DISSERTATION

ASSESSMENT OF NOISE POLLUTION IN OPERATING THEATRE AT SELECTED REFERRAL HOSPITALS IN KIGALI

By

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DECLARATION

I declare that this research titled "ASSESSMENT OF NOISE POLLUTION IN OPERATING THEATRE AT SELECTED REFERRAL HOSPITALS IN KIGALI", submitted in the fulfillment of the requirements for the degree of Master of Sciences in Nursing Perioperative Track at the University of Rwanda, College of Medicine and Health Sciences School of Nursing and Midwifery, is my original work and no part of this research has been previously presented in any academic institution for any award. Any information obtained from other sources has been duly acknowledged within the text and list of references provided in this document.

Signature..... Date.30/08/2023.

Approval for submission:

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ABSTRACT

Background: Cesarean delivery room environments have unique features potentially increasing the risk for noise exposure. The World Health Organization (WHO) recommends the noise level should not exceed 30 dB in hospitals and the Rwanda Standard board (RSB) recommends that the maximum acceptable noise levels at hospital environment could not exceed 40 - 50 db. However, little is known regarding operating theatres' noise pollution levels. **Aim:** assess noise pollution in the operating theater during caesarian section at selected hospitals in Kigali. **Methods:** Quantitative cross-sectional study design was used to measure levels and source of noise in two referral hospitals in Kigali. Purposive sampling method was used to select at least 80 caesarian section operations both hospitals. Randomly 80 caesarian sections were selected from 2 hospitals in Kigali with 40 cases per hospital. The sound measurement mobile phone app was used to measure the sound level and the checklist was used to record the source of noise. The UR/IRB ethical approval and the referral hospitals research committee's permission were obtained before data collection. Data were analyzed using SPSS, version 25 and descriptive and inferential statistics were done. **Results:** The noise level found in both facilities exceeded the 35dB recommended by the World Health Organization. The degree of the noise level was slightly different between elective and emergency surgical stages at two hospitals. The mean noise level was high during emergency C-section with a means level of 67.02dB (SD:9.7) before surgery, 50.45dB (SD: 8.8) in the middle of surgery, and 64dB (SD:8.79) in the ending stages of an emergency surgery. The noise level throughout the surgery was relatively higher during the day shifts than night shifts with the mean levels of 68dB (SD:9.4) before surgery starts, 50dB (S.D: 9.81) in the middle of surgery, and 62.17dB (SD:9.7) after the surgical process. **Conclusion and recommendations:** There is high noise pollution during caesarian section at selected 2 referral hospitals in Kigali. The noise pollution level recorded exceeded the noise pollution level recommended by the World Health Organization (WHO), International Noise Council and Rwanda Standard Board (RSB). The major source of noise during caesarian section included movement of equipment, staff conversations, suction apparatus, anesthetic monitors, objects falling on the floor, and dropping of metal instruments. Measures to reduce noise pollution level in theatres and its impact are needed in Rwanda.

Key words: noise level, pollution, referral hospital, surgery, caesarian section, theater

DEDICATION

I dedicate this study first of all to the Almighty God for his mercy and protection in the study period.

I am deeply from my heart dedicate this study to my wife and entire family, for being a source of inspiration and continually supporting me emotionally, spiritually and financially.

I also dedicate it to my supervisor, co-supervisor and my classmates for their undying support and words of encouragement.

God bless you.

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Completing this study could not have been possible without the immense support and assistance by various people like Chairman of Legacy Clinics and Diagnostic & Legacy clinic administration and colleagues who supported & facilitated me in the entire period of my schoolwork. Thank you for your support.

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I remember all efforts of the University of Rwanda leaders and lectures, online, face to face classes, may Lord bless them.

Thank you too all.

LIST OF SYMBOLS AND ACRONYMS

CHUK: Centre Hospitalier Universitaire de Kigali

CMHS: College of Medicine and Health Sciences

dB: decibels

DV: Dependent variable

IV: Independent variable

KFH: King Faisal Hospital

NPL: Noise pollution

SD: Standard Deviation

UK: United Kingdom

UR/IRB: University of Rwanda Internal Review Board

WHO: World Health Organization

RSB: Rwanda Standard Board

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CHAPTER ONE: INTRODUCTION

This chapter describes the structure of the dissertation, the background, problem statement, aim, objectives and rationale of the study.

Noise pollution is an indefinite and irregular combination of sounds around the peripheral environment(1). Excess noise is a health threat that deteriorates one's concentration and communication(2). According to Leitsmann and colleagues, the noise in the operating theater can disturb, impair communication, and can lead to both operating surgical team and patient's stress(3). In addition to that, various studies showed that much noise in operating theatre can affect patient care and disrupt the concentration during surgery(4). Both non-urgent and emergency cesarean deliveries require rapid co-ordination and communication, possibly increasing noise pollution. Studies done showed that high noise levels during caesarian section impaired the performance of obstetric teams managing postpartum hemorrhage(5).

The current study seeks to investigate the levels of noise pollution and its possible sources in the operating theatres of two selected referral hospitals in Kigali, Rwanda.

1.1.Structure of the dissertation

This dissertation is made of five chapters. Chapter one introduces the topic under study. In this chapter, the study background, the problem statement, the aim of the study, research objectives, and research questions, significance of the study and definition of key concepts are discussed. Chapter two focuses on the review of theoretical and empirical literature, and the conceptual framework underlining this study. Chapter three discusses the methodology that guided the conduct of this study. This chapter describes and provides a rationale for the choice of the research design, setting of the study, population, sample, and sampling approaches that were applied for this study. Moreover, data collection procedure, analytical approaches that were applied for the data collected, and ethical issues pertaining to the study are also discussed. Chapter four gives a detailed description of the study findings and the chapter 5 focus on the discussion of the study results and their implications in general, comparing them to other studies done in the past. Chapter 6 is made of conclusion and recommendation based on study findings.

1.2. Background

Globally, noise pollution in hospitals is a rising problem and especially in operating theaters(6). Evidence showed that around the world, levels of noise habitually exceed international recommendations(6).

The World Health Organization (WHO) recommends that in hospitals the noise level on wards should not exceed 30 dB whilst noise in treatment and surgical rooms should be kept "as low as possible(7). Furthermore, International Noise Council recommends that noise level in surgical room and intensive care unit should not exceed 45 dB during the day, 40 dB at sunset, and 30 dB at night(4). However, 40% of hospital patients in UK are bothered by noise pollution(8). In addition, previous research demonstrated that the noise in operating room is going up to a level of 131 dB in hospitals around the world(9).

In India, a study found that the sound levels were found to be 54dB and this was higher compared to the recommended international standards. The noise was contributed mainly by doors, trolleys, equipment and alarms and the incessant conversation among the operation theatre (OT) staff. In Switzerland, also the study done showed that the noise pollution in operating room was 20 dB higher than recommended levels for concentrated work. In that study, it was found that second surgeons and anesthetists were more distracted when noise pollution was high than others (10). In Iran, a study showed the level of noise reached 93 dB during the surgical operations(11).

There is a paucity of literature describing the levels of noise pollution in operating rooms in Sub-Saharan-Africa. Nevertheless, a study done in Nigeria showed that in the operating rooms the level of noise was high (74-89dB(A)(12). In Egypt, a study showed that the level of noise pollution was 1.8 times more than the recommended noise level standard(13). No such study was conducted previously in Rwanda, hence the lack of information regarding noise pollution levels in operating theatre.

In Rwanda, the government has established the National Noise Pollution Guideline set by the Rwanda Standard board (RSB)in2017 the maximum acceptable noise levels at hospital environment could not exceed 40 - 50 dB. However, no details were given specifically regarding operating room acceptable noise level.

In addition to that, there is dearth of data regarding the hospitals 'environmental noise level. In the current study, the researcher intends to explore, the noise pollution during the surgical in selected hospitals in Kigali.

1.3. Problem statement

Evidence has established that noise in operating theater has not only a direct a detrimental effect on both staff and patients' health, but it also has an indirect effect on patients by diminishing the surgeons' ability to perform their work to a high standard. Moreover, previous research shows that intraoperative noise hinders the operating team's concentration, which could lead to postoperative complications (14).

Despite the WHO set the average level of noise in operating theatre and recommended low level noise pollution to prevent noise pollution related effects(7), and the maximum acceptable noise levels at hospital environment as set by Rwanda Standard Board(RSB) (15),it is not known whether the guidelines are followed in operating theaters in Rwanda. No documented information is traceable regarding operating theatres' noise pollution levels and especially during caesarian section. Therefore, this study seeks to examine the noise pollution levels in operating rooms at selected hospitals in Kigali.

1.4. The aim of the study

The aim of this study is to assess noise pollution in the operating theater during caesarian section at selected hospitals in Kigali.

1.5. Research objectives

1. To determine the levels of noise in the operating theater during caesarian section at selected hospitals in Kigali.
2. To identify major sources of noise in the operating theater during caesarian section at selected hospitals in Kigali

1.6. Research questions

1. What are the levels of noise in the operating theater during caesarian section at selected hospitals in Kigali?
2. What are the major sources of noise in the operating theater during caesarian section at selected hospitals in Kigali?

1.7. Significance of the study

To nursing practice: The results of this study can help nurses to be aware of the consequences of noise pollution during surgical operation periods and may assist them to advocate for reducing unnecessary noise in theater.

To education: The current study results can be used for preservice and in service education regarding noise pollution prevention in theater.

To research: The results of this study can help to enhance existing literature and to inspire other aspirant researchers to do more research on noise pollution in operating theatre
The current study can also help innovators to create ways to prevent and tackle the consequences of noise pollution in operating theater

To Policy maker: The current study can inform the policy makers to put in place strategies to control and maintain the acceptable level of noise in operating theater.

1.8. Conclusion to Chapter one

Very few data are available regarding noise pollution in theaters in Africa and especially in Rwanda no study is available despite noise pollution acceptable level have been established by the government. The current proposed study will assess the level of noise and its source in theater and results from it will serve as basis in shaping measures to mitigate noise pollution in Rwanda.

CHAPTER TWO: LITERATURE REVIEW

2.0. Introduction

This chapter discusses on theoretical literature, theoretical framework, conceptual framework, and empirical literature were used in the current study.

2.1. Literature searching strategies

To find the content discussed in this chapter, the researcher used databases such as Hinari, PubMed, and Google Scholar. The MESH words or keywords included "noise, pollution, surgery, surgical operation, operating theatre, and effect." Criteria used to select theoretical and empirical articles used in this chapter were being recently published (not more than 10 years from publication date), being published in a recognized peer review publication journal and being original article. In this study various published articles in Africa, Europe, Asia and America are being explored and used.

2.2. Theoretical literature on noise pollution in surgical theatre

The World Health Organization (WHO) defines noise above 65 decibels (dB) as noise pollution(4). Noise pollution has many effects on humans, including hearing loss, emotion effects (feeling of physical discomfort in ears), impaired communication(16), psychosomatic effects on physical well-being, and inappropriate effects on the psychological states of people(17). Much noise can also leave adverse effects on work efficiency and events. It can also cause impaired sleep and behavior, increased gastric intestinal activity, heart rate, blood pressure, respiratory rate, and oxygen consumption(6).

For surgical patients, excessive noise during surgery reduces the intelligibility of speech and cause annoyance, irritation, and fatigue and reduce the quality and safety of surgical care(18). Noise pollution has been also implicated in the development of post-surgical psychosis, post-surgery hospitalization induced stress, increased post-surgical pain sensitivity, post-surgical high blood pressure, and poor mental health after surgery(19). Post-hospitalization recovery was found also to be compromised when noise pollution was high during surgery(20).

For hospital staff, high noise levels can impact negatively on surgical team communication, performance, wellbeing, and caring behaviors, and can contribute to burnout(21). It is well documented that noise is stressful eliciting changes in the autonomic nervous system, impairing

mental faculties and producing masking that could affect the staff and the conscious patient alike, leading to decreased work performance and increased anxiety respectively(22).

2.3. Empirical literature

2.3.1. The impact and adverse effect of noise in the operating theatre

In a study conducted by Mcleod and colleagues , they found that increased level of noise during surgery caused increased anxiety in patients(23). On the other side, in evaluating the effect of high noise pollution among the surgical team members, the study done in India (24) by Srivastava P, Shetty P and al, revealed that 83.8 % respondents reported that high noise level in theatre increased their stress level and deteriorated the quality of their teamwork. In that study, also, 86.2% of participants reported that noise affected communication among the surgical staff while 85.5% of them reported that noise in theater decreased their concentration level, which could be harmful in view of the patient's safety. In the study done by McNee et al, findings showed that intraoperative noise increased the perceived task load and fatigue among majority of anesthesiology residents(25).

Regarding the caesarian section noise pollution consequences, a study conducted in Egypt by Mohamed and colleagues showed that 66.7% of patients reported stress when the obstetric theater's noise pollution was 78 dB(13).

2.3.2. Noise pollution patterns and levels in the surgical suite

A study done by Baltin and colleagues to analyze noise patterns during 599 visceral surgical procedures found that the most-common noise level ranged between 55 and 60 dB during all visceral surgical procedures observed(14). Then, in the study conducted in Johns Hopkins Hospital (Unites States of America) demonstrates demonstrated that the noise pollution level in neurosurgical, urologic and gastro-intestinal surgeries ranged between 62 and 65 dB(26).

Furthermore, in the study conducted by (27) in 50 maxilo-facial surgical procedures , it was found that the mean noise level was 57.1 dB and greater than the WHO recommended noise pollution level. In Iran, a study conducted by Masoumeh et al., showed that the noise pollution in operating rooms was higher than available standards in majority of surgical procedures. In that study, it was revealed that the highest level of noise pollution was related to orthopedic procedures, and the

lowest one related to laparoscopic and heart surgery procedures. The highest and lowest registered sound level during the operation was 93 and 55 dB, respectively. Sound level generated by equipment's was 69 ± 4.1 dB, trolley movement 66 ± 2.3 dB, and personnel conversations 64 ± 3.9 dB.

2.3.3. Major sources of noise pollution in the surgical operating theatre

Previous research demonstrated that the use of surgical instruments may result in significant noise exposure. For example, a study done by Peters and colleagues showed that instruments related noise pollution level reached up to a level of 131 dB(28). In the study conducted by (27) it was found that the mean noise level for non-drilling periods was 57.1 dB (maximum, 94.8 dB). This is in contrast to the mean noise level for drilling periods of 64.9 dB (maximum, 88.0 dB). In the study conducted by Svardagalou et al., findings showed that loud intermittent noises of up to 108 dB in theatre and were emitted from sources such as suckers, "intercoms", and alarms on anesthetic monitoring devices. The noisiest time was usually during the preparation period of the operation; during surgery, noise levels were much higher than levels of normal speech between staff(23).

2.3.4.Noise pollution during caesarian section

Cesarean deliveries require rapid co-ordination and communication, possibly increasing noise pollution. In the recent study done by Sheridan et al, findings showed that the average noise level for non-emergency group and emergency caesarian section group were 66 dB and 70 dB, respectively(29).In another study conducted in Egypt by Mohammed et al., it was found that the noise pollution level during caesarian section exceeded the WHO recommendation by around 1.8 times. In that study(13).

2.5. Critical review and research gap identification

The literature review used in this study was focus on source of noise pollution in theatre, noise levels found in studies. Very few studies have been done in Africa especially in Rwanda no study is available on levels and sources of noise pollution in operating theatre.

2.6. Study conceptual framework

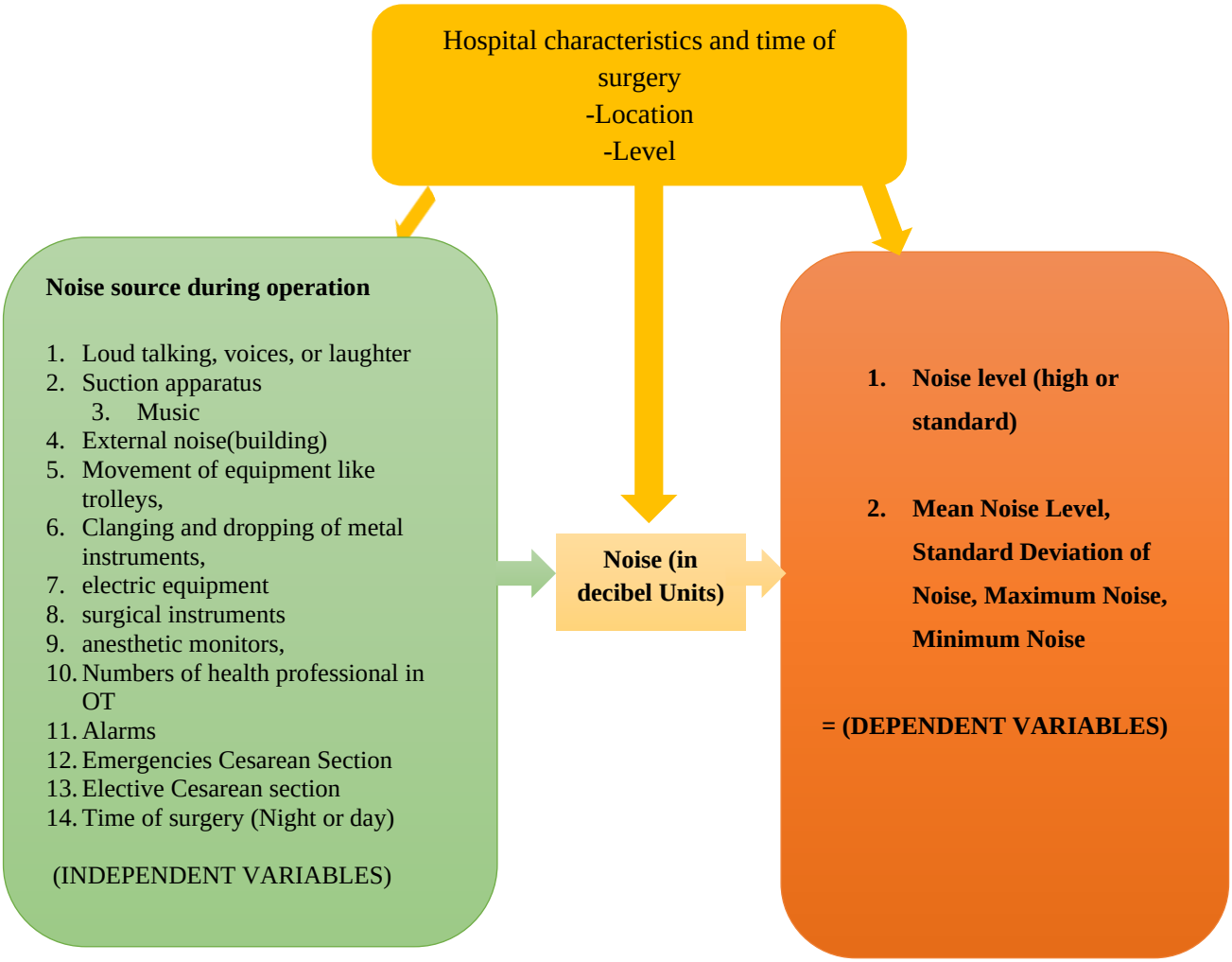

Figure 1:Study conceptual framework

The above conceptual framework shows that in the current study the researcher considered noise amount (*minimum, maximum, mean and standard deviation*) and level as dependent variables **(DV)** and hospital characteristics (level and location and time of surgery) and sources of noise as independent variables **(IV).**

2.8. Conclusion to chapter 2

The reviewed literature in this current study guided the researcher and help in discussion of findings and shaping recommendations.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1. Introduction

In this chapter, the researcher describes the study design, target population, sample design, data collection procedures and instruments used, data analysis method and ethical consideration

3.2. Research design

In this study, a descriptive cross-sectional study design was used. According to Creswell, descriptive study describes the characteristics of the population or phenomenon studied without focusing on "why" a particular phenomenon occurs(30). The researcher was interested to measure the noise level during the surgical operation and determine the source of noise.

3.3. Research approach

In this study, the researcher used the quantitative research approach. The quantitative approach uses numerical data and is used to show patterns and averages, test causal relationships, make predictions, and generalize results to wider populations(31). In the current study, only numerical data were used to show patterns of data and noise level averages were determined.

3.4. Research setting

The research setting included two referral hospitals located in Kigali, where relevant and reliable data related to my objectives would be found; including King Faisal Hospital (KFH), and University Teaching Hospital of Kigali commonly known as CHUK. These two hospitals were chosen because they are referral and high standard hospitals. King Faisal Hospital, is a multi-specialty quaternary hospital with a mandate to provide a range of specialized health care in East and Central Africa. It is a 160-bed specialty referral and teaching hospital located in Gasabo District, Kigali, Rwanda. King Faisal Hospital, Kigali contributes greatly to the realization of Rwanda's Health Sector Strategic Plan IV priorities and targets. The hospital was constructed between 1987 and 1991 with the help of the Saudi Fund for Development (SFD). For the last 22 years, King Faisal Hospital, Kigali has concentrated on clinical excellence, efficiency, and quality in health service delivery. In the effort to avail the best medical care, it has assembled some finest medical talents including physicians, surgeons, nursing professionals, and technicians enriched

with international experience. Some of the available specialties include but are not limited to Neurosurgery, Cardio-thoracic surgery, Orthopedic Surgery, Cardiology, Nephrology, Pediatrics, and its subspecialties, Radiology& Imaging, Pathology, and other medical subspecialties.

The University teaching hospital of Kigali/CHUK is the largest hospital located in District of Nyarugenge at KN 4 Ave, Kigali City. It is also the biggest referral hospital of the country with a capacity of 519 beds. CHUK provides quality healthcare to the population, training, clinical research and technical support to district hospitals. Some important dates for CHUK: In 1918: it was built; In 1928, it worked as health center; In 1965, it worked as hospital. From April 1994 to 1996, the CHK has served as a health center, a district hospital and as a referral hospital as well. In 2000, with the enactment of law Nr. 41/2000 of 7/12/2000 on the establishment and organization of the University Teaching Hospital "CHUK", the CHK became a public institution with legal personality known as “University Teaching Hospital of Kigali”. It’s a teaching hospital with different specialties such as, Orthopedics surgery, General surgery, Neurosurgery, ENT Surgery, Gynecology and Obstetrics, Internal Medicine, Pediatrics, Dermatology, Plastic surgery(32).

3.5. Population

The study population relevant to the study objectives is 150 Caesarian section. This is the mean calculated retrospectively from all caesarian section cases done in two referral hospital in 2022, Respectively Kigali University Teaching Hospital **1161 cases** (mean of 96 procedures per month) and King Faisal Hospital **648 cases** (mean of 54 procedures per month).

3.5.1. Inclusion criteria

Only caesarian sections were considered in this study and

Noise level was measured only when the patient has entered in the theatre room

Caesarian section was picked because of its particularity during the procedure. The majority of caesarian section procedure keeps patient awake with a limited interaction with the surroundings.

3.5.2. Exclusion criteria

Surgical operation other than caesarian section and No noise measuring was taken before arrival of the patient.

3.6. Sampling

This section discusses the sampling strategy with inclusion and exclusion criteria; and sample size that were used in this study.

3.6.1. Sample size and sampling strategy

From the mean of all cases done at CHUK and KFH in 2022, (1161 Cases done at CHUK and 648 cases done at KFH), with the mean of 96 procedures per month at CHUK and mean of 54 procedures at KFH respectively. The mean of procedures in both hospitals gave the average of procedures per month of 150 caesarian section in 2 hospitals.

By using Rao soft sample size calculation machine, 109 caesarians sections were taken as the sample size from a population of 150 caesarian section. Rao soft sample size calculation machine uses the margin error of 5%, and the confidence level of 95%, population of 150 caesarian sections, the response distribution of 50%(33). Due to time constraints and means to collect data, the sample size was limited to 80 caesarian sections.

3.7. Data Collection

This section discusses deeply on the data collection instrument and the procedure that were used in collecting data.

3.7.1. Data Collection Instruments

A sound measurement app installed in android phone was to measure the sound level in decibels (dB). A checklist was used to record potential source of noise. That checklist is made of two sections. Section 1 contains items about hospital, time of data collection(day/night), and type of caesarian section (in theatre(elective/emergency). Section 2 contains questions about the source of noise item (movement of equipment, clanging and dropping of metal instruments, electric or air-powered surgical instruments, suction apparatus, anesthetic monitors, monitors alarms, staff conversation, with loud talking, voices, or laughter, music, objects falling on the floor, handling of metal boxes containing sterilized material drums or other, opening, closing, or knocking on door, sneezing, coughing, the anesthesiologists' tray, putting on gloves, phone calls, external noise (building, cars etc).

3.7.2. Validity& Reliability of the tool

Validity refers to the accuracy of the study. Mohamed and colleagues defines the validity of the research instrument as the strength of the extent to which that instrument measures what is supposed to measure(34). In this study, in the data collection tools content and construct validity were ensured based on study objectives.

To ensure the relevance and clarity of the noise measurement app, experts in audiology were consulted; respectively one ENT surgeon at KFH and another ENT surgeon at CHUK.
Also, the checklist for the source of noise, to maximize the tool validity three experts in operating theatre were consulted, one from each institution; KFH, CHUK and RMH to give their inputs in the development, approval, validate the tool and appraise it before its use.

Validity of the tool was ascertained by a pilot study on 10% of the study sample size having similar characteristics to the final data collection sample before the actual data collection. According to Doody et al., the pretest helped the researcher to identify if there no essential question /item or variable forgotten on the research tool(35). Therefore, after the pilot study was done, in the current study, all challenges related to the use of the noise measurement app and source of noise checklist were settled and adjusted based on the feedback from the pre-test.

3.7.3. Data collection procedure

After the University of Rwanda Internal Review Board (UR/IRB) ethical approval and the CHUK and KFH hospitals research committee's permission were obtained, the researcher contacted the operating theatre unit manager order to get the permission of carrying out a study. Then, the researcher requested the permission to enter in theatre during the surgical operation.

After reaching the theater room, the researcher or research assistant turned on the phone app at arrival of the patient until the caesarian section is finished, and patient transferred in recovery room.
The instrument recorded the pic of noise, then the researcher recorded that specific level of noise while observing the source of noise in operating theater environment, using the checklist, the researcher or research assistant measured and recorded the level of noise for each source of noise pollution in operating theatre by listening. The measurement of noise level was collected from

hospital operating rooms and when performing surgical procedures during 5-min three periods (5 min in start of surgery, 5 min middle of surgery, and 5 min at the end stage of surgery).

3.8. Data management

The collected data were coded and entered into a Personal computer by using Statistical Packages for Social Scientists (SPSS) software version 25 After entry, the data were cleaned by scrutinizing the dataset for missing data and properly entered data for correction. The information was stored and protected for their safeguard. Therefore, were kept in a file that had a password only known by the investigator and cannot be easily guessed. Data was kept on a flash drive for backup in case the primary storage device destroyed after data entry. Filled checklist was kept in safe and a hermetically locked cupboard for protection of confidentiality.

3.9. Study variables

In this current study, the dependent (DV) variables included Noise level. Independent variables (IV) included shift time, indication of caesarian section and name of the hospital. The source of noise that was measured included staff talking, voices, and noise from suction apparatus, Music, external noise(building), movement of equipment like trolleys, clanging and dropping of metal instruments, electric equipment, surgical instruments, suction apparatus, anesthetic monitors and alarms).

3.10. Data analysis

Hilfiker, Sun and Hong state that data analysis is carried out to reduce, arrange, and give meaning to the data(36). In this study, collected data was screened and coded before entering them into the analytical computer software (SPSS v. 25). Data cleaning was done before data analysis.

After transferring of data to the computer and determining each of the noise indicators, data were analyzed using statistical descriptive tests in SPSS software. Comparison of NPL in the different stages of caesarian section was performed using one-way ANOVA, and comparison of noise pollution level, shift, hospital; and indication of caesarian section was compared using Chi-square Pearson’s correlation test.

3.11. Data Dissemination

Findings from the study to be presented to the University of Rwanda and to the hospitals where the study took place. The findings will be presented in different workshops, national /international conferences and seminars. Then the manuscript will be prepared for publication in a peer review online journal. Also, a copy of this study will be placed in the library so that whoever interested will have access to it.

3.12. Ethical considerations

Ethical approvals were sought from the Institutional Review Board (IRB) of the College of Medicine and Health Sciences (CMHS) at the University of Rwanda and then permission to collect data was sought from the research committees of hospitals in Kigali where data was collected. Confidentiality, anonymity, privacy, beneficence/non-maleficence and justice principles were assured and granted to both staff and patients. To ensure confidentiality in this study, the research tool did not have any name from the surgical team or patient's identification details but just a code for purposes of data entry. Data from the study will be used for the purpose of the study only. An informed consent to record voices and noise was also requested and obtain before starting data collection..

3.13. The conclusion to chapter three

This study was descriptive; there is no experimental manipulation. An ethical consideration was of paramount from the start to the end of this study.

CHAPTER FOUR: RESULTS

Table 1: Descriptive Distribution of noise level by stage of surgery, shift, hospital and indication of caesarian section from 80 surgical operations

		Number of surgery(n), Mean noise and noise standard(SD) deviation	Noise level (dB) at the start of the surgical operation	Noise level(dB) in middle of surgery	Noise level(dB) at the end stage of surgery
Hospital	*CHUK*	Mean	70.72	50.57	60.47
		N	40	40	40
		SD	8.2	10.00	12.02
	KFH	Mean	58.17	44.6000	52.3500
		N	40	40	40
		SD	6.8	6.00	7.58
Indication of Caesarian section	Elective	Mean	62.00	44.00	48.02
		N	40	40	40
		SD	9.2	6.7	5.0
	Emergency	Mean	67.0250	50.45	64.00
		N	40	40	40
		SD	9.7	8.80	8.79
Type of shift	*Day shift*	Mean	68.00	50.00	62.1750
		N	40	40	40
		SD	9.4	9.81	9.7
	Night shift	Mean	61.00	44.67	50.00
		N	40	40	40
		SD	8.9	6.20	7.2
Overall noise level for both KFH and CHUK		Mean	**64.45**	**47.08**	**55.91**
		N	**80**	**80**	**80**
		SD	**10.00**	**8.51**	**10.11**
		Minimum	**48.00**	**32.00**	**37.00**
		Maximum	**85.00**	**70.00**	**83.00**

As indicated in Table 1, the mean noise level of 70.72 dB (SD:8.2) before surgery, 50.57 dB (SD: 10) in middle of surgery, and 60.47dB (SD:12.02) at the end of surgery during all 40 observed surgeries were recorded. At King Faisal Hospital, the mean noise level of 58.17dB (SD:6.8) before surgery, 44.6dB (SD:6) during surgery, and 52.35dB (SD:7.58) at the end of surgery. Although the noise level during surgery at KFH was lower than CHUK, both facilities recorded the mean noise levels exceeding the 35dB recommended by the World Health Organization, 30dB

recommended by the International Noise Council(INC), and 40dB recommended by the RSB. The table further shows that the degree of the noise level was slightly different between elective and emergency surgical stages at two hospitals. The mean noise level was high during emergency C-section with a means level of 67.02dB (SD:9.7) before surgery, 50.45dB (SD: 8.8) in the middle of surgery, and 64dB (SD:8.79) in the ending stages of an emergency surgery. Furthermore, as shown in the above table, the noise level throughout the surgery was relatively higher during the day shifts than night shifts with the mean levels of 68dB (SD:9.4) before surgery starts, 50dB (S.D: 9.81) in the middle of surgery, and 62.17dB(SD:9.7) after the surgical process.

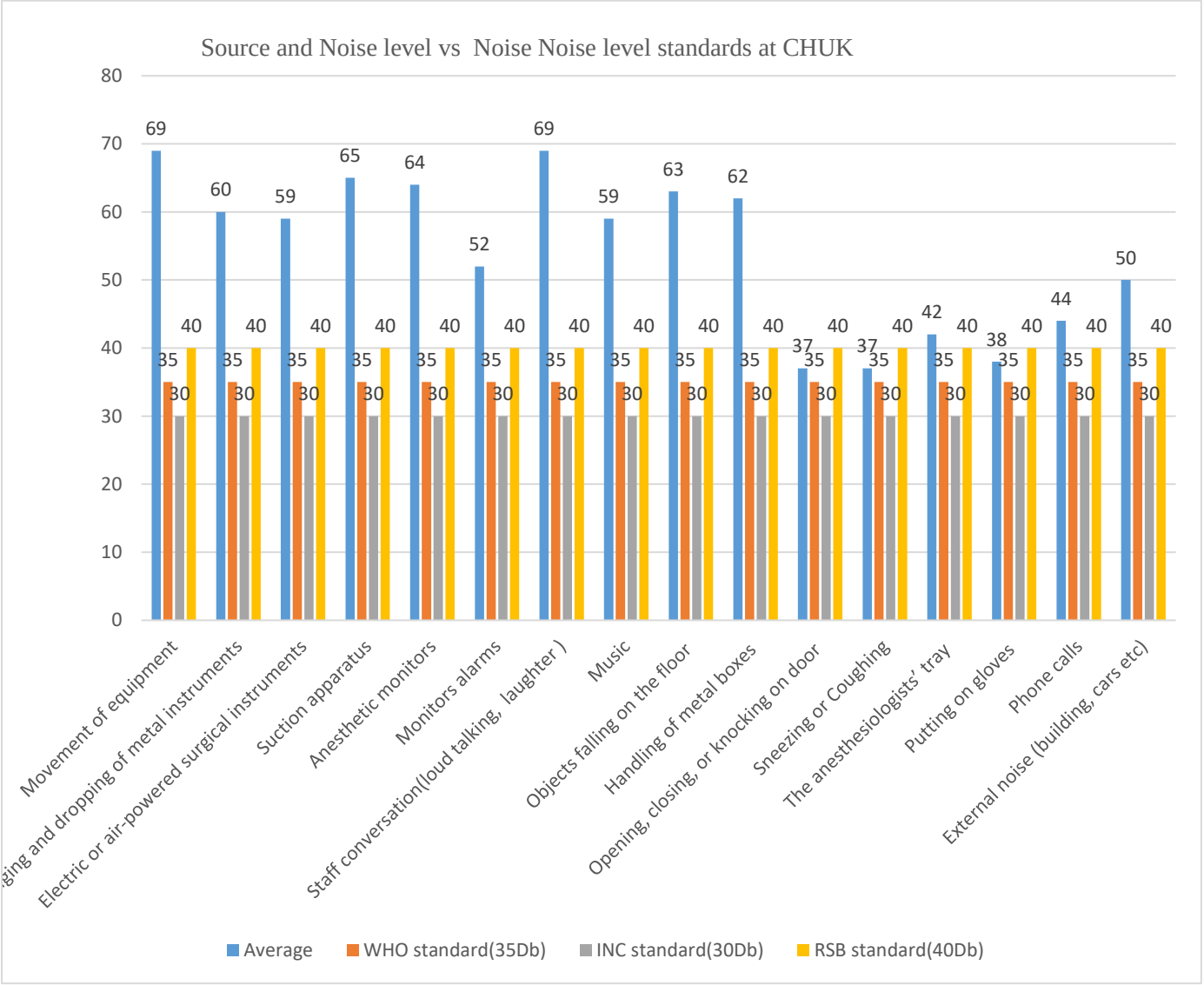

Figure 2: Source of noise

As indicated in this figure, the main sources of noise in each stage of operating process at CHUK were movement of equipment (mean: 69dB), staff conversations (mean:69dB), suction apparatus (mean: 65dB), anesthetic monitors (mean:64dB), objects falling on the floor (mean: 63dB), and dropping of metal instruments (mean: 60dB).

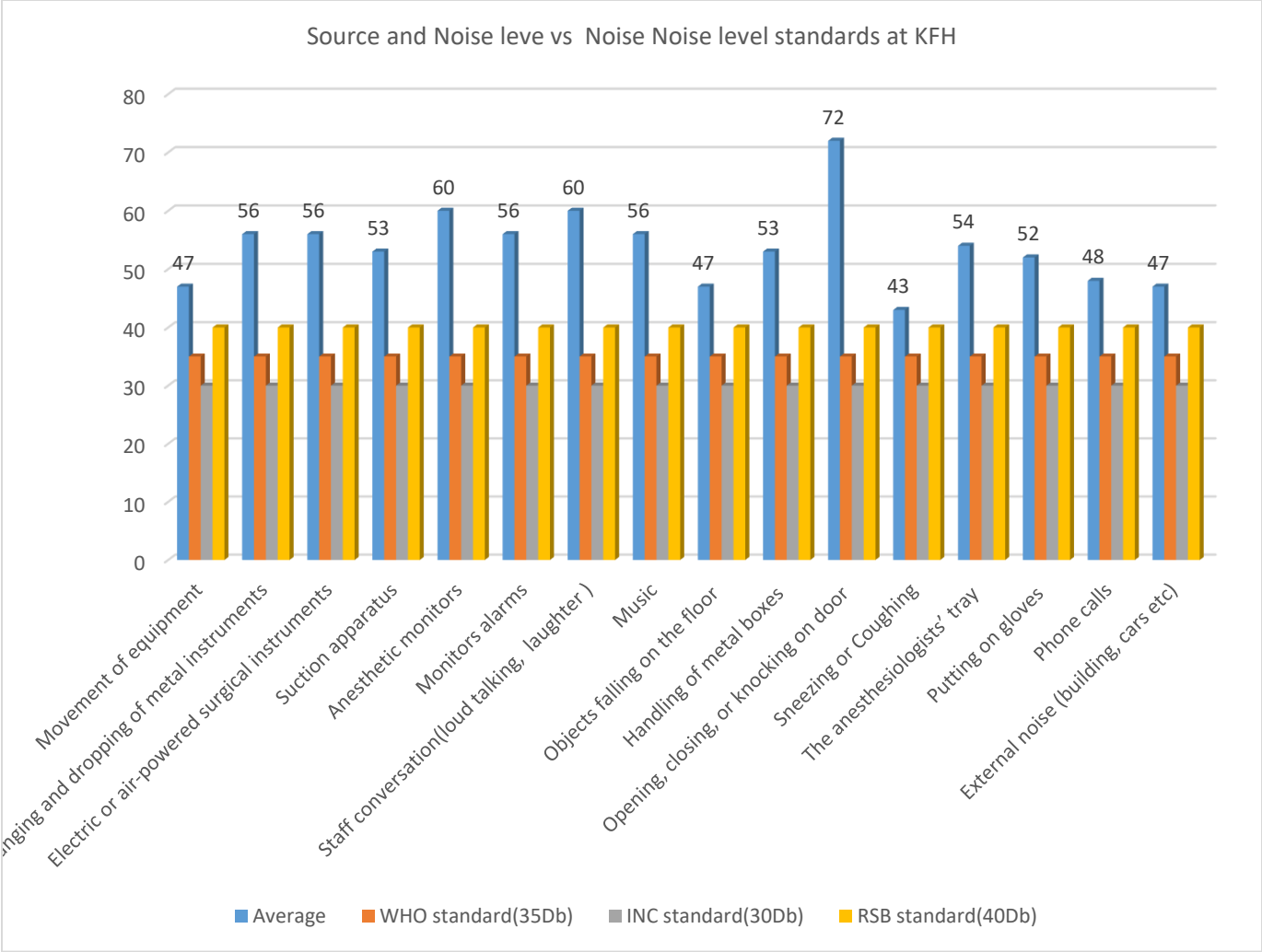

Figure 3: Source and Noise level vs Noise level standards at KFH

As indicated in this figure, the main sources of noise in each stage of operating stage at King Faisal Hospital were opening instrument containers, closing, or knocking at the door during surgery (mean: 72dB), staff conversations including loud talking and laughter (mean:60dB), anesthetic monitors (mean:60dB), dropping of metal equipment (mean: 56dB), electric or air powered surgical instruments (mean: 56dB), music (mean:56dB), and monitor alarm (mean: 56dB).

Table 2: One-way anova to compare means of noise levels during the caesarian section at both CHUK and KFH hospitals

Noise pollution level time	Noise pollution between and within groups	Sum of Squares	df	Mean Square	F	p-value
Noise level at the start of the surgical operation	Between Groups	3150.0	1	3150.0	55.4	**.000***
	Within Groups	4431.7	78	56.8		
Noise level in middle of surgery	Between Groups	495.0	1	495.0	7.3	**.008***
	Within Groups	5231.3	78	67.0		
Noise level at the end stage of surgery	Between Groups	1015.3	1	1015.3	10.0	**.002***
	Within Groups	7881.0	78	101.0		

A statistically significant difference was observed in the mean noise levels across all three stages of surgery between CHUK and KFH (P = 0.000, p=0.008, p=002). Noise pollution levels were significantly higher in CHUK than KFH during all stages of surgery.

Table 3: Bivariate analysis (chi-square test) for association between shift, indication of caesarian section, hospital name and noise level

IV vs DV	Pearson X^2 value	Df	p- Value
Noise level vs Shift	46.311[a]	32	**.049***
Noise level vs indication of caesarian section	63.111[a]	32	**.001***
Noise level vs hospital	38.356[a]	32	**.203**

As shown in this table, there is statistically significant association between the noise level and surgery type. The noise level was significantly higher for emergency surgery than elective cesarean indication (Pearson X2: 63.111[a], P=0-001). In addition, the noise level was significantly higher during the day shift than the night shift (Pearson X2: 46.311[a], P=0.049).

CHAPTER FIVE: DISCUSSION OF FINDINGS

The purpose of the current study was to assess noise pollution in operating theatre at selected hospitals in Kigali. The literature shows that both patients and hospital staff benefit from quiet environment. In a quiet environment, fatigue and mental stress of health team staff are reduced, and patients do not suffer from psychological stress and their wellbeing improves.

Our findings showed the noise level during the caesarian section was higher than the noise pollution level recommended by the world health organization and international noise council. The World Health Organization (WHO) recommends that in hospitals the noise level on wards should not exceed 30 dB whilst noise in treatment and surgical rooms should be kept "as low as possible(7). Then, International Noise Council recommends that noise level in surgical room and intensive care unit should not exceed 45 dB during the day, 40 dB at sunset, and 30 dB at night. Therefore, our findings show a greater noise pollution level than what is recommended. It was noticed the lowest recorded noise pollution level was during the middle of surgery. There is a need to explore why in further studies. Findings from our study are closely similar to those of the study done in Iran. In that study, it was found that noise pollution level during a surgical procedure was higher than national and international documented standards. The highest and lowest registered sound level during the operation was 93 and 55 dB, respectively(11).

Regarding the causes of noise pollution, findings from our study showed the main sources of noise pollution during caesarian section included opening surgical instrument containers, closing, or knocking at the door during surgery (mean: 72dB), staff conversations including loud talking and laughter, anesthetic monitors, dropping of metal equipment, electric or air powered surgical instruments, music, and monitor alarm. Findings from our study are closely similar to those of the study done by Masoumeh and colleagues where it was found that the noise pollution was generated by equipment (69 dB), trolley movement (66 dB), and personnel conversations (64 ± 3.9 dB)(23). Based on findings from our study, some causes of noise pollution during the surgical operation were easily avoidable and others not. For example, music, staff talks, trolley movement, dropping metal instruments and opening and closing doors.

However, it is difficult to control and avoid the noise from, anesthetic monitors, electric or air powered surgical instruments, and monitor alarm. Therefore, low noise monitors and alarm innovation from industries are needed.

Also, findings from our study found the noise pollution was likely to increase during the day shift or when the caesarian section was urgent. We recommend further studies to explore why there is that difference. In addition to that, despite there was no statistically significant difference found between noise pollution at KFH compared to CHUK, the maximum and great noise pollution average recorded were from CHUK.

Study limitations

We only used one smart app-based noise monitoring tool to measure the noise level.
This study is limited to have examined the levels of noise during C-section operations at the selected referral hospitals. Exploring noise levels in other type of operations and at different levels of health facilities to determine the contributing factors such as the complexity of carrying that operation and the stress associated with them would be added value.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

There is noise pollution during caesarian section at CHUK and King Faisal hospitals. The noise pollution level recorded at two hospitals exceeded the noise pollution level recommended by the World Health Organization (WHO), international noise council and Rwanda Standard Board (RSB). The major source of noise during caesarian section at both hospitals are movement of equipment, staff conversations, suction apparatus, anesthetic monitors, objects falling on the floor, and dropping of metal instruments. also, there a positive association between day shift and emergency caesarian section and higher noise pollution level. Measures to reduce noise pollution level in theatres and its impact are needed in Rwanda.

6.2 Recommendations

Based on our study findings, we would like to recommend the following;

KFH and CHUK:

Establishing strategies that could help reduce noise pollution level in theatres such as training staff on noise pollution, look for theater equipment that are in line with INC, like (monitor, suction machine) that produce low noise and install the system that control the noise in theatres. Inform outside construction engineers to establish measures that can help reducing noise from outside.

Researchers: Extend research in others surgical specialties rather than caesarian section and in other operating theatres in Rwanda. A study exploring the noise impact on quality of surgical care is also recommended

Administration and policy makers:

Install noise sensors in theatres. Also, monitoring and supervising hospitals can help to know gaps and challenges around the noise pollution in theatres

Educators

Incorporate and improve the Medical and surgical curriculum by incorporating the noise pollution chapter.

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APPENDICES

APPENDIX 1: Source of noise checklist

Hospital level: *District* ☐ *Referral* ☐

Time: Night ☐ Day ☐

Indication of caesarian section: elective ☐ Emergency ☐

Number of persons in theatre: ……

Source of noise	**Sound level in dB**
Movement of equipment,	
Clanging and dropping of metal instruments,	
electric or air-powered surgical instruments	
suction apparatus,	
anesthetic monitors,	
Monitors alarms	
Staff conversation With Loud talking, voices, or laughter	
Music	
clanging and dropping of metal instruments	
Objects falling on the floor	
Handling of metal boxes containing sterilized material drums or other	
Opening, closing, or knocking on door	
Sneezing	
Coughing	
The anesthesiologists' tray	
Putting on gloves	
Phone calls	
External noise (building, cars etc)	

APPENDIX 2. INFORMED CONSENT EXPLANATION FORM

STUDY TITLE: **Assessment of noise pollution in operating theatre at selected hospitals in Kigali**

To be read and understood and questions to be answered in a language the participants understand.

Dear Participant, my name is Emile MUKAMA, a Masters student in the Master of Sciences in Nursing (perioperative) at the University of Rwanda, College of Medicine and Health Sciences. I am carrying out a scientific study on the "Assessment of noise pollution in operating theatre at selected hospitals in Kigali" The study forms a part of the requirements for the award of a Master's Degree under the supervision of Dr.Philomene UWIMANA and Mr. Christian NTAKIRUTIMANA who are my lecturers in the University of Rwanda. I invite you to participate by answering questions on the designated questionnaire. At the end of the study; recommendations for intervention measures will be made.

Please note the following:

1. There will be NO compensation for taking part in this research.
2. Your participation is voluntary
3. Participation involves answering questionnaires and interview questions.
4. You can withdraw from the study at any time without any penalties or loss of benefits.
5. Your name will not be used anywhere in the study and the information gathered will be treated with confidence and solely for this study and for an intervention project based on findings herein.
6. No harmful or invasive procedures shall be conducted on you.
7. Feel free to ask any questions at any time of conducting the study. All information obtained will be professional and confidentiality will be upheld.

I kindly request you to sign the statement below after reading through it.

Signature of participant …… …….

Date ……..……

APPENDIX 3. RESEARCH PARTICIPANT INFORMED CONSENT

I agree to participate in this research project on "Assessment of noise pollution in operating theatre at selected hospitals in Kigali" which is being conducted by Emile MUKAMA.

I understand that this study involves answering prepared questions. I understand that my participation in this study is entirely voluntary, and that if I wish to withdraw from the study, I may do so at any time, and that I do not need to give a reason for doing so. If I withdraw from the study, I understand this will have no effect on my relationship with researchers.

I understand that I may receive any direct benefit from participating in this study, but my participation may help others in the future. I understand the information I give will be kept confidentially to the extent permitted by law. I have read and I understand this information and agree to take part in the study.

Signature of participant …… ……

Date ……..……

APPENDIX 4. GANTT CHART SHOWING TIMELINES OF THE RESEARCH STUDY

TASK / ACTIVITY	PERIOD												
	Jun 22	Jul 22	Aug 22	Sep 22	Oct 22	Nov 22	Dec 22	Jan 23	Feb 23	Mar 23	Ap 23	May 23	June 23
Shaping the research topic and identifying a research area													
Searching for literature related to study questions													
Developing a research proposal													
Presentation of the proposal													
Requesting for permission from IRB of the University of Rwanda													
Requesting data collection to study area													
A pilot study to pre-testing the data collection tool													
Data collection													
Data analysis and interpretation of the findings and report writing													
Research project presentation													
Final report to UR & Research settings													

APPENDIX 5. ETHICAL CLEARANCE APPROVAL

A. University of Rwanda Institutional Review Board approval

B. Kigali University Teaching of Kigali Institutional Review Board approval

C. King Faisal Hospital Institutional Review Board approval

UNIVERSITY of RWANDA

COLLEGE OF MEDICINE AND HEALTH SCIENCES

DIRECTORATE OF RESEARCH & INNOVATION

CMHS INSTITUTIONAL REVIEW BOARD (IRB)

Kigali, 22/12/2022
Ref: CMHS/IRB/584/2022

MUKAMA EMILE

Postgraduate Studies Program,

School of Nursing and Midwifery, CMHS, UR

Dear MUKAMA EMILE,

RE: ETHICAL CLEARANCE

Reference is made to your application for ethical clearance for the study entitled ***"Assessment of noise pollution in operating theatre at selected hospitals in Kigali".***

Having reviewed your application and been satisfied with your protocol, your study is hereby granted ethical clearance. The ethical clearance is valid for one year starting from the date it is issued and shall be renewed on request. You will be required to submit the progress report and any major changes made in the proposal during the implementation stage. In addition, at the end, the IRB shall need to be given the final report of your study.

We wish you success in this important study.

Assoc. Prof. Stefan Jansson (PhD)
Acting Chairperson Institutional Review Board,
College of Medicine and Health Sciences, UR

Cc:

- Principal College of Medicine and Health Sciences, UR
- University Director of Research and Postgraduate studies, UR

CENTRE HOSPITALIER UNIVERSITAIRE
UNIVERSITY TEACHING HOSPITAL

Quality Health Care Training & Research

Ethics Committee / Comité d'éthique

24th Mar,2023 Ref.:EC/CHUK/054/2023

Review Approval Notice

Dear Emile MUKAMA,

Your research project: ***"ASSESSMENT OF NOISE POLLUTION IN OPERATING THEATRE AT SELECTED HOSPITALS IN KIGALI "***

During the meeting of the Ethics Committee of University Teaching Hospital of Kigali (CHUK) that was held on 24th Mar,2023 to evaluate your request for ethical approval of the above mentioned research project, we are pleased to inform you that the Ethics Committee/CHUK has approved your research project.

You are required to present the results of your study to CHUK Ethics Committee before publication by using this link:www.chuk.rw/research/fullreport/?appid=802&&chuk.

PS: Please note that the present approval is valid for 12 months.

Yours sincerely,

Dr Emmanuel Rusingiza Kamanzi
The Chairperson, Ethics Committee,
University Teaching Hospital of Kigali

ETHICS COMMITTEE
CHUK

Scan code to verify.

" University teaching hospital of Kigali Ethics committee operates according to standard operating procedures (Sops) which are updated on an annual basis and in compliance with GCP and Ethics guidelines and regulations "

KING FAISAL HOSPITAL RWANDA

INSTITUTIONAL REVIEW BOARD

Patient Centered Care

IRB Notification of Approval

Ref: KFH/2023/ 067/IRB

Date: April 13, 2023
Protocol Title: ASSESSMENT OF NOISE POLLUTION IN OPERATING THEATRE AT SELECTED HOSPITALS IN KIGALI.
Principal Investigator:
Emile Mukama **Email:** emilemukama@gmail.com
Protocol Reference #: KFH/2023/ 067/IRB
Date of IRB Initial Review: April 11, 2023
Review Type: Expedited Review
IRB Review Decision: Approved
Date of Effectiveness: April 13, 2023
Date of Expiry: April 12, 2024

Dear Emile Mukama,

King Faisal Hospital Rwanda's Institutional Review Board (KFH IRB) reviewed your submission. This letter is to notify you that the KFH IRB approved your submission, and this approval is valid for one (1) year and then must be renewed according to the KFH IRB Standard Operating Procedures.

Please note the following considerations:

1. Please review the KFH IRB Standard Operating Procedures and ensure compliance with all requirements, including participant content, changes or amendments to the protocol, and reporting requirements.
2. All project materials, including signed consent forms, must be retained and are subject to review in case of a routine audit
3. Notify the KFH Directorate of Research once data collection is completed
4. The Principal Investigator is requested to submit a hard copy of his/her final manuscript to the Directorate of Research upon completion.
5. Principal Investigators must follow the appropriate study continuing review and closure procedures as indicated in the Standard Operating Procedures Manual.

Please contact us at irb@kfhkigali.com in case of any questions or clarifications.

Sincerely,
Dr. Jean Marie Vianney Dushimiyimana
Consultant ENT Surgeon
Chair, Institutional Review Board