.4% (126), whilst Hekman and colleagues reported a 0% compliance to preoperative chlorhexidine gluconate showers in the baseline (127).

4.1.3 Percent of women who bathed with soap before intervention

Both women who bathed at least once and those who completed recommended bath have (100%) all bathed with soap. Our results are higher than those of Kapadia and colleagues in the USA where 78% of patients were noncompliant with preoperative disinfection protocols (128). Our results are also higher than those reported by Schaffzin and colleagues in the USA whose baseline protocol adherence for patients/families was 83.8% (111). It is possible that regular use of soap probably results from massive campaigns and community mobilization for regular use of soap to prevent dirty hand diseases.

4.2 Intervention Findings

Improvements were noted on the three indicators on which poor performances were noted during the baseline assessment. The target values (50% improvement from the baseline) that were set as improvement goals were all reached. For example, preoperative bath recommendations increased from 44.44% (baseline) to 92.00% in the intervention (PDSA) phase; the number of women who had at least one preoperative bath and those who completed the number of recommended baths increased from 41.66 % to 86.95% and from 25.00% to 73.91%, respectively. Also, the baseline results remained unchanged (sustained at) 100% for the use of soap for both of those bathing at least once and those completing recommended baths.

Our results are also comparable to those of Habonimana and colleagues in Burundi who used the QI methodologies to improve long-lasting insecticidal nets use in Kayange community of

north-western Burundi. The number of long-lasting insecticidal nets use increased from 32% to 75% and the number of persons from the general population sleeping under long-lasting insecticidal nets increased from 35% to 73%. The number of children under five years and the number of pregnant women sleeping under long-lasting insecticidal nets respectively increased from 31% to 76% and from 43% to 73%. Moreover, the averages of the number of nights in each week that the general population slept under long-lasting insecticidal nets increased from 2.13 to 5.11; specifically from 1.68 to 4.78 for children under five years and from 1.56 to 4.47 for pregnant women (106).

With the QI approaches, other studies report results which are either greater or lower than ours. On the one side, greater results are those reported by Kilan and colleagues in their QI project aimed at improving antibiotic prophylaxis in gastrointestinal surgery patients. The utilization of the adapted order form increased from 1.8% to 92.0% following the intervention (129). Compliance with a bundle of appropriate antibiotic selection, dosing and timing improved from 47.3% to 82.2% after the intervention (129).

On the other hand, lower results than ours are for instance reported in the study of Schaffzin and colleagues which aimed at standardizing preoperative preparation to reduce SSIs among paediatric neurosurgical patients (111). A standard intraoperative bundle that recommended preoperative bathing was implemented and resulted in an improvement of the median protocol adherence for clinic nurses from 92.90% to 100%; whereas it was sustained at approximately 100% throughout the study period for the preoperative nurses. Moreover, the protocol adherence for patients/families was 83.80% and improved to 100.00% (111).

4.3 ENDLINE FINDINGS

The endline period was characterized by sustained improvements achieved in the intervention phase. Thus, compared to baseline, there were significant improvements in outcome indicators and improvements achieved in the intervention phase were ultimately sustained on a short-term period.

Many authors have used PDSA cycles and reported improvements that are comparable to our results. Schaffzin and colleagues reported an overall adherence increase to preoperative chlorhexidine gluconate bathing from 56.3% to 86.6% (111). Leeds and colleagues in their comparative QI study improved patient adherence with preoperative chlorhexidine gluconate bathing for elective patients undergoing colorectal surgery from 58% to 75 % in the first hospital and maintained the 92% adherence of the second hospital a year after change implementation (98).

Similar significant improvements are also noted by Kong K. and colleagues who reported an overall increase of appropriate hand hygiene which improved from 13.4% to 48.6%, making a 3.6-fold improvement of the hand hygiene practice of hospital staff (126). Ahmed Awaji M. and colleagues reported a steady increase of hand hygiene compliance amongst healthcare workers from a baseline of 5% up to 20% (130).

Khurana and colleagues in India used PDSA cycles to improve compliance to aseptic non-touch techniques. Thus, compliance to aseptic non-touch techniques practices strikingly increased from baseline to endline; especially the compliance in use of procedure tray/trolley (16% to 49%, P=0.001) intravenous hub scrubbing (0% to 60%, P=0.001), local skin cleaning (33% to 67%, P=0.004), personal protective equipment use (55% to 80%, P=0.02) and disposal (27% to 51%, P=0.03), use of non-touch technique (50% to 70%, P=0.001). Moreover, such improvement went along with reduction in key part contamination (45% to 31%, P=0.03 (121).

Similarly, Byabagambi and colleagues in Uganda, used PDSA cycles to improve the quality of voluntary medical male circumcision. At baseline, less than 20% of sites scored in the "good" range (>80%) for supplies and equipment, patient counselling and surgical procedure. However, the proportion of sites scoring "good" by the endline rose to 67%, 93% and 90%, respectively (93).

Herkman and colleagues who implemented a bundled QI intervention to reduce SSIs in lower extremity vascular bypass procedures found a significant increase in compliance with pre-operative chlorhexidine gluconate showers ranging from 0% to 71%. At the same time, in-hospital SSI rates fell from 18% to 4% after implementation of the SSI reduction bundle (p=0.002) (127).

4. 2 THE PROCESS OF IMPROVEMENT

The improvement process consisted in implementing four PDSA cycles, and each of them resulted in increase of outcome indicators. For instance, educating stakeholders on the relevance of a given evidence-based intervention was the first change action we implemented and has yielded significant changes.

Other authors used the same strategy to improve different areas of healthcare associated infections. Ahmed Awaji M. and colleagues who work in the Kingdom of Saudi Arabia have successfully engaged in education and patient empowerment to make them key partners to improve hand hygiene compliance among healthcare workers, thus, prevent healthcare associated infections (130). With regards to education, Ramadan and colleagues (126) also engaged in educational interventions to achieve improvement objectives (118,126).

4. 1. 2 Factors associated with preoperative bathing

Our baseline findings revealed that nurses were not recommending preoperative bathing because they did not know it was a good practice (64 %) or have never recommended it before (23%). Only 9% did not recommend it because they forgot and 4% did not recommend it on a day when there was no water in the facility.

In a study conducted by Musuuza and colleagues, nurses are aware of the advantages of preoperative bathing, which was however considered as a comfort measure. Therefore, factors such as perceived workload and or patients' factors would undermine the practice of preoperative bathing (124). Adugbire and colleagues in Ghana found that patients did not bath despite being recommended to bath by nurses and wanted to be reminded (132). Our findings are similar to the WHO conclusions stating that neglection and lack of awareness of the advantages of the preoperative bathing as one of the barriers to implement preoperative in developing countries (107).

Apart from low levels of awareness, forgetting was another challenge that hindered beneficiaries' adherence to evidence-based actions that were being implemented. The same challenge is reported in the study of Leeds and colleagues through which it was revealed that in some instances, patients could forget (98). Forgetfulness and poor knowledge were also reported as a challenge to compliance in the study of Ramadan and colleagues (118).

4.2.3 Summary of tests of change actions

All four change actions led to improved results. After the first change action, the increase in the number of women encouraged to bath and women who bathed at least once before C-section was higher than the increase in the number of women who completed recommended

baths and in the number of women who completed recommended baths using soap. In other words, more women bathed once but only a few numbers completed recommended baths.

The second change action, reminding nurses to encourage women to bath preoperatively, resulted in all women being encouraged to bath preoperatively and in an increase of the number of women who completed recommended baths. However, the number of women who bathed at least once decreased compared to the first change action.

The combination of three change actions (fourth change action) resulted in a considerable increase in the number of women encouraged to bath preoperatively; women bathing at least once and women completing recommended baths.

Of the five outcome indicators, significant improvements were noted in three of them; in two outcome indicators, baseline showed a 100% adherence to the use of soap while bathing which was sustained throughout the whole period of the study.

4.2.4 Limitations and strengths

Our sample size was small. The methods of data collection do not allow for in depth answers about complexities related to pre-operative bathing. Furthermore, we did not assess the impact of pre-operative bathing on the reduction in SSI. We are also unsure if small tests of change have resulted in an improved practice that can be scaled up and sustained on a long-term basis.

In addition, our study did not assess implementation outcomes like implementation fidelity and acceptability when we were testing different change actions. Furthermore, the study did not assess the impact of improved preoperative bath practices on the incidence of SSIs following elective C-section. Moreover, the study engaged in a convenience sampling which makes generalizability of findings difficult (133).

Among the strengths of the study include accuracy and completeness of primary data and the potential to translate these findings to other research sites in Burundi.

CHAPTER 5. CONCLUSIONS, RECOMMENDATIONS AND FUTURE DIRECTIONS

This chapter draws overall conclusions, makes recommendations, and suggests future directions.

5.1 Conclusions

The small tests of change have overall improved the practice of preoperative bathing prior to elective C-section in the OBGYN Unit of Cibitoke Hospital. The proportion of preoperative bath recommendation increased from 44.44% to 92.7%; the proportion of women who perform at least one preoperative bath increased from 41.66% to 86.6% whilst the proportion of preoperative bath completion significantly improved from 33% to 72.5%. Concomitantly, the use of soap was sustained at 100% for those who either bathed at least once or completed the recommended baths.

In conclusion, there has been considerable increase for three outcome indicators and sustained performance for two indicators whose baseline value was 100%. The significant increase of outcome indicators resulted from a combination of an enabling context and an effective implementation of an evidence-based QI intervention such as the MFI. Time constraint did not allow us to observe impact on a long-term basis.

5.2 Recommendations

With only four PDSA cycles within a period of three months, an ascending trend in the practice of preoperative bathing was observed in the OBGYN Unit of Cibitoke Hospital. This proves that it is possible to improve the preoperative bathing as a strategy to prevent SSIs and ultimately improve health outcomes. Hence, we highlight the need for the following actions:

The government of Burundi and other stakeholders engaged in prevention of infectious diseases and promotion of healthcare security:

- Conduct smaller studies in other regions of Burundi using the same methodology to determine whether results are comparable. Results from these studies would help identify and implement larger hospital-level strategies aimed at improving systematic preoperative bathing recommendation.
- Conduct improvement projects on longer periods using time-series study designs to observe the sustainability of the impact.
- Conduct also RCT to examine the potential impact of pre-operative bathing on the reduction of SSIs and
- Conduct cost-effectiveness and in-depth qualitative researches to explore both perspectives of women undergoing pre-operative bathing and providers, to explore if they have time to implement the practice.

Recommendations from this study have implications to other similar health settings in Burundi where SSIs threaten the care safety and wellbeing of patients who undergo surgical procedures and potentially, in other LMICS of the sub-Saharan region and beyond.

4.2 Future directions

Small tests of change at a hospital unit level have the potential of improving health outcomes. Overall, it is essential to obtain support and collaboration from stakeholders and engage more health professionals. The change package used in this study can be wholly implemented at larger scales even for different contexts, rural and urban settings with limited incomes. For high income settings, it is preferable that change actions used in our study be adapted first and tested before moving to the scale-up phase. Such scalability study has been reserved to future work.

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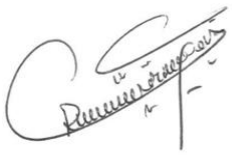
APPENDIXES

APPENDIX ONE: PLAGIARISM DECLARATION

I, Roger Ciza, (Student number: **1623208)**, am a student registered for the degree of MSc in Epidemiology and Implementation Science in the academic year 2019.
I hereby declare the following:

- I am aware that plagiarism (the use of someone else's work without their permission and/or without acknowledging the original source) is wrong.
- I confirm that the work submitted for assessment for the above degree is my own unaided work except where I have explicitly indicated otherwise.
- I have followed the required conventions in referencing the thoughts and ideas of others.
- I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my own unaided work or that I have failed to acknowledge the source of the ideas or words in my writing."



Signature: _____ Date: December 3, 2020.

Dr Roger CIZA

APPENDIX TWO: THE MODEL FOR IMPROVEMENT

Part 1: The three fundamental questions.

1. **What are we trying to accomplish?** The step consists in stating a time-specific and measurable aim. The aim must be able to define the specific beneficiaries who will be affected by the implemented change.
2. **How will we know that a change is an improvement?** The QI team establishes quantitative measures that will help to determine if a specific change really leads to an improvement.
3. **What changes can we make that will result in improvement?** It is the step when the QI team identifies the changes that should result in improvement. The identification is guided by the experience from past successful improvements".

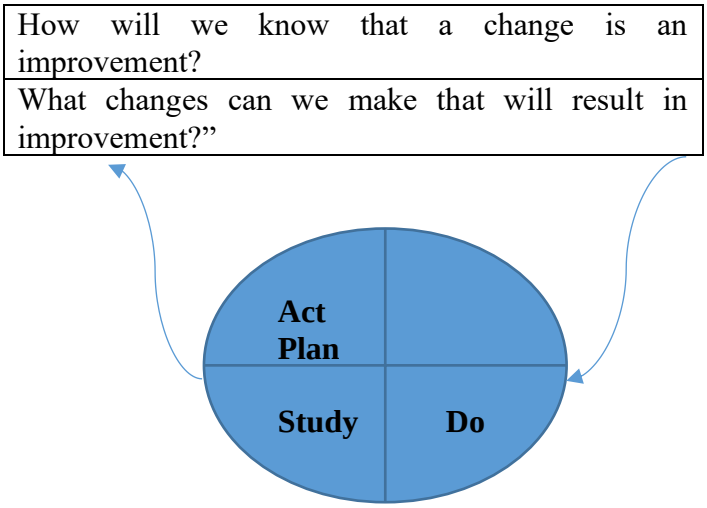
Part 2: The Plan-Do-Act-Study (PDSA) cycles

The PDSA offers an opportunity to test changes in the real work setting and on a small scale. Changes are planned, tried; results observed and the QI acts according to the learning from the observation.

1. Plan: In this step, the QI team establishes objectives which must be specific, measurable, attainable, realistic and timely. The key questions which have to be answered "who?, what? Where and when. It is the step for planning data collection.
2. Do: in this step, the QI team carry out the plan, monitor the process and record data.
3. Study: This step corresponds to the data analysis, comparison of results with objectives and the summary of key lessons learnt (in order to state what works, what does not work and why)
4. Act: It is the step of building on the lessons learnt from the "Study" step. The QI team identifies the changes that can improve better, and the next PDSA cycles start with new improvement strategies.

The PDSA cycles are iterative; the QI team tries different strategies and each PDSA cycle tests one set of strategies."

"What are we trying to accomplish?



"The five steps in an improvement process

There are six steps that any QI team has to use when the MFI is being applied in a healthcare setting.

1. Set an aim: An aim is stated and must be time-specific and measurable. It must answer the "How good? By when? For whom (or what system)?
2. Establish measures: it is the step when the QI team needs feedback. Quantitative measures can be used to conclude if a specific change really leads to an improvement.
3. Identify changes: It is the step when the QI team identifies the changes that should result in improvement. These changes must be rigorously analysed given the fact that any improvement process requires changes but not all changes result in improvement.
4. Test changes. It is the step where the PDSA cycle, second part of the MFI comes in. A test of change is planned, tried, results observed, and the QI team acts according to the lessons learnt. It becomes a scientific method used in action-oriented learning that makes the team progressively move toward the aim.
5. Implement Changes: After a change that results in improvement is obtained, the final step is to make it the new standard process of the organization."

APPENDIX THREE: IMPROVEMENT MEASURES

"Improvement measures were established to respond to the question "How *will we know that a change is an improvement?"*. Three categories of measures were set and are i.e. outcome, process and balancing measures.

Outcome, process and balancing measures

Outcome indicator number one: Proportion of women to whom nurse recommended to bath

1. Outcome measure: Proportion of women recommended to bath
2. Process measure: Number of women recommended to bath
3. Balancing measure: Number of nurses who report time constraints; Number of nurses who perceive systematic bath recommendation as increasing daily tasks.

Outcome indicator number two: Proportion of baths taken before c-section

a. Proportion of women who bathed at least once

1. Outcome measure: Proportion of women who bathed at least once before c-section
2. Process measure: Number of women who bathed at least once
3. Balancing measure: number of women get delayed because of bath; number of women unable to buy soaps.

b. Proportion of women who bathed at least once with a soap

1. Outcome measures: Proportion of women who bathed at least once with a soap before c-section
2. Process measures: Number of women who bathed at least once before c-section
3. Balancing measures: number of women unable to purchase soap, number of women who are uncomfortable with nurses' recommendations and reminders.

"Outcome indicator number three: Proportion of women completing recommended baths

a. Proportion of women who completed recommended bath

1. Outcome measures: Proportion of women who completed recommended bath
2. Process measures: Number of women who completed recommended bath
3. Balancing measures: number of women unable to purchase soap, number of women who are uncomfortable with nurses' recommendations and reminder.

b. Proportion of women who completed recommended bath with soap.

1. Outcome measures: Proportion of women who completed recommended bath using soap all the times.
2. Process measures: Number of women who completed recommended baths using soap all the times;"
3. Balancing measures: Number of women who report bankruptcy from soap shopping; number of who delayed proceeding to operatory room; number nurses reporting water wastage.

APPENDIX FOUR : GLOBAL GUIDELINES FOR THE PREVENTION OF SSI

List of measures for the prevention of SSI

"Preoperative measures

1. Preoperative bathing
2. Decolonization with mupirocin ointment with or without chlorhexidine gluconate body wash for the prevention of Staphylococcus aureus infection in nasal carriers undergoing surgery
3. Screening for extended-spectrum beta-lactamase colonization and the impact on surgical antibiotic prophylaxis
4. Optimal timing for preoperative surgical antibiotic prophylaxis
5. Mechanical bowel preparation and the use of oral antibiotics
6. Hair removal
7. Surgical site preparation
8. Antimicrobial skin sealants
9. Surgical hand preparation

Preoperative and/or intraoperative measures

10. Enhanced nutritional support
11. Perioperative discontinuation of immunosuppressive agents
12. Perioperative oxygenation
13. Maintaining normal body temperature (normothermia)
14. Use of protocols for intensive perioperative blood glucose control
15. Maintenance of adequate circulating volume control/normovolemia
16. Drapes and gowns
17. Wound protector devices
18. Incisional wound irrigation
19. Prophylactic negative pressure wound therapy
20. Use of surgical gloves
21. Changing of surgical instruments
22. Antimicrobial-coated sutures
23. Laminar airflow ventilation systems in the context of operating room ventilation

Postoperative measures

24. Surgical antibiotic prophylaxis prolongation
25. Advanced dressings
26. Antibiotic prophylaxis in the presence of a drain and optimal timing for wound drain removal"

APPENDIX FIVE: INFORMATION SHEET AND CONSENT FORM

Greetings,

"My name is Roger CIZA; I am a student in the Division of Epidemiology and Biostatistics, School of Public Health at the University of the Witwatersrand, Johannesburg, South Africa. I am currently conducting a study in order to improve the preoperative bathing practices of nurses with women prior to CS. Better quality of preoperative bathing will decrease the microbial load on the skin and ultimately decrease the risk of surgical site infection.

Despite the WHO guidelines and the Government's will to implement them, rate of SSIs is still high which means that the guidelines are not correctly implemented. Therefore, I am conducting this study to identify ways that would improve quality of adherence of nurses to one of the guidelines. I would really value your perceptions and ideas. However, you can refuse to participate in this study and there will be no consequences.

Firstly, I would like to invite you to read this information sheet so that understand why the research is being conducted. Therefore, ask any question if you find anything that is not clear, or you need more clarification. Every effort will be made to keep personal information confidential and anonymous. This will be done through not indicating the date of interview, your name, gender, age, address or any other identifying information will be collected while being interviewed.

Secondly, I would like to let you know that participation is voluntary, there will be no penalties, loss or benefits whether you refuse to participate or not. You can also discontinue or terminate participation at any time without penalty or loss of benefits.

The entire survey will take about 15 to 20 minutes. The information from this study will elucidate questions about preoperative bathing practices. Data collected will be reported in a thesis report and may be published or presented, but your identity will never be shared. If you have any questions regarding any aspect of this study or wish to obtain a summary of the results of the survey, please kindly contact me on the following details:"

Name: Roger CIZA

Tel: +257 79928474

Email: 1623208@students.wits.ac.za | rogersciza@gmail.com

Supervisors

1. Dr. Sumaya Mall

University of the Witwatersrand

Email: sumaya.mall@wits.ac.za

2. Prof Gabriel Ndayisaba

University of Burundi

Email: gndayisaba@yahoo.fr

"University of the Witwatersrand| WITS

Human Research Ethics Committee (Medical)"

Chairperson: Prof Clement Penny

Email: Clement.Penny@wits.ac.za.

Tel: 011 717 2301

Administrators:

Ms Zanele Ndlovu

Mr Rhulani Mukansi

Faculty of Health Sciences, Phillip Tobias Building, Offices 301,302 and 304, 3rd Floor, 29 Princess of Wales Terrace, Parktown, 2193

Emails: Zanele.Ndlovu@wits.ac.za ; Rhulani.Mukansi@wits.ac.za

Tel 011 717 1234 / 1252 / 2656 / 2700.

APPENDIX SIX: DATA COLLECTION FORM

Day ….

Dear participant,

"I am a Roger CIZA, a student in the field of Implementation Science at the University of the Witwatersrand, Johannesburg South Africa. The aim of my research is to improve the preoperative bathing practices of nurses prior to caesarean section in the Obstetrics-Gynaecology Unit of Cibitoke Hospital using small tests of change. We are inviting you to participate. I trust that this research will contribute to improving preoperative bathing practices and ultimately decreasing surgical sites infections at the hospital of Cibitoke. Your responses are much appreciated and will hopefully improve the quality of life of women who are about to undergo caesarean sections. The interview should take approximately 15 minutes of your time. We also want to thank you for your cooperation and assure you that all information will be handled with the greatest confidentiality. Thank you very much."

Day …..(01)

1. How many women have come for elective CS today?.....
2. Did you systematically recommend them to bath/ shower prior to CS? Yes ☐ No ☐
    a. If Yes, how many times per day? (the minimum should be 2): ……
    b. If No, why?
        i. No water in the facility ☐
        ii. Don't know it's a good practice. ☐
        iii. Forgot ☐
        iv. Other reason; specify….
3. Where do women find soap for bathing/shower?
    a. Buy it themselves ☐
    b. Offered by the hospital ☐
    c. Other; specify _____
4. Have you checked that women have bathed/ showered? Yes ☐ No ☐

a. If yes (have checked and women bathed):
    1. How many women have bathed/ showered today?.....
    2. How many have used soap?.....
    3. Why others did not use a soap? (choose one answer)

i. No soap available ☐
ii. Forgot ☐
iii. Other, specify ….

b. If yes (have checked and women did not bath): reasons why:

What are reasons for women not bathing? (choose one answer)

i. They are not told to bath ☐
ii. Bathroom of bad quality ☐
iii. There is no water ☐
iv. There is no soap ☐
v. No soap and water ☐
vi. They arrived late ☐
vii. They forgot ☐
viii. Other reason, specify …

c. If no (no checking), reason why no verification made:

i. Too busy ☐
ii. Forgot ☐
iii. Other, specify ……

5. How many women have completed recommended baths/showers prior to CS (total number)?

6. How many women have taken all the recommended baths/showers with soap?

APPENDIX SEVEN : FRENCH VERSION OF THE PARTICIPANT CONSENT FORM

Formulaire de consentement pour la participation à l'étude

Salut,
« Je m'appelle Roger CIZA, je suis médecin en cours de spécialisation dans le Département d'Épidémiologie et Bio-statistiques, École de Santé Publique de l'Université de Witwatersrand, Johannesburg, Afrique du Sud. Je suis en train de mener une étude pour améliorer les pratiques des infirmiers en matière de douche préopératoire envers les femmes qui accouchent par césarienne. Une douche préopératoire de bonne qualité diminue la charge bactérienne sur la peau ce qui résulte automatiquement en une diminution du risque d'infection du site opératoire (ISO).
Malgré les lignes directrices de l'Organisation Mondiale de la Santé (OMS) pour la prévention des ISO et la volonté du Gouvernement de les mettre en pratique, le taux des ISO est encore élevé, ce fait croire que les lignes directrices ne sont pas correctement mises en œuvre. Ainsi, je conduis cette étude pour identifier les voies d'amélioration de qualité et d'augmentation la compliance des professionnels de santé à l'une des lignes directrices. En tant que professionnel de sante qui participe activement dans l'offre de soins, j'aimerais vous inviter à participer dans cette étude car votre participation est importante ».
Premièrement, j'aimerais vous inviter à lire ce formulaire d'information pour que vous compreniez pourquoi la recherche est menée et de me demander toute question là où tout n'est pas claire ou s'il persiste un besoin pour plus de clarification. L'enquête est anonyme et confidentielle, cela étant garanti par la non-mention de votre nom sur le questionnaire. Si vous optez pour participer dans notre étude, soyez rassurés que votre participation est volontaire et que vous pouvez vous retirer n'importe quand que vous voulez sans avoir à fournir des explications.
Il n'y a ni risques, pénalités, pertes ou profits de participer ou pas. Les données émanant de cette étude répondront aux questions liées aux pratiques de la douche préopératoire. Les données collectées seront reportées dans un mémoire de fin d'études universitaires et pourront même être publiées ou présentées, mais en aucun cas votre identité sera révélée.
« Au cas où vous avez une question en rapport avec cette étude ou souhaitez avoir un résumé des résultats de l'étude, prière me contacter aux adresses suivantes : »

Nom et Prénom : Roger CIZA
Téléphone : +257 79 928 474
Email : 1623208@students.wits.ac.za | rogersciza@gmail.com"

APPENDIX EIGHT : FRENCH VERSION OF THE DATA COLLECTION FORM

Questionnaire de collecte des données

Cher participant,

"Je m'appelle Roger CIZA, je suis médecin en cours de spécialisation dans le domaine des Sciences de Mise en Œuvre « Implémentation Science » à l'Université de Witwatersrand, Johannesburg, Afrique du Sud. Le but de ma recherche est d'utiliser les petits tests de changements pour améliorer les pratiques de la douche préopératoire des infirmiers avant de pratiquer la césarienne. Nous vous invitons donc à participer. Je suis persuadé que cette étude contribuera à l'amélioration de la pratique de la douche préopératoire et conséquemment réduire le taux d'infections du site opératoire à l'hôpital de Cibitoke. Vos réponses seront vivement appréciées, et cela vous prendre approximativement 15 minutes de votre temps. Nous aimerions aussi vous remercier de votre coopération et vous assurer que toute information fournie sera traitée avec la plus grande confidentialité. Merci beaucoup".

Jour ……

1. Combien de femmes sont venues pour césarienne programmée aujourd'hui?
2. Avez-vous systématiquement recommandé de prendre la douche/bain avant la césarienne? Oui☐ No ☐

a. Si oui, combien de fois par jour? (Le minimum devrait être 2): ……

b. Si non, pourquoi?

   i. Pas d'eau à l'hôpital ☐
   ii. "Ne sais pas si c'est une bonne pratique. " ☐
   iii. A oublié ☐
   iv. Autre raison à spécifier ….

3. Ou est-ce que les femmes trouvent le savon pour la douche/le bain?

   i. L'achètent elles-mêmes ☐
   ii. Est offert par l'hôpital ☐
   iii. Autre, à spécifier _____

4. Avez-vous vérifié que les femmes ont pris douche/ bain? Oui ☐ No ☐

a. Si oui (a vérifié et les femmes ont pris douche)

   1. Combien ont pris douche aujourd'hui?.....
   2. Combien ont utilisé le savon?.....

ii.Pourquoi les autres n'ont pas utilisé le savon? (Choisis une réponse)

a. Pas de savon disponible ☐
b. Elles ont oublié ☐
c. Autres, spécifiez ….

b. Si Oui (a vérifié mais les femmes n'ont pas pris douche) : raisons :

Quelles sont les raisons des femmes pour ne pas prendre douche/ bain? (choisir une réponse)

i. Ne sont pas recommandées de prendre douche ☐
ii. Douche en mauvais état ☐
iii. Pas d'eau disponible ☐
iv. Pas de savons ☐
v. N'y avait ni savon ni eau ☐
vi. Arrivée tardive ☐
vii. Elles ont oublié ☐
viii. Autre raison, spécifier …

c. Si non (pas de vérification faite), pourquoi vous n'avez pas vérifié:

i. Très occupé ☐
ii. Elles ont oublié ☐
iii. Autres, spécifiez ….

5. Combien de femmes ont pris le nombre de douches recommandé avant la césarienne (nombre total)?....
6. Combien de femmes ont pris le nombre de douches recommandé avec le savon? …..

APPENDIX NINE : RESEARCH AUTHORIZATION

REPUBLIQUE DU BURUNDI **April 20, 2018**

MINISTERE DE LA SANTE PUBLIQUE
ET DE LUTTE CONTRE LE SIDA
DIRECTION GENERALE DE LA SANTE
DIRECTION DES SERVICES ET PROGRAMME DE SANTE

No Réf. 633/225/DGSSLS/2018

Re: Research authorization

To Whom It May Concern,

I am writing to confirm that Dr. Roger CIZA, Postgraduate student at the University of the Witwatersrand, Johannesburg (Student ID: **1623208)** has been authorized to conduct his research titled "**Quality improvement of the preoperative bathing practice before caesarean section in the Obstetrics-Gynaecology Unit of Cibitoke Hospital, North-Western Burundi".** This research requires collecting data among clinicians of the Obstetrics and Gynaecology Unit of Cibitoke Hospital, Health District and Province of Cibitoke, in Burundi.

The present authorization letter, as well as the previous authorization letter provided to him on February 6, 2018 (Referenced: Ref.633/052/DGSSLS/2018) **stands in lieu of the Human Research Clearance certificate**. The candidate is therefore allowed to conduct the study without undergoing any further requirements related to Ethics considerations.

Dr. Isaac MINANI
General Director of Health Services and Fight Against HIV,
Bujumbura.
P.O. Dr Isaac NDAYISENGA

APPENDIX 10 : WITS HREC ETHICS CLEARANCE

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

R14/49 Dr R Ciza

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M180242

NAME: (Principal Investigator)	Dr R Ciza
DEPARTMENT:	School of Public Health Division of Epidemiology and Biostatistics Medical School University
PROJECT TITLE:	Quality improvement of the preoperative bathing practice before caesarian section in the Obstetrics and Gynaecology Unit of Cibitoke Hospital, North-Western Burundi
DATE CONSIDERED:	23/02/2018
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr S Mall and Professor G Ndayisaba
APPROVED BY:	Professor CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	17/07/2018

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on 3rd floor, Phillip V Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.

I/We fully understand the conditions under which I am/we are authorised to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated from the research protocol as approved, I/we undertake to resubmit to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in **February** and will therefore be due in the month of **February** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature

24/07/2018
Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES