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DEPARTMENT OF CLINICAL MICROBIOLOGY

MICROBIAL ANALYSIS OF STETHOSCOPES AND OTOSCOPES USED BY STAFF AS POTENTIAL SOURCES OF NOSOCOMIAL INFECTIONS IN KOMFO ANOKYE TEACHING HOSPITAL-KATH

A THESIS SUBMITTED TO THE DEPARTMENT OF CLINICAL MICROBIOLOGY IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF THE MASTER OF SCIENCE DEGREE (M.SC.) IN CLINICAL MICROBIOLOGY

BY

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DECLARATION

I hereby declare that this submission is my own work towards the M.Sc. (Clinical Microbiology) degree and that, to the best of my knowledge; it contains no material previously published by another person or material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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TABLE OF CONTENTS

PROJECT TITLE ii

DECLARATION..... iii

ACKNOWLEDGEMENT..... iv

TABLE OF CONTENTS..... v

LIST OF TABLES..... ix

LIST OF FIGURES..... x

ABSTRACT..... xi

CHAPTER I

1.0: INTRODUCTION..... 1

1.1: Background to the study..... 1

1.2: Statement of Problems..... 3

1.3: Aim of Study..... 3

1.4.0: Objectives of Study..... 3

1.4.1: Main Objective..... 3

1.4.2: Specific Objectives..... 4

1.5: Hypothesis..... 4

1.6: Justification of Study..... 4

CHAPTER II

2.0: LITERATURE REVIEW 6

2.1: Historical Background..... 6

2.1.0: Discovery of the Importance of Hygiene 7

2.1.1: Sanitation..... 7

2.1.2: Hand hygiene..... 7

2.2: Nosocomial Infections are Still Persistent..... 9

2.3.0: Epidemiology of Nosocomial Infections 11

2.3.1: Introduction..... 11

2.3.2: Prevalence of Nosocomial Infections..... 12

2.3.3: Reservoirs and transmission of nosocomial pathogens..... 13

2.4.0: Types of Nosocomial Infections..... 16

2.4.1: Definition..... 16

2.4.2.0: Urinary Tract Infections..... 17
2.4.2.1: Causes and Common Pathogens..... 18
2.4.3.0: Surgical Site Infections..... 18
2.4.3.1: Causes and Common Pathogens..... 19
2.4.4.0: Pneumonia..... 20
2.4.4.1: Causes and Common Pathogens..... 20
2.4.5.0: Intravascular Device-Related Bloodstream Infections..... 22
2.4.5.1: Causes and Common Pathogens..... 22
2.4.6.0: Gastrointestinal Tract Infections..... 23
2.4.6.1.0: Causes of Gastrointestinal Tract Infections..... 24
2.4.6.1.1: *C. difficile*..... 24
2.4.6.1.2: Noroviruses..... 25
2.5.0: Factors Influencing the Development of Nosocomial Infections..... 26
2.5.1.0: Patient-related factors..... 26
2.5.1.1: Special patient populations..... 27
2.5.2.0: Iatrogenic factors..... 28
2.5.2.1: Devices and equipment..... 28
2.5.2.2: Surgery..... 30
2.5.2.3: Antibiotic use..... 31
2.5.3: Environmental factors..... 34
2.5.4: Architectural design..... 34
2.6: Impact of Nosocomial Infections..... 36
2.7: Management of Nosocomial Infections; the Challenges and the Way Forward..... 38
2.7.1: Hand decontamination..... 40
2.7.2: Personal medical device decontamination..... 41
2.8: The Cost-Effectiveness of Managing Nosocomial Infections..... 43

CHAPTER III

3.0: MATERIALS AND METHODS..... 45
3.1: Study design..... 45
3.2: Study area..... 45

3.2.1: Study Site..... 46
3.2.2: Sampling Period..... 46
3.2.3: Study Population..... 47
3.2.4: Inclusion and Exclusion Criteria..... 47
3.3.0: Sample Size determination..... 47
3.3.1: Sampling Scheme..... 48
3.3.2: Contact Process..... 48
3.3.3: Sample Collection, Labeling and Confidentiality..... 48
3.4.0: Laboratory Processing of the samples..... 49
3.4.1.0: Identification of isolates..... 49
3.4.1.1: The BD BBL crystal identification system..... 49
3.4.1.2: Testing procedure..... 50
3.4.2: Plate count of bacteria..... 51
3.5: DATA ANALYSIS..... 51

CHAPTER IV

4.0: ANALYSIS OF RESULTS..... 53
4.1: RESULTS..... 53
4.1.0: Recruitment of subjects and their characteristics..... 53
4.1.1: Sociodemographic characteristics of participants..... 53
4.1.2: Device usage, handling and maintenance (cleaning) practices..... 56
4.2:0 Test Results from culture..... 60
4.2.1: Results on otoscopes..... 60
4.2.2.0: Results on stethoscopes..... 60
4.2.2.1: Participants' Demographic information in relation to stethoscope contamination..... 61
4.2.2.2: Stethoscope usage, handling and maintenance in relation to stethoscope contamination..... 65
4.2.2.3: Effectiveness of various disinfectant used in KATH; Evidence From Culture..... 68

CHAPTER V

5.0: DISCUSSION..... 69

5.1: Contamination levels of otoscopes used in KATH..... 70
5.2.0: Contamination levels of stethoscopes used in KATH..... 70
5.2.1: Participants' Demographic information in relation to stethoscope contamination..... 71
5.2.2: Stethoscope usage, handling and maintenance in relation to stethoscope contamination..... 72

CHAPTER VI
6.0: CONCLUSION AND RECOMMENDATIONS..... 75
6.1: Study Limitations..... 75

REFERENCES..... 77

APPENDICES..... 97
APPENDIX 1: Copy of Structured Questionnaire..... 98
APPENDIX 2: STERILIZATION OF MATERIALS AND MEDIA PREPARATION..... 100
2.1: HOT-AIR OVEN..... 100
2.2: AUTOCLAVING..... 100
2.3: PREPARATION OF CULTURE MEDIA..... 100
APPENDIX 3: LABORATORY TESTS..... 101
3.1: GRAM TECHNIQUE..... 101
3.2: BIOCHEMICAL TESTS TO IDENTIFY BACTERIA.... 101
3.2.1: Catalase Test..... 101
3.2.2: Coagulase Test..... 102
APPENDIX 4: RESULTS FROM STUDY..... 103
APPENDIX 5: LETTER OF ETHICAL APPROVAL..... 110

LIST OF TABLES

Table 4.1: Number of participants (devices) enrolled from the various departments of KATH..... 53

Table 4.2: Ownership of devices used by participants..... 56

Table 4.3: Average number of patients the devices are used on daily..... 57

Table 4.4: Response on having ever received instruction on cleaning of these devices 57

Table 4.5: Bacteria isolates from stethoscopes of health staff of KATH..... 61

Table 4.6: Relationship between Participants' demographic parameters and levels of bacterial contamination of stethoscopes..... 62

Table 4.7: Bacterial contamination (MCC) by department..... 63

Table 4.8: Analysis of culture results for O&G and Surgery departments..... 63

Table 4.9: Bacterial contamination (MCC) by Number of years of practice of participants..... 64

Table 4.91: Bacterial contamination (MCC) by Professional status of participants..... 64

Table 4.92: Bacterial contamination (MCC) by number of years of usage of stethoscopes..... 65

Table 4.93: Bacterial contamination (MCC) by average number of patients devices were used on daily..... 66

Table 4.94 Bacterial contamination (MCC) by frequency of stethoscope disinfection by participants..... 66

Table 4.95: Bacterial contamination levels vs. agents used by staff for disinfection of stethoscopes 67

LIST OF FIGURES

Figure 4.1: Age distribution of participants 54

Figure 4.2: Sex of participants..... 54

Figure 4.3: Number of years of practice of participants..... 55

Figure 4.4: Professional status of participants..... 55

Figure 4.5: Distribution of number of years the devices had been used by participants..... 56

Figure 4.6: Frequency of disinfection of devices by participants..... 58

Figure 4.7: Agents used by participants for disinfecting devices..... 59

Figure 4.8: Belief in possibility of devices serving as sources of spread of nosocomial infections..... 60

ABSTRACT

Nosocomial infections have been recognized as a critical problem affecting the quality of health care provided in hospitals as they lead to significant morbidity and mortality and as well increased health care costs. Disinfection of routinely used apparatus in the clinical setting is generally accepted as a method of reducing nosocomial infections although compliance by health care providers is of concern. This study was undertaken to determine bacterial agents contaminating stethoscopes and otoscopes used by medical staff in Komfo Anokye Teaching Hospital (KATH); to compare the effectiveness of common cleaning methods (i.e. dry cotton wool, soapy water, 70% alcohol, and savlon) in disinfecting stethoscopes and otoscopes; to determine the stethoscope and otoscope cleaning practices among staff of KATH and to determine views of staff in KATH concerning stethoscopes and otoscopes as possible sources of spread of nosocomial infections. One hundred and sixty (160) consented participants were enrolled in this study. Participants were made up of students, house officers, resident physicians and nurses from the various departments of KATH including the Ear, Eye, Nose and Throat (EENT), Obstetrics and Gynecology (O&G), Surgery, Medicine and Child health Departments. Participants were asked among questions on demographic information, the average number of patient their devices were used on daily, whether they had ever received any form of tutelage on cleaning of these devices, how often they clean them and what their cleansing agent of choice was. Swabs were then obtained from the diaphragms/surfaces of the devices. Two samples were obtained; one from one-half of the device surfaces before cleaning and the other sample from the other half after cleaning. Results showed that 100% of all otoscope earpieces were disinfected after single use with 70% alcohol and savlon. There was no bacterial growth on any of the

otoscope earpieces sampled. The same could not be said of the stethoscopes. Only 26% (N=38) of the participants clean their stethoscope after single use, 39% (N=57) did this daily with 24.7% (N=36) cleaning them between twice weekly and once monthly. 10.3% (N=15) never clean their stethoscopes. 70% Alcohol was the most commonly used agent for cleaning [78.8% (N=115)]. 39.7% (N=58) of the 146 stethoscopes analyzed had bacterial contaminations with a mean colony count (MCC) of 15.14 colonies per membrane. All the isolates were nonpathogenic or opportunistic pathogens, mainly coagulase-negative staphylococci. The results indicate that otoscopes used in KATH are safe and play no role in nosocomial infection spread. The stethoscope though potentially playing a role in transmitting microorganisms in the KATH environment, may only play a minor role. They may however be ruled out as sources of infection spread by cleansing them regularly with 70% alcohol, the most cost effective of all the disinfectants assessed. This data should be helpful to authorities in the planning of hospital acquired infection control programmes in KATH and other hospitals in Ghana.

CHAPTER I

1.0: INTRODUCTION

1.1: Background to the Study

Nosocomial infections are becoming increasingly common worldwide affecting both developed and developing countries. For more than a century, nosocomial infections have been recognized as a critical problem affecting the quality of health care provided in hospitals as they lead to significant morbidity and mortality and as well increased health care costs (Haley, *et al*., 1985). The World Health Organization offers several definitions for a nosocomial infection: "an infection acquired in (a) hospital by a patient who was admitted for a reason other than that infection; an infection occurring in a patient in a hospital or other health care facility in whom the infection was not present or incubating at the time of admission. This includes infections acquired in the hospital but appearing after discharge and also occupational infections among staff of the facility (Coffin & Zaoutis, 2005)" (Ducel, *et al*., 2002).

It is estimated that at any one time more than 1.4 million people worldwide are suffering from infections acquired in hospitals (nosocomial infections) (Tikhomirov, 1987; Vincent, 2003). In developed countries, between 5% and 10% of patients acquire one or more infections, and 15-40% of patients admitted to critical care are thought to be affected (Lazzari, *et al*., 2004; Klevens, *et al*., 2007). In the United States alone, it results in more than 2 million hospitalizations each year. In resource-poor settings such as most developing countries including Ghana, rates of infection can exceed 20% (Pittet, 2005; WHO, 2008), but available data are scanty and more research is urgently needed to assess the burden of nosocomial infections in developing and transitional countries.

Results of previous studies show that at least one third of all nosocomial infections are preventable (Hughes, 1988). For planning preventive actions, it is essential to identify the reservoirs of microorganisms that cause nosocomial infections. Hands of hospital staff, medical equipment such as catheters, surgical instruments, implants, ventilators, endoscopes, thermometers, ultrasound probes and otoscopes, may all serve as the reservoir for microorganisms (Verghese &Patel, 1999; Pittet, *et al.*, 1999; Thompson, *et al.*, 1984; Wallace, *et al.*, 1989; Jimenez *et al.*, 1989; Bond, 1987; Livornese, *et al.*, 1992; Ohara, *et al.*, 1998; Cohen, *et al.*, 1997). A significant number of studies have however shown that transmission of microorganisms by the hands of health care workers (HCWs) is the main route of spread (Bauer, *et al.*, 1990). This is the rationale behind the time-honoured advice for all to wash their hands before and after seeing each patient.

The stethoscope, an almost universal tool of the medical profession, is an additional possible source of infection as it touches many patients. Stethoscopes are used to detect and study sounds arising within organs such as the heart, lung, and stomach prior to treatment. About forty years ago, stethoscopes used in hospitals by medical doctors, medical students and other health practitioners for assessing patients' health were shown to harbour microbes (Gerken, *et al.*, 1972), yet standard sources on infection control still give no advice on cleaning these instruments (Aycliffe, Brumfitt, *et al.*, 1990; Aycliffe, Lowbury, *et al.*, 1992). Another personal medical device of great concern when it comes to cross infection in hospitals is the otoscope. The otoscope is a device used to shine a beam of light into the ear to help visualize and examine the condition of the ear canal and eardrum. Examining the ear can reveal the cause of symptoms such as an earache, the ear feeling full, or hearing loss.

Overend and his colleagues in a study about two decades ago concluded that otoscope earpieces might harbour microbes, including pathogenic ones (Overend, *et al*., 1992).

1.2: Statement of Problems

- There is inadequate education on the essence of disinfecting personal medical devices such as stethoscopes and otoscopes in KATH.
- There is lack of education on effective methods of disinfecting personal medical devices in the hospital.
- High workload and understaffing limits the practice of stringent disinfection precautions in KATH.

1.3: Aim of Study

The main aim of this study is to analyze by microbiological culture diaphragms of stethoscopes and earpieces of otoscopes used by staff in Komfo Anokye Teaching Hospital, and to explore staff beliefs about dirty personal medical devices and the methods used to clean them.

1.4.0: Objectives of Study

1.4.1: Main Objective

To provide information on stethoscopes and otoscopes used by staff in KATH.

1.4.2: Specific Objectives

1. To determine bacterial agents colonizing diaphragms of stethoscopes and earpieces otoscopes used by medical staff in KATH;
2. To compare the effectiveness of common cleaning methods (i.e. dry cotton wool, soapy water, 70% alcohol, and savlon) in disinfecting stethoscopes and otoscopes;
3. To determine the stethoscope and otoscope cleaning practices among staff of Komfo Anokye Teaching Hospital;
4. To determine views of staff in KATH concerning stethoscopes and otoscopes as possible sources of spread of nosocomial infections;
5. To generate data to inform intervention programmes on cross infections resulting from personal medical devices (especially, stethoscopes and otoscopes) used in KATH.

1.5: Hypothesis

Null hypothesis (H_0): Stethoscopes and otoscopes used by staff in KATH are not a possible source of nosocomial infection.

Alternate hypothesis (H_1): Stethoscopes and otoscopes used by staff in KATH are a possible source of nosocomial infection.

1.6: Justification of Study

There are increasing reports of the tremendous risk of transmitting infectious bacteria including antibiotic-resistant ones within the hospital environment. An example being the outbreak of MRSA early 2012 which resulted in the close down of the children's ward of the Korle-bu Teaching Hospital in Accra (Quansah, 2012). Because most hospital-acquired

infections are primarily nosocomial and not autoinfections (Hoogkamp-Korstanje, *et al.*, 1982), their acquisition in the hospital environment adds to morbidity, mortality, and economic costs (Parmar, *et al.*, 2004).

Results from previous studies show that at least one third of all nosocomial infections are preventable (Hughes, 1988). For planning preventive actions, it is essential to identify the reservoirs of microorganisms that cause nosocomial infections. Hands of hospital staff, medical equipment such as catheters and surgical instruments have been implicated in HAI (Verghese &Patel, 1999; Pittet, *et al.*, 1999; Thompson, *et al.*, 1984; Wallace, *et al.*, 1989; Jimenez *et al.*, 1989; Bond, 1987; Livornese, *et al.*, 1992; Ohara, *et al.*, 1998; Cohen, *et al.*, 1997) for which reason active measure are taken to ensure their decontamination. Although personal medical devices including stethoscopes and otoscopes have also been found to harbor potentially pathogenic bacteria (Osorio *et al.*, 2000), little is done about them in this respect.

In Ghana, stethoscope and otoscope care are hardly covered in medical training of staff, and even when students are taught about nosocomial infections, little or no emphasis is placed on the potential of these devices to transmit infections in the hospital environment. By raising the issue of nosocomial infections transmission by these personal medical devices, physicians and other hospital personnel would be made aware of the magnitude of the problem and inherent dangers associated with hospital acquired infections. To this end, these menacing infections can be reduced or even eliminated.

CHAPTER II

2.0: LITERATURE REVIEW

2.1: Historical Background

The term nosocomial infection derives from "nosos" and "komeion" which are the Greek words for "disease" and "to take care of" respectively (Garner *et al.*, 1988). Nosocomial infections have been a part of hospital care for as long as there have been hospitals and have become an important public health issue worldwide.

The ancient historical view was that disease was spontaneously generated instead of being caused by microorganisms (Madigan & Martinko, 2005). In support of this view was the view that disease was the making of supernatural beings, that is to say God or the gods. Records from the Christian Bible show several instances of diseases unleashed upon individuals, groups of people and even whole nations as punishment from an angry God for wrong doings (International Bible Society, 1984). No concern was given to the possibility of transmission of disease from the environment or one person to another.

"He rolled up his shirt sleeves and, in the corridor to the operation room, took an ancient frock from a cupboard; it bore signs of a chequered past, and was utterly stiff with old blood. One of these coats was worn with special pride, indeed joy, as it had belonged to a retired member of the staff. The cuffs were rolled up to only just above the wrists..." Leeds, England, 1884 (Mangiadi & Marcovici, 2007). This was the state of affairs in hospitals, before the introduction and acceptance of the principles and rituals of antisepsis.

The connection between the high death rate of hospitalized patients and the exposure of patients to infectious microorganisms was first made in the mid-nineteenth century.

2.1.0: Discovery of the Importance of Hygiene:

2.1.1: Sanitation

In the 1850s, before the science of pathogens had even come into existence, Florence Nightingale understood the relevance of medical hygiene (O'Connor & Robertson, 2003). She was a pioneering nurse, writer and statistician. It was through her observations and statistics that the link between sanitary conditions and healing became recognized and established. Nightingale's most famous contribution came during the Crimean War. She and her nurses found out that among other things, hygiene was neglected and mass infections were common (often resulting in fatalities) in the British army's infirmary. Nightingale was a proponent of the Miasma theory of disease, a theory that held that "bad air" was the cause of disease. She and her colleagues thus began immediately by thoroughly cleaning the hospital and equipment to get rid of the stench. Mortality rates dropped sharply from 42.7 % to 2.2 % in just six months of her arrival (O'Connor & Robertson, 2003). This experience influenced her later career, when she avidly advocated sanitary living conditions to be of great importance in health.

2.1.2: Hand hygiene

In 1843, Oliver Wendell Holmes, a prominent New England physician conducted a survey strongly suggesting that childbed (puerperal) fever was a contagious disease caused by an infection passed to pregnant women by their doctors, who frequently moved from patient to patient, and even from autopsy to patient, without washing their hands (Holmes, 1843). His

colleagues ridiculed him. From their point of view, puerperal fever was caused by chance or God; no gentleman could have hands so dirty as to cause disease, and it was inconceivable that physicians could be responsible for the deaths of their own patients. Later that same decade Ignaz Philipp Semmelweis a Hungarian – Austrian physician also came to as similar conclusion.

Semmelweis became the titular house officer of the first of two obstetrical clinics in 1846 of the Vienna Lying-in Hospital. His clinic had a neonatal mortality rate due to puerperal fever of 13.10% in contrast to 2.03% of the second clinic (Rangappa, 2010). The two clinics admitted on alternate days but due to the bad reputation of the first clinic women begged to be admitted to the second clinic and many women preferred to give birth to their children even on the street than be brought to his clinic. The two clinics of this hospital used the same techniques, with the only difference being the individuals who worked there. The first was the teaching service for medical students, while the second had been selected for the instruction of midwives.

The breakthrough for Semmelweis occurred with the death of his friend Jakob Kolletschka from an infection contracted after his finger was accidentally punctured with a knife while performing a postmortem examination (Best & Neuhauser, 2004). Kolletschka's own autopsy showed a pathological situation similar to that of the women who were dying from puerperal fever. Semmelweis immediately proposed a connection between cadaveric contamination and puerperal fever. Detailed study of the mortality statistics of both obstetrical clinics proved his hypothesis true (Best & Neuhauser, 2004). He concluded that he and the students carried the infection particles on their hands from the autopsy room to the patients. He instituted a policy

of using a solution of chlorinated lime for washing hands between autopsy work and the examination of patients. Mortality rate dropped from its then-current level of 12.24% to 2.38% (Rangappa, 2010), comparable to the second clinic. Widening the scope of his washing protocol to include all instruments exposed to patients in labour, he virtually eliminating puerperal fever from the hospital ward bringing the rate to only 0.85% (Rangappa, 2010). However, it was only after Pasteur, Koch, and Lister had produced more evidence of the germ theory of disease (Best & Neuhauser, 2004) (thus tumbling the popularly upheld spontaneous generation theory) was the value of his work as well as that of Holmes appreciated. They were both the laughing stock of their contemporaries who thought their findings were ludicrous.

2.2: Nosocomial Infections are Still Persistent

The works of these ingenious minds spurred a series of steps over the next century, which have culminated in today's observance of sterile or near-sterile conditions in the operating theatre and hygienic practices in our hospitals.

150 years after Holmes and Semmelweis, and more than a century after Lister and Pasteur, all physicians accept the germ theory of disease, and all acknowledge the importance of antisepsis (Magner, 1992). Nevertheless, in 1981 Albert and Condie observed that hand washing rates in an intensive-care unit varied between 30-48%. The problem persists. In 1996, Tibbals reported that only 12% of physicians in a paediatric intensive-care unit washed their hands after patient contact. Even after an intensive program of education, monitoring, and feedback, hand-washing rates rose only to 17%. When another sample of doctors were surveyed about their behaviour, they reported that they washed their hands from 50-95% of

the time; but when they were surreptitiously observed, their actual rate was as low as 9% (Pritchard & Raper,1996). Apparently, hand washing does not come any naturally to modern physicians and other health workers than it did their 19th century forebears.

Transmission of infection through contaminated medical devices is also a possibility. Outbreaks of nosocomial infections have already been linked to latex gloves (Patterson, *et al.*, 1991), electronic thermometers (Livornese, *et al.*, 1992), and blood pressure cuffs (Layton, *et al.*, 1993). Catheters, surgical instruments, implants, ventilators, endoscopes, ultrasound probes and otoscopes, may all serve as the reservoir for microorganisms (Verghese & Patel, 1999; Pittet, *et al.*, 1999; Thompson, *et al.*, 1984; Wallace, *et al.*, 1989; Jimenez, *et al*, 1989; Bond, 1987; Livornese, *et al.*, 1992; Ohara, *et al.*, 1998; Cohen, *et al.*, 1997).

Health staff now routinely wear gloves to eliminate skin-to-skin contact with patients, even during the most delicate procedures. Nevertheless, pathogens can adhere to the outsides of gloves, as well as to hands. A study by Thompson *et al.* (1997) indicates that while hospital staff usually wear gloves when they are required, they do not change their gloves as often as they should, so that the problem of patient-to-patient transmission persists.

In a study by Base-Smith in 1997, sphygmomanometer cuffs from various inpatient settings were found to have bacterial colonization rates of 81-100%. In addition, 45.7% of the "clean" cuffs were contaminated with organic and/or inorganic substances that should not have been present. Myers identified a single blood pressure cuff as the common source of a nosocomial infection outbreak in a neonatal intensive care unit (Myers, 1978).

Similarly, Livornese, *et al.* found in 1993 an electronic thermometer that served as the vehicle which caused an outbreak of vancomycin resistant *Enterococcus Faecium* in a medical-surgical intensive care unit and ward of a university hospital.

Stethoscopes have always been part of the physician's basic paraphernalia when examining patients. They have recently been shown to harbour various organisms on their diaphragm surfaces with coagulase negative staphylococci as the predominant isolates (Marinella, *et al.*, 1997; Breathnach, 1992). Other organisms isolated include *Staphylococcus aureus*, *Corynebacterium spp.*, *Bacillus spp.*, *Neisseria spp.*, alpha-haemolytic streptococci, *Micrococcus luteus*, *Enterococcus spp.*, *Candida spp.*, Gram negative organisms and *Aspergillus spp.* (Jones, *et al.*, 1992; Mongi & Andriole, 1972; Wright *et al.*, 1995; Smith, *et al.*, 1996). Marinella *et al.* (1997) found that 100% of stethoscopes in their study were contaminated with coagulase negative staphylococcus and 38% were contaminated with *Staphylococcus aureus*. In a recent study conducted on stethoscopes of medical students in Nigeria bacterial contamination was found to be as high as 80.1% with *Staphylococcus aureus* and *Pseudomonas aeruginosa* as major isolates (Uneke, *et al.*, 2009).

2.3.0: Epidemiology of Nosocomial Infections

2.3.1: Introduction

Nosocomial infections have traditionally referred to infections that develop during hospitalization and so have also been known as hospital-acquired infections. As health care increasingly expands beyond hospitals into outpatient settings, nursing homes, long-term care facilities, and even home care settings, the more appropriate term has become healthcare-acquired infection (HCAI). Nosocomial infections may be considered either as endemic or

epidemic. Epidemic infections occur during outbreaks, when an unusual increase above the baseline of a specific infection or infecting organism occurs.

2.3.2: Prevalence of Nosocomial Infections

By any name, nosocomial infections are a significant problem throughout the world and are increasing. For example, nosocomial infection rates range from as low as 1% in a few countries in Europe and the Americas to more than 40% in parts of Asia, Latin America and sub-Saharan Africa (Lynch, *et al.*, 1997). At any one time, more than 1.4 million people worldwide are suffering from infections acquired in hospitals (Tikhomirov, 1987; Vincent, 2003). In 1987, a prevalence survey conducted under the auspices of WHO in 55 hospitals of 14 developing countries representing four WHO Regions (Europe, Eastern Mediterranean, South-East Asia and Western Pacific) showed an average of 8.7% of hospital patients had nosocomial infections. The highest frequencies of nosocomial infections were reported from hospitals in the Eastern Mediterranean and South-East Asia Regions, 11.8% and 10.0% respectively (Mayon-White, *et al.*, 1988), with a prevalence of 7.7 and 9.0% respectively in the European and Western Pacific Regions.

In resource-poor settings such as most countries in Africa including Ghana, rates of infection may exceed 20% (Pittet, 2005; WHO, 2008), but available data is scanty with no credible country estimates. The WHO estimates, however, provide some guidance as to which types of nosocomial infections occur most frequently in developing countries. Surgical site infections, urinary tract infections and lower respiratory (pneumonia) infections were the leading types reported. This sequence differs somewhat from what is reported in the US, for

example, where urinary and respiratory tract infections are the most common followed by surgical site infections (Emori & Gaynes, 1993).

In the US, nosocomial infections affect more than 2 million patients each year (about 5-10% of hospitalized patients) leading to approximately 90,000 deaths per year (Weinstein, 2004; Burke, 2003). A government report on hospital-acquired infection in England, suggests that there are at least 100,000 cases of hospital-acquired infection every year in England, costing the UK National Health Service some £1 billion each year (House of Commons Committee of Public Accounts, 2003).

The WHO study (2008), and others, show that the highest prevalence of nosocomial infections occurs in intensive care units and in acute surgical and orthopaedic wards. Not surprisingly, infection rates are higher among patients with increased susceptibility because of old age, underlying disease, or chemotherapy.

2.3.3: Reservoirs and transmission of nosocomial pathogens

The patient is exposed to a variety of microorganisms during hospitalization. Contact between the patient and a microorganism does not by itself necessarily result in the development of clinical disease. A healthy human body has several defences against infection: the skin and mucous membranes form natural barriers to infection, and immune responses (nonspecific and specific) are activated to resist microorganisms that are able to invade. The skin can effectively protect the body from most microorganisms unless there is physical disruption. For example, the human papillomavirus can invade the skin, and some parasites can penetrate intact skin, but bacteria and fungi cannot (Beers & Berkow, 1999).

Other disrupters of the natural barrier are lesions or injury or, in the healthcare setting, invasive procedures or devices.

In addition to breaks in the skin, other primary entry points for microorganisms are mucosal surfaces, such as the respiratory, gastrointestinal, and genitourinary tracts (Pier, 2004). The membranes lining these tracts comprise a major internal barrier to microorganisms due to the antimicrobial properties of their secretions. The respiratory tract filters inhaled microorganisms, and mucociliary epithelium in the tracheobronchial tree moves it out of the lung. In the gastrointestinal tract, gastric acid, pancreatic enzymes, bile, and intestinal secretions destroy harmful microorganisms. Commensal bacteria make up the normal flora in the gastrointestinal tract and act as protection against invading pathogenic bacteria (WHO, 2002).

The likelihood of exposure leading to infection depends partly on the characteristics of the microorganisms, including resistance to antimicrobial agents, intrinsic virulence, and amount (inoculum) of infective material. Nosocomial infections are commonly caused by bacteria. They can also be caused by viruses, fungi, and parasites, but these types of infection occur less frequently, especially those caused by parasites (e.g., scabies), and often do not carry the same risks of morbidity and mortality as bacterial infections. Viral nosocomial infections are more common in children than in adults and carry a high epidemic risk (Weinstein, 2004). Fungal nosocomial infections frequently occur during prolonged treatment with antibiotics and in patients who have compromised immune systems (WHO, 2002).

Microbes that cause nosocomial infections can be acquired in several ways:

1. The permanent or transient flora of the patient (endogenous infection)

Bacteria present in the normal flora cause infection because of transmission to sites outside the natural habitat (urinary tract), damage to tissue (wound) or inappropriate antibiotic therapy that allows overgrowth (*C. difficile*, *Candida spp.*).

2. Flora from another patient or member of staff (exogenous cross-infection)

Bacteria are transmitted between patients:

- through direct contact between patients (hands, saliva droplets or other body fluids),
- in the air (droplets or dust contaminated with bacteria from a patient),
- through staff contaminated through patient care (hands, clothes, nose and throat) who become transient or permanent carriers, subsequently transmitting bacteria to other patients by direct contact during care,
- through objects contaminated by the patient (including equipment such as stethoscopes and otoscopes), visitors or other environmental sources (e.g. water, other fluids, food).

3. Flora from the health care environment (endemic or epidemic exogenous environmental infections)

A healthcare facility increases the risk of infection for two primary reasons. "First, it is likely that normally sterile body sites will become exposed, allowing pathogens to cause infection through contact with mucous membranes, non-intact skin, and internal body areas. Second, the likelihood of a susceptible host is high because of the vulnerable health status of patients. Especially in an era of decreased hospital stay and increased outpatient treatments, it is the sickest patients who are hospitalized, increasing the risk not only for infection to develop in these patients but also for their infection to be more severe and for it to be transmitted to others" (Tietjen, *et al*, 2003).

2.4.0: Types of Nosocomial Infections

2.4.1: Definition

Nosocomial infection is clearly defined by the Centers for Disease Control and Prevention (CDC) in the National Nosocomial Infections Surveillance (NNIS) system as a "localized or system condition (WHO, 2002) that results from adverse reaction to the presence of an infectious agent(s) or its toxin(s); and (Weinstein, 2004) that was not present or incubating at the time of admission to the hospital" (Garner, *et al.*, 1988). Thus, infections that are unrelated to the admitting diagnosis that develop within 48 hours after admission are considered to be nosocomial infections.

According to the CDC definitions, the diagnosis of infection is made on the basis of a combination of clinical findings and the results of laboratory studies or other diagnostic testing (Garner, *et al.*, 1988). The definitions also note that an infection should be considered nosocomial if it is thought to be acquired in the hospital but did not become evident until after discharge (Garner, *et al.*, 1988). The NNIS system provides comprehensive details about the criteria for infection at 13 major anatomic sites and has developed clinical and biologic criteria for 48 specific sites or types of infection (Garner, *et al.*, 1988; Horan & Gaynes, 2004). WHO in the 2002 document simplified the criteria to facilitate infection control in healthcare institutions with limited resources.

As noted earlier, the most common nosocomial infections are urinary tract infections, surgical site infections, pneumonia, intravascular device-related bloodstream infections, and gastrointestinal tract infections. Other nosocomial infections defined by the NNIS include infection of bones and joints; the central nervous system; the cardiovascular system; the eye,

ear, nose, throat, or mouth; the lower respiratory tract (other than pneumonia); the reproductive tract; the skin and soft-tissue; and systemic infection. Many of these infections are complications of surgically implanted devices (Vinh & Embil, 2005).

The microorganisms causing nosocomial infection vary by anatomic site. Gram-negative bacilli account for a high percentage of infections in intensive care units. In an analysis of NNIS data from 2003, gram-negative bacilli were associated with 71% of urinary tract infections, 65% of cases of pneumonia, 34% of surgical site infections, and 24% of bloodstream infections (Gaynes & Edwards, 2005).

Infectious agents also vary among healthcare facilities and even units within a single institution. Knowledge of trends in the pathogens responsible for nosocomial infections is important in determining appropriate empiric therapy. This information changes frequently and updates are required to facilitate and improve patient care (Jones, 2003).

2.4.2.0: Urinary Tract Infections

The urinary tract is the most common site of nosocomial infection, accounting for approximately 35% of such infections (Burke, 2003). Their costs, in terms of morbidity, mortality, and economics, are low, especially compared with the other types of nosocomial infections (Farr, 2002; Buonanno & Damweber, 2006). A urinary tract infection will develop in approximately 20% of patients who have an indwelling catheter, and a catheter is associated with nearly 80% of all nosocomial urinary tract infections (WHO, 2002; Wong & Hooton, 1981). The rate of nosocomial urinary tract infection is especially high in some patient populations, including patients who have had kidney transplant (Polack, *et al*., 2004).

Several risk factors have been identified, including female gender, diabetes, renal insufficiency, duration of catheterization, insertion of a urinary catheter late in the hospital stay, and others (Weinstein, 2004; Tietjen, 2003; Falagas & Kompoti, 2006).

2.4.2.1: Causes and Common Pathogens

Urinary tract infections can be caused by both endogenous and exogenous transmission. Normal flora from the gastrointestinal tract can spread to the urinary tract, or pathogens can be transmitted by caregivers carrying out tasks related to the catheter or drainage bag (Weinstein, 2004). Occasionally, pathogens are transmitted through urologic equipment that has not been adequately disinfected. Nosocomial urinary tract infections are usually caused by gram-negative pathogens, the most common being *Escherichia coli*, *Proteus mirabilis*, *Klebsiella spp.*, and *P. aeruginosa*; other causal pathogens include enterococci and *Enterobacter spp.* (Gaynes & Edwards, 2005). Candida is the leading cause of nosocomial urinary tract infections in intensive care units (Weinstein, 2004). In most of the cases, the infections are caused by only one pathogen.

2.4.3.0: Surgical Site Infections

Surgical site infections account for approximately 40% of infections acquired in a healthcare setting and are costly in terms of length of stay, morbidity and mortality, and actual costs (Burke, 2003; Zhan & Miller, 2003; Griffin, 2005; Odom-Forren, 2006). These costs are even higher for patients 70 years of age and older. One study showed that mortality associated with surgical site infection with *S. aureus* was higher for this population than for either younger patients with *S. aureus* infection or for older patients with no infection (McGarry, *et al.*, 2004). Length of stay and actual costs were similarly elevated. Of all

patients who have surgery, infection will develop postoperatively in approximately 3% to 5% (Griffin, 2005; Odom-Forren, 2006; Cheadle, 2006). The rate of surgical site infection has become lower over the past few years. However, this decrease is not thought to be an accurate representation because of an increased number of operations done on an outpatient basis; a decrease in the length of the postoperative hospital stay; and a wound infection incubation period of five to seven days (Weinstein, 2004; Burke, 2003). This potential for underestimation of the number of surgical site infections is reflected in the 2005 findings of Nan in a study in which one-third of nosocomial wound infections were detected after the patient had been discharged.

2.4.3.1: Causes and Common Pathogens

Surgical site infections arise from both endogenous and exogenous transmission, and several patient-related and surgery-related factors have been implicated as risk factors (Weinstein, 2004; Mangram, *et al*., 1999; Griffin, 2005; Odom-Forren, 2006; Cheadle, 2006; Falagas & Kompoti, 2006). Among the surgery-related factors are anesthesia score, duration of the operation, the use of drains, and inadequate aseptic technique.

The microbial sources of surgical site infections vary according to the type of surgery, and the most common microorganisms are *S. aureus*, coagulase-negative staphylococci, *Enterococcus spp*., *Escherichia coli*, *P. aeruginosa*, and *Enterobacter spp*. (Mangram, *et al*., 1999). According to data from the NNIS, the frequency of infection with gram-negative bacilli has decreased over the past two decades, but these pathogens are still responsible for about one-third of surgical site infections (Gaynes & Edwards, 2005). The incidences of *S.*

aureus and coagulase-negative staphylococci have increased over the past two decades, while the frequency of the other pathogens has remained the same or decreased.

2.4.4.0: Pneumonia

Another common nosocomial infection is pneumonia, accounting for 15% to 20% of all nosocomial infections (Weinstein, 2004; Burke, 2003; Tietjen, *et al.*, 2003). The rate is especially high (10% to 65%) for critically ill patients and is 6 to 21 times higher for patients receiving continuous mechanical ventilation than for those who are not receiving such support (Dodek, *et al.*, 2004; Kollef, 2005; Davis, 2006). Thus, most research on hospital-acquired pneumonia has focused on ventilator-associated pneumonia, which is defined as pneumonia that develops within 48 hours after tracheal intubation (Kollef, 2005). Ventilator-associated pneumonia develops in approximately 9% to 27% of patients who are intubated, and approximately 25% to 60% of deaths for patients with nosocomial infection can be attributed to ventilator-associated pneumonia (Burke, 2003; Kollef, 2005). The costs in terms of morbidity, mortality, and economics are among the highest for nosocomial infections (Weinstein, 2004; Tietjen, *et al.*, 2003; Farr, 2002; Kollef, 2005).

2.4.4.1: Causes and Common Pathogens

Most cases of nosocomial pneumonia are caused by aspiration of bacteria originating in the oropharynx or the stomach (Tietjen et al, 2003). Approximately 50% of all cases occur after surgery, with the highest risk associated with cardiac and lung surgery, and cross-contamination, either through staff or through equipment, is another cause (Tietjen, *et al.*, 2003).

It is unclear whether the most common causative pathogens for nosocomial pneumonia are the same for patients in the intensive care unit and those in other units. Timing of the onset of pneumonia has been thought to be an aid in identifying the causative pathogens, with early onset (within four to five days after hospitalization) most likely being caused by an antibiotic-sensitive pathogen, such as *Streptococcus pneumoniae*, *Haemophilus influenzae*, *E. coli*, nonresistant enteric gram-negative bacilli, or methicillin-sensitive *S. aureus* (Kollef, 2005; Flanders, *et al*., 2006).

Under this same theory, late onset pneumonia (beyond five days after hospitalization), is more likely caused by resistant bacteria, such as *Pseudomonas aeruginosa*, *Acinetobacter spp*., other resistant enterobacter species, and MRSA (Flanders, *et al.*, 2006). Some studies have shown that *S. aureus* is common among patients who are in a coma or have diabetes or renal failure. *Pseudomonas* is common among patients who have had a prolonged stay in the intensive care unit, have received prior antibiotics or corticosteroids or who have structural lung disease; and *Legionella* is usually found in patients who have compromised immune systems (Flanders, *et al*., 2006).

The most common pathogen associated with ventilator-associated pneumonia is *S. aureus*, followed by *P. aeruginosa*, other *Staphylococcus spp*., and *Enterobacter spp*. (Kollef, 2005; Kollef & Micek, 2005). These microbes are among those that have become resistant to antibiotics, and the frequency of infection with MRSA is increasing (Kollef, 2005). Almost half of all cases of ventilator-associated pneumonia are caused by infection with more than one pathogen (Weinstein, 2004; Kollef, 2005). While bacteria are the primary causative

agents, viral and fungal microorganisms are beginning to emerge as causes (Depuydt, *et al.*, 2006).

2.4.5.0: Intravascular Device-Related Bloodstream Infections

Bloodstream infections, such as septicaemia and bacteraemia, can develop from other types of nosocomial infections or infections at other sites in the body, but about half are caused by intravascular devices, primarily central venous catheters (Weinstein, 2004). Bloodstream infections stemming from intravascular devices account for approximately 15% of all nosocomial infections, affecting approximately 1% of all hospitalized patients (Hugonnet, *et al.*, 2004; Chen, *et al.*, 2006). It has been estimated that 5.3 infections occur per 1,000 catheter days in the intensive care unit.

The costs of these infections are the highest among nosocomial infections, with an attributable mortality of 18%, or about 14,000 deaths each year (Burke, 2003; Safdar, *et al.*, 2005; O'Grady, *et al.*, 2002; Blot, *et al.*, 2005; Pittet, *et al.*, 1994). In addition, the costs of intravascular device-related bloodstream infections have increased with the rise in cases caused by resistant bacteria. These infections have gained even more attention because of the growing number of patients with central venous catheters in the community (Maki & Crnich, 2005).

2.4.5.1: Causes and Common Pathogens

Intravascular device-related bloodstream infections are transmitted by both endogenous and exogenous routes. Lack of aseptic technique can cause contamination of the catheter from either the patient's skin or the caregiver's hands, with microorganisms entering the

bloodstream by moving along the catheter-tissue interface to the catheter tip, usually during the first week after insertion (Weinstein, 2004; Tietjen, *et al*., 2003). Contamination of the hub of the catheter can also lead to intravascular device-related bloodstream infections; in fact, for devices that have been left in place for more than 30 days, the infection is most likely a result of contamination of the hub (Tietjen, *et al*., 2003). Contamination of infusion fluid is rare, but is the most common cause of epidemic intravascular device-related bloodstream infection (Weinstein, 2004).

In 2002, the CDC reported that the most common pathogens, for the period of 1992 to 1999, were coagulase-negative staphylococci, enterococci, and gram-negative rods (O'Grady, *et al*., 2002). In a more recent report, based on data from the NNIS for the period of 1986–2003, gram-negative bacilli were among the most common microorganisms causing intravascular device-related bloodstream infections, although the rate has decreased over the past two decades (Gaynes & Edwards, 2005). Other common bacterial pathogens include *S. aureus*, *K. pneumoniae*, *E. coli*, and *P. aeruginosa* (Weinstein, 2004; Tietjen, *et al*., 2003; O'Grady, *et al*., 2002). Fungal infection with *Candida sp.* has also been reported to be the cause of 8% of intravascular device-related bloodstream infections (O'Grady, *et al*., 2002). Creating further challenge to treatment is the increase in Vancomycin Resistant *E. Coli* (VRE), which rose from 0.5% in 1989 to 25.9% in 1999 (O'Grady, *et al*., 2002).

2.4.6.0: Gastrointestinal Tract Infections

Gastrointestinal tract infections in adults in the healthcare setting are caused primarily by *C. difficile*, a pathogen that causes diarrhoea in about 30% of hospitalized adults (Lautenbach, 2001; Bauer and Madaras-Kelly, 2006). The prevalence and severity of *C. difficile* has

increased significantly over the past few years, and more than twice as many cases were documented on hospital discharge records in 2003 than in 1996 (178,000 compared with 82,000) (McDonald, *et al.*, 2006). These infections can have a substantial impact (Lautenbach, 2001; McDonald, *et al.*, 2006; Sunenshine & McDonald, 2006). *C. difficile*-associated disease may occasionally develop in the community, but it is most commonly found in hospitals and long-term facilities (Laffan, *et al.*, 2006). Within these settings, epidemic strains may be transmitted (McDonald, *et al.*, 2006; McDonald, 2005). In fact, one strain of *C. difficile* was associated with outbreaks in 11 states of America, as well as in Canada, in the early 2000s (Sunenshine & McDonald, 2006; McDonald, 2005).

In some patients, only colonization with *C. difficile* occurs, but usually, the production of toxins (A and B) leads to inflammation, secretion of mucous and fluid, and damage to the mucosa, resulting in diarrhoea or colitis (Sunenshine & McDonald, 2006). Disease can further progress to toxic megacolon, sepsis with or without intestinal perforation, and death (McDonald, *et al.*, 2006; McDonald, 2005).

2.4.6.1.0: Causes of Gastrointestinal Tract Infections

2.4.6.1.1: *C. difficile*

C. difficile is an exogenous infection that is transmitted through the faecal-oral route. Spread occurs through contact with surfaces (commodes, bathtubs), devices (rectal thermometers), or materials that are contaminated with faeces. The primary risk factor for infection with *C. difficile* is antibiotic use; up to 90% of nosocomial infections with *C. difficile* are associated with use of an antibiotic (Sunenshine & McDonald, 2006; Palmore, *et al.*, 2005). In one study, clindamycin was associated with a 3.9-fold likelihood of the development of *C.*

difficile-associated disease, and first-generation cephalosporins and fluoroquinolones have also been implicated (Bauer & Madaras-Kelly, 2006; Palmore, *et al*., 2005; Muto, *et al*., 2005). Aminoglycosides have not been associated with the infection (Sunenshine & McDonald, 2006).

In addition to antibiotic use, several other risk factors have been identified with patients older than 65 years of age at greatest risk (Bauer & Madaras-Kelly, 2006; McDonald, *et al*., 2006; Sunenshine & McDonald, 2006).

2.4.6.1.2: Noroviruses

Another group of gastrointestinal tract infections are noroviruses, a group of highly contagious viruses previously referred to as "Norwalk-like viruses" (CDC, 2005). These viruses gained increased attention through highly publicized outbreaks on cruise ships. The viruses are transmitted primarily through the faecal-oral route and thrive in a small environment populated by many people. In the healthcare setting, transmission occurs through person-to-person contact, faecally contaminated food or water, and hand transfer of the virus to the oral mucosa (CDC, 2005). The CDC (2005), notes that 30% of norovirus infections may be asymptomatic.

Standard precautions should be used for patients who are suspected of having norovirus infection, and appropriate hand hygiene is essential. Barrier protection (gloves, gowns, and masks) should be used when caring for patients with the virus and when cleaning contaminated areas. It may be helpful to cohort patients suspected of having the virus.

No hospital disinfectants registered by the U.S. Environmental Protection Agency (EPA) have specific claims for activity against noroviruses. The CDC recommends that, in the event of an outbreak, chlorine bleach (in a dilution of one part household bleach to 50 parts water) should be used to clean hard, non-porous, environmental surfaces (CDC, 2005). Disinfection with heat (at a temperature of at least 60 degrees Centigrade) is recommended for items that cannot be cleaned with chemical disinfectants.

2.5.0: Factors Influencing the Development of Nosocomial Infections

In general, development of nosocomial infections can be categorized as being related to;

- patient factors,
- iatrogenic factors and
- environmental factors

2.5.1.0: Patient-related factors

Patient-related risk factors for nosocomial infection include age, general health status and the type of procedure to be carried out, and the risk involved can be classified as minimal, medium or high (WHO, 2002).

Patients are at minimal risk if they have no significant underlying disease, have an intact immune system, and will not undergo an invasive procedure. Medium risk is assigned to older patients who are susceptible to disease for a variety of reasons, including decreased immune function, comorbid conditions, and low nutritional status. The extremes of life infancy and old age are associated with high risks to infection. Neonates are at high risk basically as a result of deficiency in humoral immunity to most infectious pathogens. In a

study of 185 hospitalized patients who were a mean of 82 years of age, the rate of nosocomial infection was 59%; the patients' altered nutritional status was another independent risk factor for infection (Paillaud, *et al.*, 2005). Medium risk also refers to patients who are to have a nonsurgical invasive procedure, such as a peripheral venous catheter or a urinary catheter.

Advances in medical treatments have led to longer lives for individuals of all ages who have had organ transplantation, cancer, or infection with human immunodeficiency virus (HIV) and their compromised immune system puts them at high risk for nosocomial infection. High risk is also assigned to patients with multiple trauma or severe burns, or those who have surgery or an invasive procedure that is considered to be high risk, such as endotracheal intubation or insertion of a central venous catheter.

2.5.1.1: Special patient populations

The highest rates of infection are found in intensive care units (adult and neonatal), burn units, and organ transplant units. While only 15% to 20% of all hospital beds are located in intensive care units, 40% to 60% of all life-threatening nosocomial infections occur in these units (Bearman, *et al.*, 2006; Dodek, *et al.*, 2004). Neonatal intensive care units have been reported to have rates of nosocomial infection of 6% to 25% (Polack, *et al.*, 2004). The rate in an organ transplantation unit was reported to be 62% among patients who had received a kidney from a deceased donor; the rate was 40% for patients who had received the kidney from a living related donor (Dantas, *et al.*, 2006). The aetiology of the infection and the types of infection vary among the settings. One study found that, for patients in burn units, the body surface area burned, comorbidities, and the use of invasive devices were significantly

associated with nosocomial infection, and *Staphylococcus aureus* and *Pseudomonas* were the most common resistant organisms identified (Wibbenmeyer, *et al*., 2006)

2.5.2.0: Iatrogenic factors

Three primary iatrogenic factors contribute to the development of nosocomial infections;

- devices and equipment used in the healthcare setting,
- surgery, and
- The use of antibiotics

The four most common nosocomial infections—urinary tract infection, surgical site infection, pneumonia, and intravascular device-related bloodstream infection—are related to invasive procedures or the use of invasive devices; these infections comprise approximately 80% of all nosocomial infections (Burke, 2003).

2.5.2.1: Devices and equipment

Nosocomial infection has been associated with several types of devices and equipment in healthcare facilities. The Spaulding classification, developed in 1968, is widely used to categorize devices according to their associated risk of infection (Tietjen, *et al*., 2003; Favero & Bond, 2001). The system includes three categories:

• Critical: A device that enters normally sterile tissue or the vascular system.

• Semi critical: Devices that come into contact with intact mucous membranes and do not ordinarily penetrate sterile tissue.

• Noncritical: A device that does not ordinarily touch a patient or touches only intact skin.

Most nosocomial infections can be attributed to devices in the critical and semi critical categories, including intravascular catheters, surgical drains, urinary catheters, and endoscopic instruments (Weinstein, 2004).

Healthcare workers often overlook noncritical devices as sources of infection. These devices include diagnostic equipment, stethoscopes, otoscopes and other commonplace items. Recent studies have however demonstrated significant risk of transmission of nosocomial infection with these devices (Schabrun & Chipchase, 2006). A systematic review of 23 studies found bacterial contamination of 87% of sampled healthcare equipment, primarily stethoscope membranes, as well as diagnostic ultrasound equipment, and otoscopes (Schabrun & Chipchase, 2006). Contamination on the stethoscopes, as quantified by the number of colony-forming units, was approximately four times the tolerated level (Bernard, *et al.*, 1999). Most (27%) of the organisms were *Staphylococcus aureus*, 15% of which were multidrug resistant. Other pathogens identified included *Pseudomonas* spp., *Acinetobacter spp.* and *Pasteurella spp.*

Ward-based computer terminals have also been shown to have low levels of contamination. In a study of two hospitals, methicillin-resistant *S. aureus* (MRSA) was found on one of 13 computer terminals in one hospital and on five of 12 in another hospital. The rate of MRSA transmission was significantly higher at the hospital with the greater number of contaminated computers (Devine, *et al.*, 2001). Attention to noncritical device use is of great essence if the fight against nosocomial infections is to be won, with the other devices not overlooked.

2.5.2.2: Surgery

Approximately 45 million operations are performed each year on an inpatient basis (DeFrances & Podgornik, 2004). This represents a large population at risk for nosocomial infections, which can have a tremendous impact on morbidity, mortality, and financial costs. Postoperative sepsis and wound dehiscence were the two most costly patient safety indicators in the Zhan & Miller report (2003).

The rate of infection after surgery varies according to the wound classification and type of surgery. The wound classification system, developed in 1964, has been widely used to predict the rate of infection after surgery. It consists of the following four categories (Berard & Gandon, 1964; Gottrup, *et al*., 2005):

- Clean (Class I): Noninfected wound with no inflammation (elective surgery, with no entrance into respiratory, gastrointestinal, biliary, or genitourinary tract; wound closed at end of surgery).
- Clean-contaminated (Class II): Wound in which the respiratory, gastrointestinal, biliary, or genitourinary tract was entered but no or minimal spillage (usually emergency or urgent surgery).
- Contaminated (Class III): Open, fresh accidental wound or incision with acute, nonpurulent inflammation; surgery with gross spillage from gastrointestinal tract, entry into biliary or genitourinary tract in the presence of infected bile or urine; or major break in aseptic technique.
- Dirty (Class IV): Old wound with dead tissue or with existing clinical infection, or preoperative perforation of respiratory, gastrointestinal, biliary, or genitourinary tract.

Before antibiotics were given prophylactically prior to surgery, the rates of infection were 1% to 2% for clean wounds, 6% to 9% for clean-contaminated wounds, 13% to 20% for contaminated wounds, and 40% for dirty wounds (Gottrup, *et al.*, 2005). Since the routine use of preoperative antibiotics, the rates have dropped for clean-contaminated, contaminated, and dirty wounds (3%, 6%, and 7%, respectively); the rate for clean wounds has remained stable (Gottrup, *et al.*, 2005).

The type of surgery is also a factor in whether infection develops postoperatively. According to data collected by the National Nosocomial Infections Surveillance (NNIS) of America, abdominal surgery is associated with the highest rate of infection, and the use of a laparoscope has lowered the rates of infection after cholecystectomy, colon and gastric operations, and appendectomy (NNIS, 2004). Coronary artery bypass grafting is also associated with high rates of infection, at both the donor site in the leg and the primary incision in the chest (NNIS, 2004).

2.5.2.3: Antibiotic use

Antibiotic use is another important factor in the development of nosocomial infections. The inappropriate use of antibiotics is a major contributor to the increase in drug-resistant strains of bacteria, and coupled with the natural selection and exchange of genetic resistance elements with microorganisms, drug resistance has emerged as a worldwide problem, with an increasing number of microorganisms becoming resistant to treatment each year (Knobler, *et al.*, 2003). Resistance typically emerges first in the healthcare setting before the community, and drug-resistant bacteria have become the source of approximately 70% of nosocomial infections (Burke, 2003). In addition, nosocomial infections caused by drug-resistant bacteria

are associated with higher rates of morbidity and mortality and other costs (Knobler, *et al.*, 2003; Raymond, *et al.*, 2003; Shlaes, *et al.*, 1997; WHO, 2001).

Recognizing the importance of drug-resistant bacteria to infection control, a joint committee of Society for Healthcare Epidemiology of America (SHEA) and Infectious Diseases Society of America (IDSA) published a position paper in 1997 to recommend that all hospitals take steps to control the use of antibiotics (Shlaes, *et al.*, 1997). In addition, the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) requires that healthcare facilities review their antibiotic formulary as part of compliance to JCAHO standards (JCAHO, 2007). Thus, over the past several years, the management of antibiotic use has been a priority of healthcare institutions' infection control programs (Lautenbach, 2001).

Staphylococci, enterococci, and pneumococci present some of the most serious problems with drug resistance (Knobler, *et al.*, 2003). *S. aureus* was treatable with penicillin when the drug was introduced over 60 years ago. As strains became resistant to penicillin, other antibiotics were developed, including methicillin, oxacillin, nafcillin, and vancomycin. MRSA has become one of the most common bacteria involved in nosocomial infections (Knobler, *et al.*, 2003; Shlaes, *et al.*, 1997; WHO, 2001). An outbreak of this pathogen recently resulted in the close down of the children's ward of the Korle-bu Teaching Hospital in Accra (Quansah, 2012). According to a NNIS report on data collected between 1995 and 2004, the percentage of *S. aureus* isolates in intensive care units that were resistant to methicillin, oxacillin, or nafcillin was nearly 60% (NNIS, 2004). Other trends found in that data included a 50% increase in *Klebsiella pneumoniae* isolates that were resistant to third-generation cephalosporins between 2002 and 2003, a steadily increasing rate of vancomycin-

resistant enterococci (VRE), and a decrease in fluoroquinolone-resistant *P. aeruginosa* between 2002 and 2004 (NNIS, 2004).

A review of studies published between 1966 and 2005 showed that the frequency of multidrug-resistant *P. aeruginosa* has also increased, with rates ranging from 0.6% to 32%. In addition, multidrug-resistant *P. aeruginosa* developed in 27% to 72% of patients who had *P. aeruginosa* isolates that were initially sensitive to treatment (Obritsch, *et al.*, 2005). A study reported in 2006 suggested that *Corynebacterium striatum* was an emerging multidrug-resistant nosocomial pathogen in patients who were hospitalized for a prolonged period and had underlying disease (Obritsch, *et al.*, 2005).

As noted, the widespread use of antimicrobials as treatment or prophylaxis, both in the community and in the healthcare setting, is the primary determinant of drug-resistant strains of bacteria (Knobler, *et al.*, 2003; Shlaes, *et al.*, 1997; WHO, 2001). The high number of inappropriate antibiotic prescriptions written each year and antibiotic treatment courses that are not completed by patients fosters resistance. In the healthcare setting, the prophylactic use of antibiotics preoperatively and the empiric use of antibiotics have helped bacteria to develop resistance.

In addition to causing resistance, the inappropriate use of antibiotics can be a risk factor for infection itself. For example, *C. difficile*, the primary cause of nosocomial diarrhoea, is almost always related to antibiotic use (Lautenbach, 2001).

2.5.3: Environmental factors

Factors specifically related to the healthcare environment are not common causes of nosocomial infections. However, consideration should be given to the prevention of infection with environmental pathogens, such as fungi (e.g., *Aspergillus*), bacteria (e.g., *Legionella species*), or viruses (e.g., varicella). In 2003, the CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC) revised the guideline related to environmental factors for infection (Sehulster & Chinn, 2003). The report provides clear recommendations for infection control measures according to several environment-related categories, including air (normal ventilation and filtration, as well as handling during construction or repair), water (water supply systems, ice machines, hydrotherapy tanks and pools), and environmental services (laundry, housekeeping). The infection control program of a facility has oversight of these measures.

2.5.4: Architectural design

Another factor in the transmission of infection in the healthcare setting is the architectural design of the facility, although it has not been shown to have an appreciable effect (Dettenkofer, *et al.*, 2004). The American Institute of Architects (AIA) and the Facility Guidelines Institute (FGI) released the Guidelines for Design and Construction of Hospital and Health Care Facilities in 2001, and an updated edition was published in 2006 (American Institute of Architects,2001; American Institute of Architects,2006). A primary difference in the most recent version is setting single-bed private rooms as the minimum standard for new hospital construction (American Institute of Architects, 2006). This change is based on a report of literature review that showed, in part, that private rooms have been associated with lower rates of nosocomial infections as well as with a reduction in risk factors for nosocomial

infections, such as prolonged hospital stays and patient transfers (Chaudhury & Mahmood, 2003).

The WHO guideline on infection control refers to "architectural segregation" according to risk (WHO, 2002). Four areas of a healthcare facility are defined, with administrative sections considered as low-risk areas; regular patient wards as moderate-risk areas; intensive care units, burn units, or isolation units as high-risk areas; and operating rooms as very high-risk areas. WHO and others have recommended traffic flow to be limited in higher risk areas (WHO, 2002; Tietjen, *et al*., 2003). The choice of floor, wall surfaces, and ceilings is of minimal concern, as bacteria are rarely found on these surfaces unless they become moist or damaged (Tietjen, *et al*., 2003; Noskin & Peterson, 2001). The surfaces should be smooth, to resist accumulation of dust; water-resistant; and easily cleaned. The use of carpet should be limited to low-risk areas, such as office space, as bacteria can survive in carpet. Microorganisms can colonize in wet acoustical tiles, so they should also be avoided in high-risk areas. Some antimicrobial resistant bacteria have been found on furniture, but the risk of infection is thought to be low (Noskin & Peterson, 2001).

The type of sink and the placement of sinks throughout a healthcare facility have been of critical concern because of the substantial role of handwashing in reducing the transmission of infection. As a result, sinks have been placed within easy access in each patient room. However, it is unclear that such placement promotes better hand hygiene. A study was undertaken to assess handwashing compliance when a new hospital was built. In the new hospital design, sinks were placed within five meters of every place where clinical activity

occurred. Handwashing improved over the first month but no clinically significant improvement was found over nine months (Whitby & McLaws, 2004).

With the advent of alcohol-based handrub solutions as more effective hand hygiene, the placement of handrub dispensers has become more important than the placement of sinks (Boyce & Pittet, 2002). The CDC guideline on hand hygiene recommends placing dispensers in convenient locations, such as at the entrance of each patient room or at the bedside.

2.6: Impact of Nosocomial Infections

Studies throughout the world document that Hospital-acquired infections add to functional disability and emotional stress of patients and may, in some cases, lead to disabling conditions that reduce the quality of life (WHO, 2002; Weinstein, 2004; Burke, 2003; Stone, *et al*., 2002; Zhan & Miller, 2003; Weinstein, *et al*., 2005). Nosocomial infections are also one of the leading causes of death (Zhan & Miller, 2003). The economic costs are considerable (Stone, *et al*., 2002; Chen, *et al*., 2005).

The increased length of stay for infected patients is the greatest contributor to cost (Dulworth & Pyenson, 2004; Boyce & Pittet, 2002; JCAHO, 2007). One study (Institute for Healthcare Improvement, 2005) showed that the overall increase in the duration of hospitalization for patients with surgical wound infections was 8.2 days, ranging from 3 days for gynaecology to 9.9 for general surgery and 19.8 for orthopaedic surgery. The impact of nosocomial infections takes on even more significance in resource-poor countries such as in Africa, especially those affected most by HIV/AIDS, because recent findings strongly suggest that

unsafe medical care may be an important factor in transmitting HIV (Gisselquist, *et al.*, 2002).

Prolonged stay not only increases direct costs to patients or payers but also indirect costs due to lost work. The increased use of drugs, the need for isolation, and the use of additional laboratory and other diagnostic studies also contribute to costs. Hospital-acquired infections add to the imbalance between resource allocation for primary and secondary health care by diverting scarce funds to the management of potentially preventable conditions. Within the realm of safety in the healthcare setting, nosocomial infections have the most substantial impact. Consequently, in resource poor countries, efforts to prevent nosocomial infections must assume even greater importance if progress is to be made in improving the quality of patient care in hospitals and other healthcare facilities.

Medicolegal issues are also a concern, since patients or their families sometimes blame the hospital or staff for the infection, and demand compensation (House of Commons Committee of Public Accounts, 2003)

The advancing age of patients admitted to health care settings, the greater prevalence of chronic diseases among admitted patients, and the increased use of diagnostic and therapeutic procedures which affect the host defences will provide continuing pressure on nosocomial infections in the future. Organisms causing nosocomial infections can be transmitted to the community through discharged patients, staff, and visitors. If organisms are multiresistant, they may cause significant disease in the community.

2.7: Management of Nosocomial Infections; the Challenges and the Way Forward

As health care has evolved, lowering the rate of nosocomial infections has been a challenge for infection control programs. Advances in medical treatments have led to more patients with decreased immune function or chronic disease. The increase in these patients, coupled with a shift in health care to the outpatient setting, yields a hospital population that is both more susceptible to infection and more vulnerable once infected. The increased use of invasive devices and procedures has also contributed to higher rates of infection (WHO, 2002; Weinstein, 2004; Burke, 2003). Of particular danger are the several resistant strains of bacteria that have developed through their natural course of adaptation and the overuse of antibiotics.

Reducing the risk of healthcare-associated infections is one of the National Patient Safety Goals developed by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO, 2007). Reflecting the expansion of nosocomial infections beyond the hospital, this goal is included in the JCAHO safety goals developed for a variety of settings in addition to hospitals, including ambulatory care/office-based surgery, long-term care, and assisted living settings. In 1985, the CDC Study on the Efficacy of Nosocomial Infection Control based on the JCAHO standards noted that these infection control programs could lead to a one-third reduction in the rate of nosocomial infection (Weinstein, 1998).

Numerous organizations worldwide including the World Health Organization (WHO) and the Infection Control Practices Advisory Committee at the Centre for Disease Control and Prevention (CDC) have developed recommendations on protecting patients and health care workers from HAI's.

Handwashing has been shown as the simplest and most effective, proven method to reduce the incidence of nosocomial infections (Pittet, *et al.*, 2000). However, despite being one of the most basic, as well as the most vital infection control measure, it is one of the most neglected practices (Bryan, 1986; Pittet, *et al.*, 1999; Harris, *et al.*, 2000). The CDC 2002 guidelines explicitly cover indications for handwashing and hand antisepsis, hand-hygiene technique, surgical hand antisepsis, and selection of hand-hygiene agents (Boyce & Pittet, 2002). Decontamination of personal medical devices after each patient use has also proven useful in some studies (Marinella, *et al.*, 1997; Africa-Purino, *et al.*, 2000; Uneke, *et al.*, 2009).

If healthcare workers achieved 100% compliance with proper hand and personal medical device hygiene techniques, it would significantly reduce the spread of HAI's. Unfortunately, studies have found compliance rates to be low. Consistently compliance to hand hygiene has been low ranging from 16% to 81%, with most reports in the 30% to 50% range (Burke, 2003; Boyce & Pittet, 2002; Clark & Houston, 2004).

Perceived barriers to hand hygiene include;

- skin irritation,
- inaccessible supplies,
- interference with worker-patient relation,
- patient needs perceived as priority,
- denial about risks,
- forgetfulness,
- ignorance of guidelines,

- insufficient time,
- belief that gloves are sufficient,
- high workload and understaffing, and
- Lack of scientific information demonstrating impact of improved hand hygiene on hospital infection rates

Most of these barriers may also contribute to lack of compliance to decontamination of personal medical devices. Eliminating these perceived barriers to hand and personal medical device hygiene is an important first step in improving hand and personal medical device hygiene compliance rates and reduction of HAI's.

2.7.1: Hand decontamination

The development of effective alcohol-based hand rub solutions has addressed many of these concerns when it comes to hand hygiene, and the 2002 CDC guideline on hand hygiene recommends the use of such solutions on the basis of several advantages, including (Boyce & Pittet, 2002):

- Better efficacy against both gram-negative and gram-positive bacteria, mycobacteria, fungi, and viruses than either soap and water or antimicrobial soaps (such as chlorhexidine).
- More rapid disinfection than other hand hygiene techniques.
- Less damaging to skin.
- Time savings (18 minutes compared with 56 minutes per eight-hour shift).

The CDC guideline suggests that healthcare facilities promote compliance by making the hand rub solution available in dispensers in convenient locations (such as the entrance to patients' room or at the bedside) and provide individual pocket-sized containers (Boyce &

Pittet, 2002). The hand rub solution may be used in all clinical situations except for when hands are visibly dirty or are contaminated with blood or body fluids. In such instances, soap (either antimicrobial or nonantimicrobial) and water must be used.

As part of its guideline, the CDC asked healthcare facilities to develop a system for measuring improvement in adherence to its recommendations. Studies have demonstrated that alcohol-based handrub solutions have increased compliance (Johnson, *et al*., 2005; Gordin, *et al*., 2005; Pittet, *et al*., 2000). Frequent performance feedback has also been shown to enhance compliance, and other interventions have included automatic sinks, mass campaigns (posters, buttons, newsletters), education, and behavioural modification programs (Rosenthal, *et al*., 2005).

Because enhancing compliance with recommendations for hand hygiene requires behavioural changes, it has been suggested that input from behavioural and social sciences may aid in the effort (Akyol, *et al*., 2006).

2.7.2: Personal medical device decontamination

In the 2009 study by Uneke *et al*., there was comparatively less bacterial colonization on stethoscopes of students who used soapy water and methylated spirit as cleaning agents. An earlier study showed that bacterial colony counts were significantly reduced from the stethoscope diaphragm after cleaning with isopropyl alcohol, sodium hypochlorite or benzalkonium chloride (Marinella, *et al*., 1997). Another related report indicated that cleaning the stethoscope diaphragm resulted in immediate reduction in the bacterial count by 94% with alcohol swabs, 90% with nonionic detergent and 75% with antiseptic soap (Jones,

et al., 1995). Cleaning with soap and water would be the simplest and most convenient method of disinfecting the stethoscope (Africa-Purino, *et al.*, 2000). Since the mode of transmission of pathogens from stethoscopes is identical to that of otoscope (both being fomites and personal diagnostic devices), similar decontamination procedure may be effective for that too. One of the objectives of this study is to reach a conclusion on this.

The CDC has also published clear guidelines for isolation precautions, prevention of hospital acquired pneumonias, intravascular device-related infections, surgical site infections, and catheter related urinary tract infections and these guidelines must also be closely followed to achieve maximum patient safety. These recommendations include: (Tietjen, *et al.*, 2003)

1. Establish policies and procedures for containing, transporting, and handling patient-care equipment and instruments/devices that may be contaminated with blood or body fluids.

2. Remove organic material from critical and semi-critical instrument/devices, using recommended cleaning agents before high level disinfection and sterilization to enable effective disinfection and sterilization processes.

3. Wear PPE (e.g., gloves, gown), according to the level of anticipated contamination, when handling patient-care equipment and instruments/devices that is visibly soiled or may have been in contact with blood or body fluids.

Other components that will be required in the quest to reduce nosocomial infections to the barest minimum include:

- Appropriate isolation strategies
- Appropriate architectural design of hospitals to controlling environmental risks for infection

- Protecting patients with appropriate use of prophylactic antimicrobials, nutrition, and vaccinations
- Improving aseptic technique and development of non-invasive monitoring devices and minimally invasive surgical techniques that avoid the high risk associated with bypassing normal host defence barriers
- Forestalling the post antibiotic era by implementing aggressive antibiotic control programs (Goldmann, *et al*., 1996)
- Surveillance of infections, identifying and controlling outbreaks
- Prevention of infection in staff members
- Enhancing staff patient care practices, and continuing staff education.
- Lastly, ensuring that patients and healthcare workers are immune or vaccinated can help decrease the availability of potential hosts

2.8: The Cost-Effectiveness of Managing Nosocomial Infections

Proper hand washing is the single most important preventive measure for nosocomial infections (Burke, 2003; Boyce & Pittet, 2002). A CDC Fact Sheet states that improved adherence to hand hygiene has been shown to terminate outbreaks in healthcare facilities, to reduce transmission of antimicrobial resistant organisms, and to reduce overall infection rates (IHI, 2005). Studies have borne out this fact, with reductions in overall rates of nosocomial infections, including those caused by MRSA and VRE (Rosenthal, *et al*., 2005; Johnson. *et al*., 2005; Gordin, *et al*., 2005; Pittet, *et al*., 2000).

Some studies have also show that appropriate decontamination of personal medical devices such as stethoscopes and otoscopes may contribute to reducing nosocomial infections

(Marinella, *et al*., 1997; Saxena, *et al*., 2005; Sood, *et al*., 2000). In the 2009 study by Uneke *et al*., the rate of bacterial contamination was lower on stethoscopes of medical students who practised handwashing after each patient care. This was expected since most hospital-acquired pathogens are transmitted from patient to patient through the hands of healthcare workers (Larson, 1988) and these same hands handle personal medical devices. Hand decontamination and personal medical devices decontamination go hand in hand and their appropriate practice may go a long way to reduce these infections.

The cost-effectiveness of efforts to enhance hand hygiene was evaluated in one study; the cost of a patient education campaign was weighed against an estimated cost of $5,000 for each nosocomial infection. The annual savings was approximately $57,600 for a 300-bed hospital with 10,000 admissions annually (McGuckin, *et al*., 1999).

Although some measures required to curb nosocomial infection are very simple and cheep (e.g. Hand washing, personal medical device hygiene) others are very costly and may require expensive architectural alterations to old hospital structures and the building of new ones (such as the multimillion-dollar accident complex at Komfo Anokye Teaching Hospital). No matter the cost involved in the bid to upset these infections, it will be nowhere near the cost in terms of the impact on morbidity, mortality, and financial expenditure as well as the concomitant anti-microbial resistance facilitated by these infections as discussed under the impact of nosocomial infections above.

CHAPTER III

3.0: MATERIALS AND METHODS

3.1: Study design

A cross-sectional study of the possibility of stethoscopes and otoscopes serving as sources of nosocomial infections was conducted at the Komfo Anokye teaching Hospital (KATH) in the Kumasi Metropolis, Ashanti Region from March 2011 to June 2011. In all 160 health staff from the various departments of the Hospital were recruited after fulfilling inclusion criteria.

3.2 Study area

The Komfo Anokye Teaching Hospital (KATH) in Kumasi, Ghana, is the second-largest hospital in the country and the only tertiary health institution in the Ashanti Region. It is the main referral hospital for the Ashanti, Brong Ahafo, Northern, Upper East and Upper West Regions.

The hospital was built in 1954 as the Kumasi Central Hospital. It was later named Komfo Anokye Hospital after Okomfo Anokye, a legendary fetish priest of the Ashanti. It was converted into a teaching hospital in 1975 affiliated to the medical school of the Kwame Nkrumah University of Science and Technology. The hospital is also accredited for postgraduate training by the West African College of Surgeons in surgery, obstetrics and gynaecology, otorhinolaryingology, ophthalmology and radiology. The hospital currently has about 1000 beds, up from the initial 500 when first built.

The study was conducted in the various departments of the hospital including the Ear, Eye Nose and Throat (EENT) department, the Obstetrics and Gynecology (O&G), Surgery,

Medicine and Child health departments. Samples were collected from the above-mentioned departments and analyzed at the Microbiology laboratory.

3.2.1: Study Site

The Microbiology laboratory of the hospital, which is under the diagnostics directorate offers diagnostic as well as research services. The department is fully equipped with three modern automated blood culture incubators (2 BACTEC 9050 BD and 1 BACTEC 9240 BD Diagnostics Sparks Massachusetts, USA), 5 incubators, 1 safety cabinet for bacteriological culture and sensitivity testing, there are 3 light microscopes, scientific fridges and freezers as well as a centrifuge and a water bath. Laboratory tests are carried out from approved standard Operating Procedures (SOP) and every activity undertaken in the laboratory is well documented. The department participates in the quarterly External Quality Assessment program of the National Institute of Communicable Diseases/National Health Laboratories (NICD/NHL) in Clinical Microbiology and Parasitology from South Africa.

3.2.2: Sampling Period

Recruitment was from March 2011 to June 2011. Pre-sampling activities included the acquisition of ethical clearance from the Committee on Human Research, Publications and Ethics (CHRPE) of the Komfo Anokye Teaching Hospital, and the School of Medical Sciences, KNUST.

3.2.3: Study Population

The study population comprised health Staff of KATH including Physicians, Nurses and Students who fulfilled the inclusion criteria.

3.2.4: Inclusion and Exclusion Criteria

The study included all health staff and students who use stethoscopes and/or otoscopes in KATH. Staff and students who did not use any of the two medical devices were excluded.

3.3.0: Sample Size determination

Considering the fact that stethoscope contamination levels from several studies ranged between 80-100% (Jones *et al.*, 1995: Smith *et al.*, 1996: Cohen *et al.*, 1997: Marinella *et al.*, 1997), a prevalence level of 90% was used in this study.

The minimum required sample size (N) for the stethoscopes at 90% prevalence (p) with a 95% confidence level (t=1.96) and a 5% acceptable margin of error (m) was 138 samples. The sample size estimation formula below was used.

Sample size formula

$$\text{Sample Size (N)} = \frac{[t^2 \times p\,(100-p)]}{m^2}$$

$$N = \frac{[1.96^2 \times 90(100-90)]}{5^2}$$

N=138 samples

One hundred and forty-six (146) staff and students were enrolled for the study on stethoscopes: one participant from the EENT department, 35 each from the O&G and from the Child Health Departments, 34 from Surgery department and, 41 from, the department of Medicine. Fourteen (14) reusable otoscope earpieces from the EENT department were sampled.

3.3.1: Sampling Scheme

Stethoscopes and/or otoscopes of staff and students were sampled consecutively until the required sample size of 160 was obtained.

3.3.2: Contact Process

After obtaining consent from each participant through participant information leaflets (which included the protocol of the study), and the endorsement of consent forms, anonymous study questionnaires to gather information on demography, stethoscope/otoscope usage, handling and maintenance practices were administered. The questionnaires (Appendix 1) were given only to staff and students who had stethoscopes/otoscopes with them.

3.3.3: Sample Collection, Labeling and Confidentiality

An attempt was made to take a sample of representative areas of the hospital's departments and to obtain the most random sample possible. Samples from the surface of reusable earpieces of otoscopes and diaphragms of the stethoscopes of consenting staff and students were obtained using sterile cotton-tipped swabs moistened in sterile physiological saline (0.85%). These swabs were inoculated on blood and MacConkey agar plates.

To satisfy the objective of testing for the most effective disinfection procedure amongst those practiced by participants (including the use of 70% alcohol, savlon, soapy water, water only and the use of dry cotton to wipe the surfaces) there was the need to obtain a "before disinfection sample" and an "after disinfection sample". The samples were thus obtained from each device by first swabbing half of the device's surface, the entire surface was then disinfected using one of the procedures. After this, the other half of the device's surface was then swabbed. A code (known to the study investigators only) was assigned to each sample.

3.4.0: Laboratory processing of the samples

After streaking out, the culture plates were incubated aerobically for 48 hours at 37°C. The plates were inspected for growth. Identification and colony counts were performed on the culture positive plates.

3.4.1.0: Identification of isolates

Isolates were identified by assessing colony characteristics, Gram reaction and by conducting catalase and coagulase tests according to standard protocols (Cheesbrough, 2000; Appendix 3). Further identification was carried out using the BD BBL crystal identification system (BD Diagnostics Sparks Massachusetts, USA).

3.4.1.1: The BD BBL crystal identification system

The BBL Crystal Identification system (BD Diagnostics Sparks Massachusetts, USA) is a miniaturized identification method employing modified conventional, fluorogenic and chromogenic substrates. It is intend for the identification of frequently isolated aerobic Gram positive and negative bacteria. In general, many of the tests used in the BBL Crystal ID

System are modifications of classical methods. These include tests for fermentation, oxidation, degradation and hydrolysis of various subsrates. In addition, there are chromogens and fluorogen linked substrates, as in the BBL Crystal GP and GN ID panel, to detect enzymes that microbes use to metabolize various substrates.

3.4.1.2: Testing procedure

The BBL Crystal ID kit consists of

(i) BBL Crystal ID panel lids,

(ii) BBL Crystal bases and

(ii) BBL Crystal ANR, GP, RGP, N/H ID Inoculum Fluid (IF) tubes.

The lid contains 29 dehydrated substrates and a fluorescence control on tips of plastic prongs.

The base has 30 reaction wells.

Test inoculums, after subculture on nutrient agar for 24hrs at 37°C were prepared with the inoculum fluid and used to fill all 30 wells in the base. Aligning the lid with the base and snapping them in place, the test inoculum rehydrates the dried substrates and initiates test reactions.

Following an incubation period of four hours at 37°C, the wells were examined for colour changes or presence of fluorescence that result from metabolic activities of the microorganisms using a BBL Crystal autoreader. The resulting pattern of the 29 reactions were converted into a ten-digit profile number that is used as the basis for identification. Biochemical and enzymatic reaction patterns for the 29 BBL Crystal ID substrates for a wide variety of microorganisms are stored in the BBL Crystal ID database. Identification was

derived from a comparative analysis of the reaction pattern of the test isolate to those held in the database.

3.4.2: Plate count of bacteria

Plate count of bacteria was done using the spread-plate method to determine the number of colony-forming units of bacteria per membrane for the stethoscope and colony-forming units of bacteria per earpiece for the otoscopes based on authorized norms of device cleanliness (AFNOR, 1989).

Levels of contamination were estimated in mean colony counts (MCC).

$$\text{MCC} = \frac{\text{Total (colony count per device surface} \times \text{No. of respondents)}}{\text{Total No. of respondents}}$$

3.5: DATA ANALYSIS

Data collected on each sample was recorded in a site notebook (register) which had columns for serial (code) numbers, age, sex, culture results for both before disinfection and after disinfection as well as their corresponding colony counts. Results for each sample were also recorded on their corresponding questionnaires where after they were entered into the MS Excel computer software (Atlanta, USA). Data analysis was done using SPSS version 16.0 (2007; Chicago Illinois) and the MS Excel 2007 softwares.

Data validation was done by manually inspecting the register and crosschecking the entries in the database with the information on each questionnaire to ensure that the correct responses for each code have been entered into their appropriate places.

Data cleaning was done by running all frequencies, identifying missing and duplicated records, entering missing records, deleting duplicated records and filling in missing data.

Percentage Prevalence and confidence interval of the various results from the study were determined using the above analytical softwares. In the analytical process, the culture results including colony counts of each sample were compared with the sociodemographic information, personal medical device hygiene and the knowledge of participants on the possibility of nosocomial infection spread through these devices.

CHAPTER IV

4.0: ANALYSIS OF RESULTS

4.1: RESULTS

4.1.0: Recruitment of subjects and their characteristics

A total of 160 participants were enrolled in this study. Participants were made up of students, house officers, resident physicians, nurses and other health staff from the various departments of KATH including the EENT, O&G, Surgery, Medicine and Child health Departments. The number of participants and devices examined in the various departments are as shown in Table 4.1.

Table 4.1: Number of participants (devices) enrolled from the various departments of KATH

Department	Device examined	No. of participants (devices) examined
EENT	Otoscopes	14
	Stethoscope	1
O&G	Stethoscope	35
Surgery	Stethoscope	34
Medicine	Stethoscope	41
Child health	Stethoscope	35
Total		160

4.1.1: Sociodemographic characteristics of participants

The age of study participants ranged between 20 and 58 years with a mean and modal age of 29.61 and 27 years respectively. The age distributions are as shown in Figures 4.1.

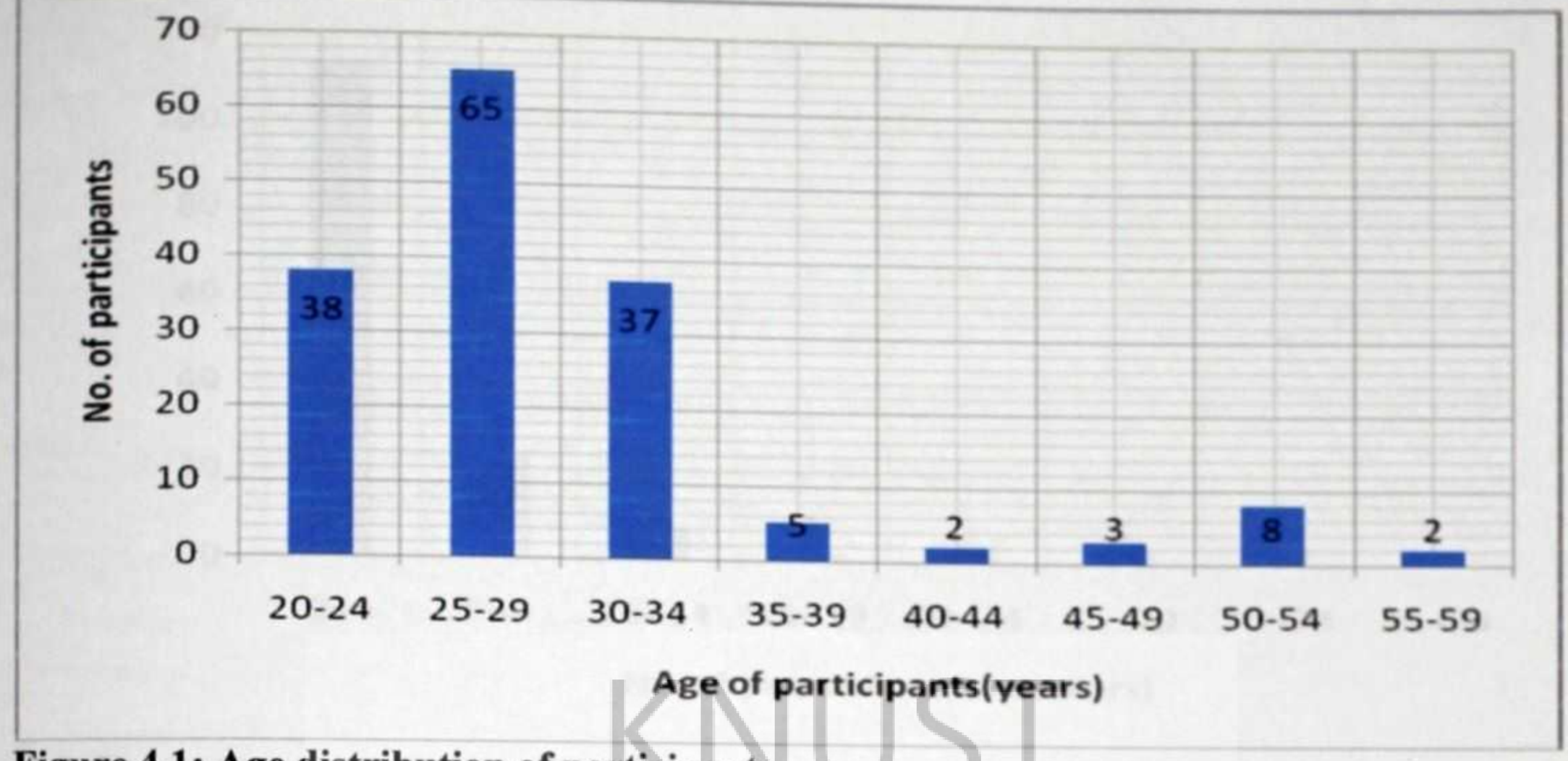

Figure 4.1: Age distribution of participants

From the data obtained, 55% (N=88) of the participants were females, the remaining 45% (N=72) were males. The number of years of practice of participants ranged from less than 1 year to 35 years with a mean and mode of 4.89 and 1 respectively. The distributions for sex and number of years of practice of participants are shown in Figures 4.2 and 4.3.

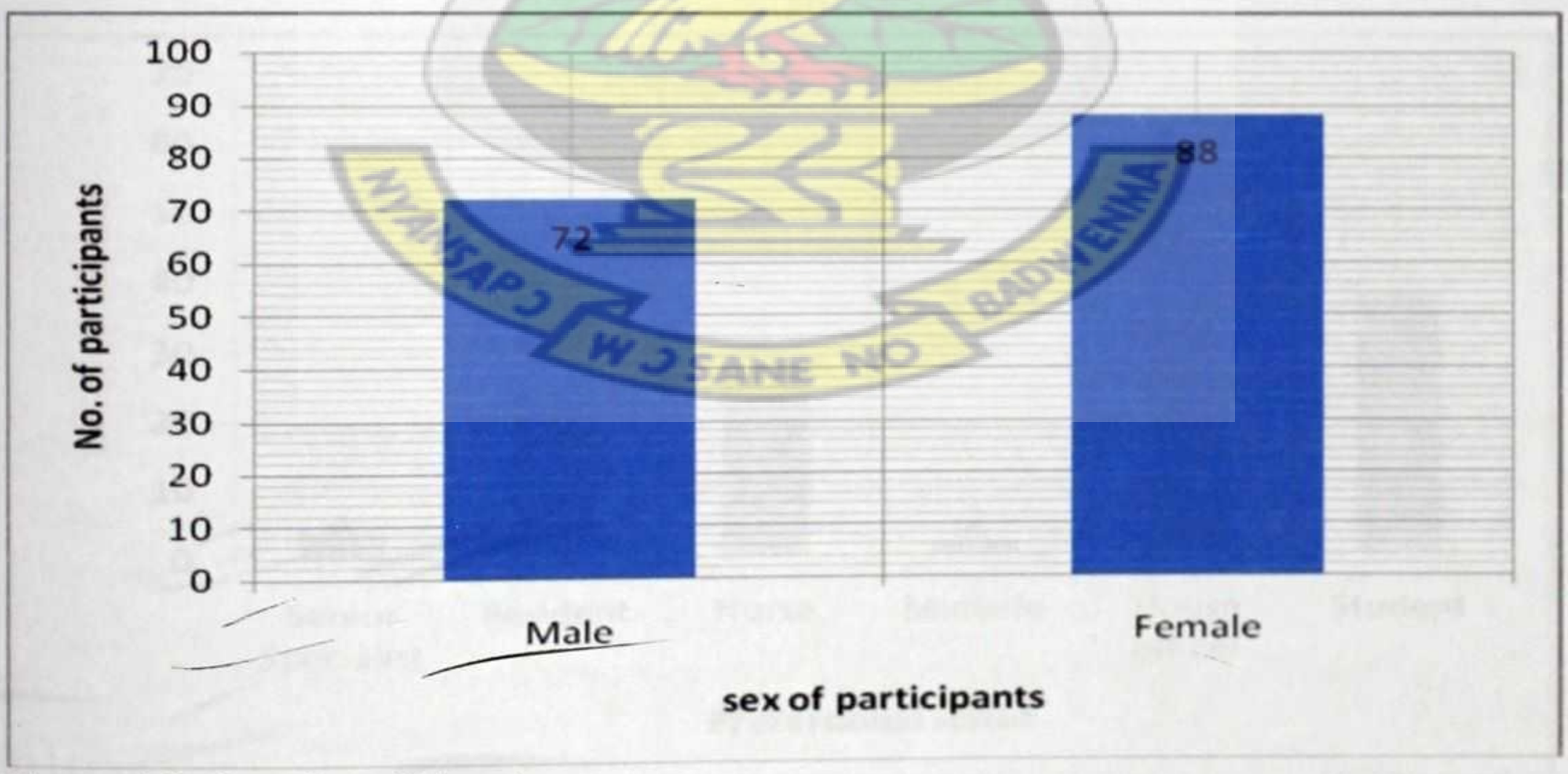

Figure 4.2: Sex of participants

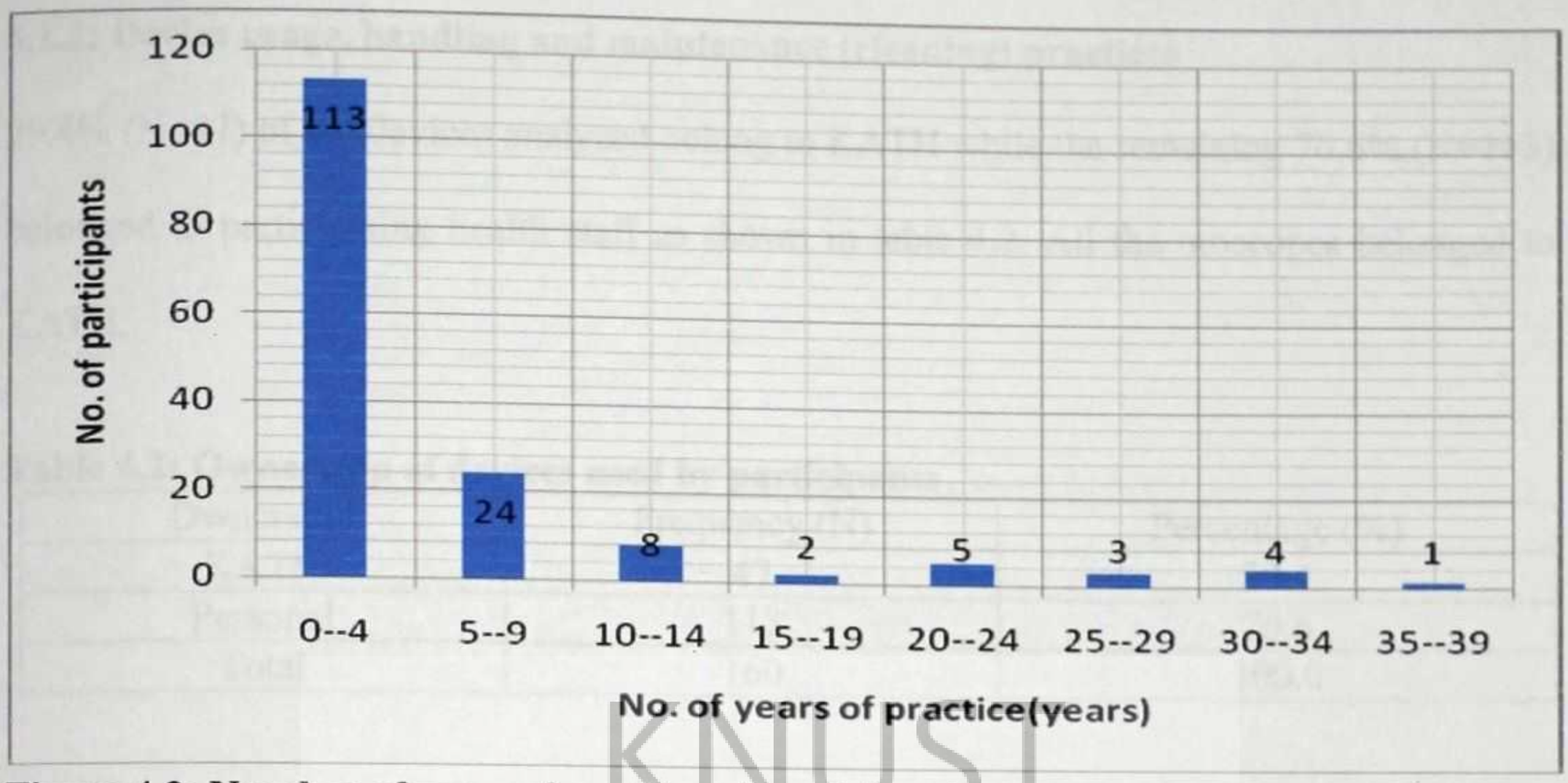

Figure 4.3: Number of years of practice of participants

Of the 160 devices analyzed, the least participation was from midwives with a contribution of 1.3% (N=2), while the highest number of participants was recorded with house officers with 40.6% (N=65) participants. The distribution of the participants per their professional status is shown in Figure 4.4.

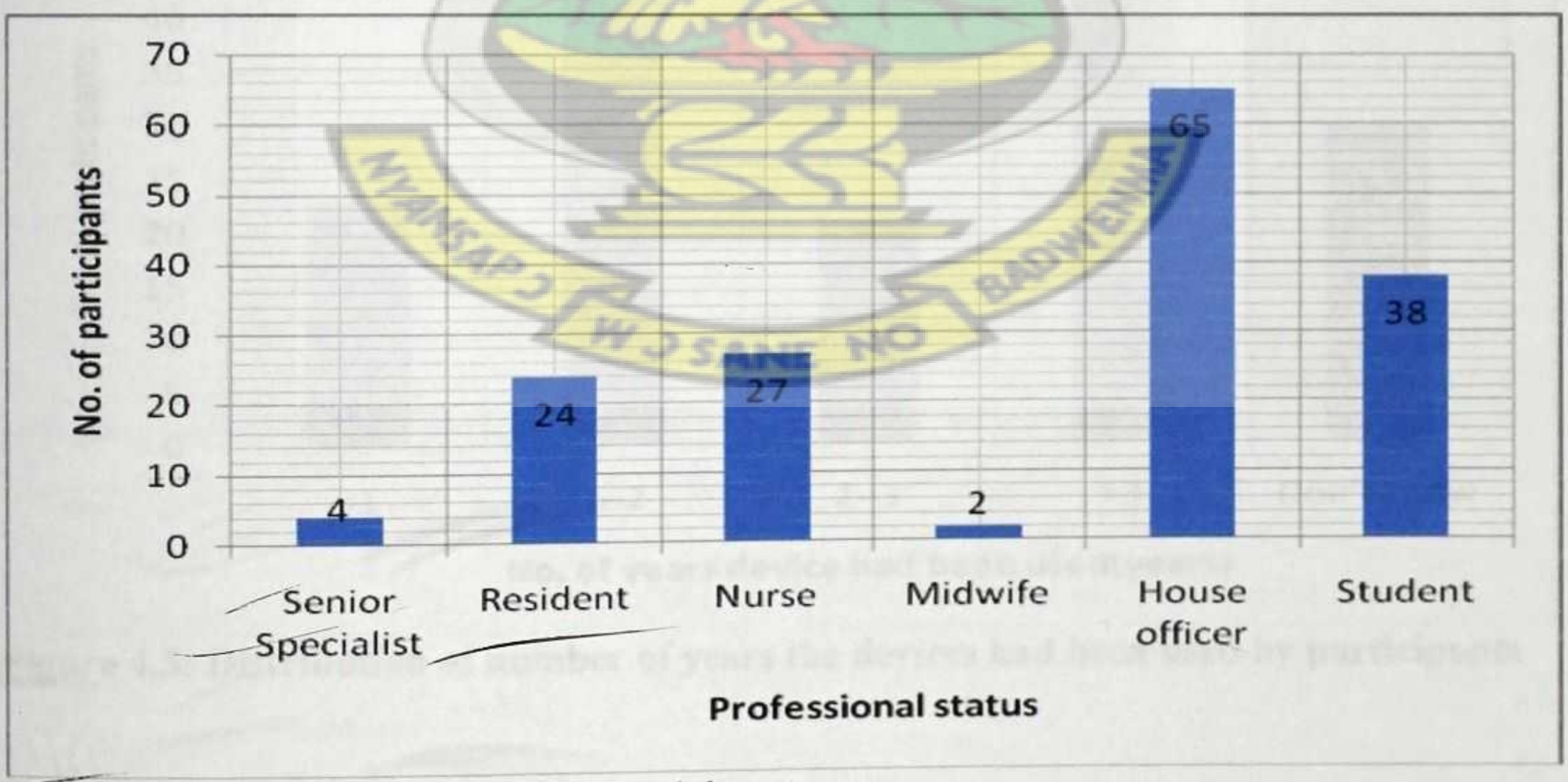

Figure 4.4: Professional status of participants

4.1.2: Device usage, handling and maintenance (cleaning) practices

29.4% (N=47) of the devices analyzed belong to KATH while the remaining 70.6% (N=113) belonged to participating health staff as shown in table 4.2. All the otoscopes belonged to KATH.

Table 4.2: Ownership of devices used by participants

Ownership	Frequency (N)	Percentage (%)
KATH	47	29.4
Personal	113	70.6
Total	160	100.0

The number of years the devices had been used ranged from less than a year to greater than three years. 27.5 %(N=44) of the devices had been used between 1 and 2 years while 26.3 %(N=42) had been used more than 3 years. Thirty out (30) of the 160 participants were not sure of how long their devices had been used. This distribution is shown in Figure 4.5.

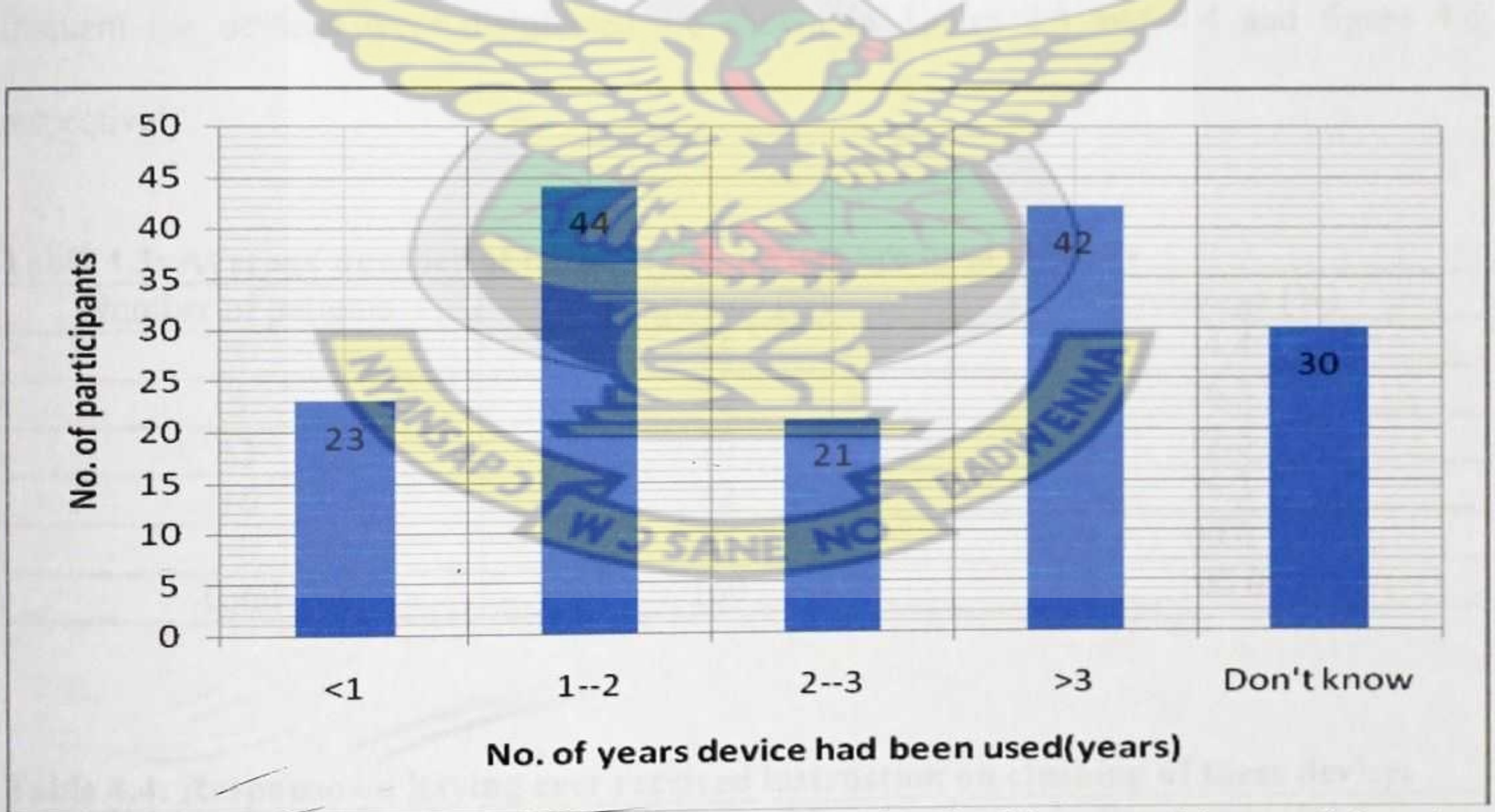

Figure 4.5: Distribution of number of years the devices had been used by participants

The average numbers of patients the devices were used on daily range from 3 to 16 patients. 67.5% (N=108) had never received any instruction on cleaning of these personal medical devices. The remaining 32.5% (N=52) reported they had received tutelage on cleaning of these devices.

When asked the question how often the devices were cleaned, the answers ranged between after each single use to never. The highest percentage of participant 36.3% (N=58) reported that they cleaned their devices daily followed by 31.3% (N=50) who indicated that they cleaned their devices after each single use. 9.4% (N=15) of the participant indicated they had never cleaned their devices.

The distributions for the average number of patients the devices were used on, responses as to whether participants had any form of tutelage on disinfection of these devices and how frequent the devices were disinfected are shown in Tables 4.3 and 4.4 and figure 4.6 respectively.

Table 4.3: Average number of patients the devices are used on daily

Number of patients	Frequency (N)	Percentage (%)
3	55	34.4
8	42	26.3
13	20	12.5
16	42	26.3
4	1	00.6
Total	160	100.0

Table 4.4: Response on having ever received instruction on cleaning of these devices

Response	Frequency (N)	Percentage (%)
Yes	52	32.5
No	108	67.5
Total	160	100.0

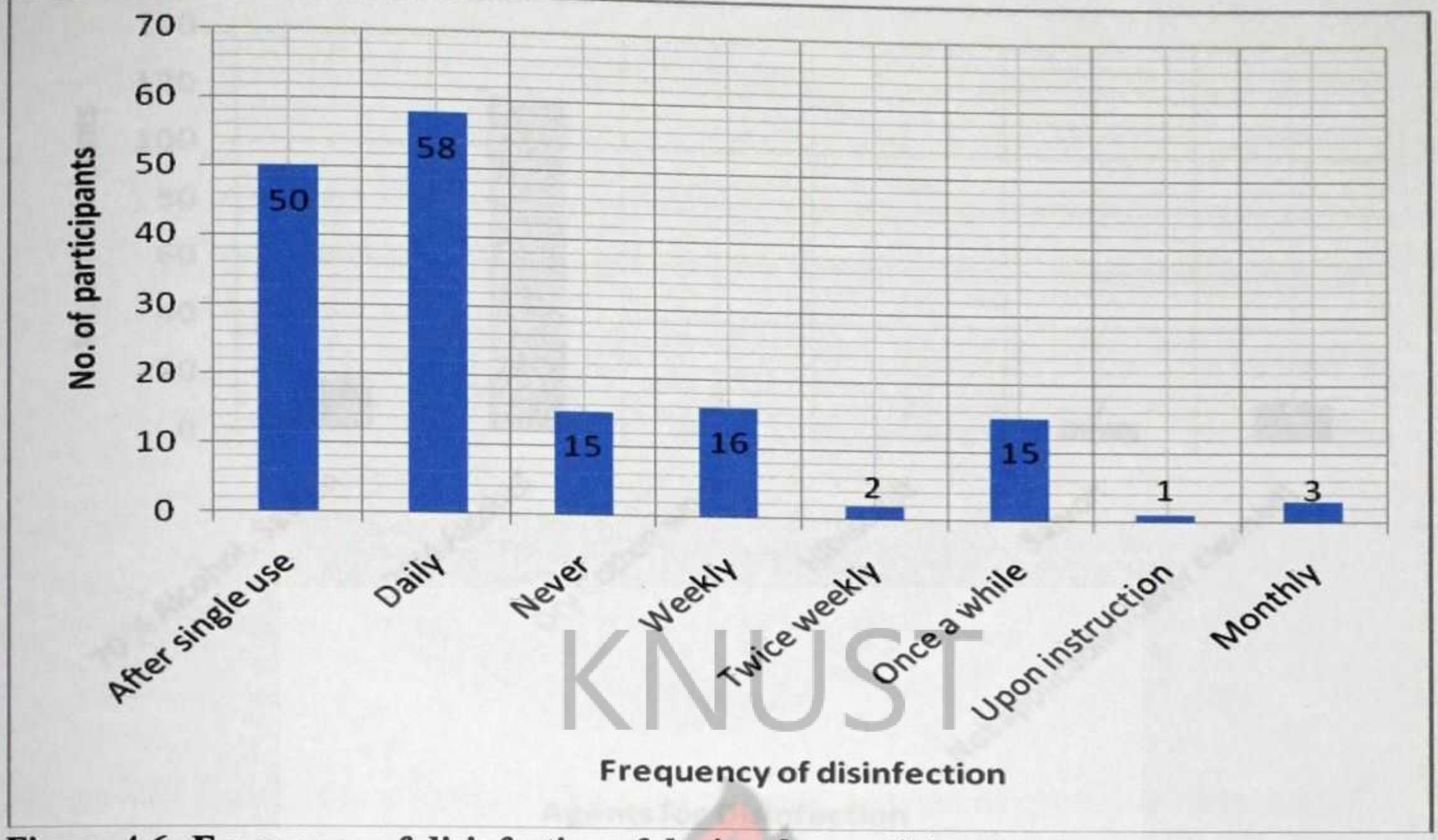

Figure 4.6: Frequency of disinfection of devices by participants

73.1% (N=117) of the participants indicated that they used 70% alcohol for cleaning their devices. 8.8% (N=14) never cleaned their devices and as such used no agents. The responses concerning agents used for disinfection are shown in Figure 4.7

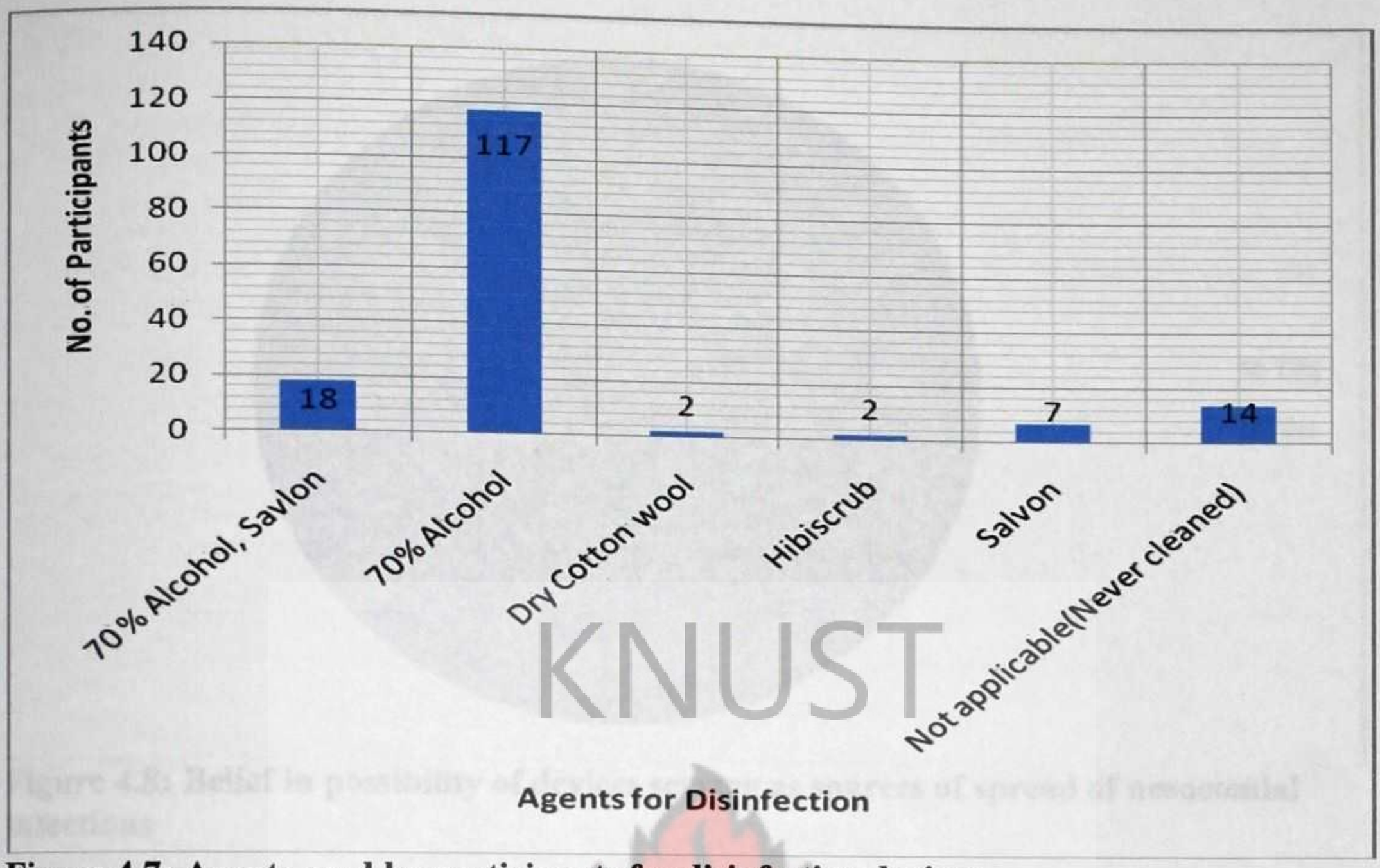

Figure 4.7: Agents used by participants for disinfecting devices.

98.1% (N=157) of the participants claimed that they believe these devices could serve as possible sources of nosocomial infection while 1.9% (N=3) said they did not think this was possible as represented in Figure 4.8

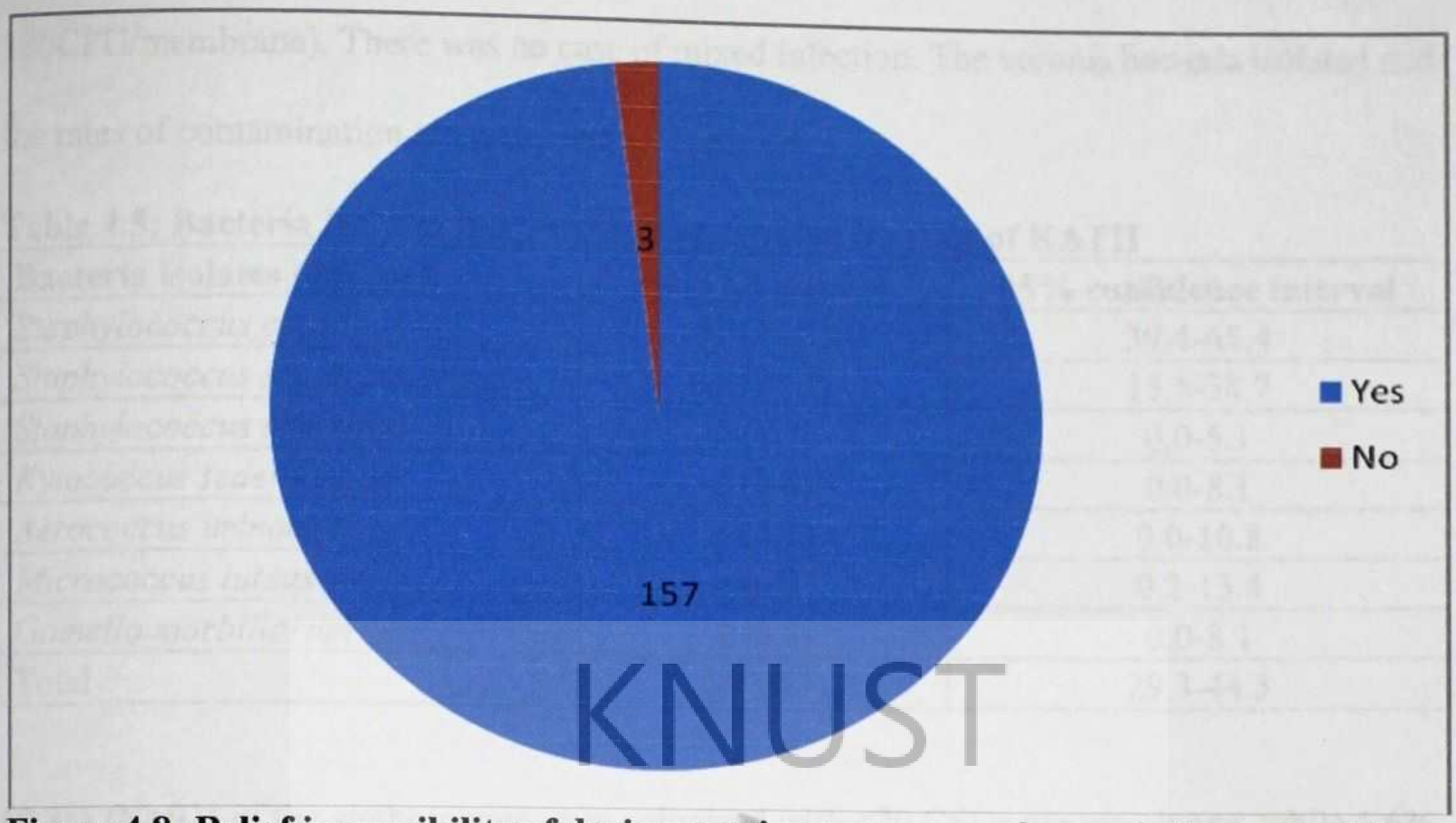

Figure 4.8: Belief in possibility of devices serving as sources of spread of nosocomial infections

4.2:0 Test Results from culture

4.2.1: Results on otoscopes

None of the 14 otoscope earpieces had bacterial contamination. Responds from the questionnaires indicated that the otoscope earpieces were disinfected after single use. Disinfectants used here were 70% alcohol and savlon. The earpieces were used on one patient in a day after which they were all collected and disinfected for the next day. All 14 participants here had ever received some form of tutelage on disinfection of otoscopes. They all also thought these devices could lead to spread of nosocomial infections.

4.2.2.0: Results on stethoscopes

Of the 146 stethoscopes analyzed, 39.7% (N=58) had bacterial contaminations. The mean colony count (MCC) for the stethoscopes was 15.14 per membrane. There was no case of

180CFU/membrane). There was no case of mixed infection. The various bacteria isolated and the rates of contamination are presented in Table 4.5

Table 4.5: Bacteria isolates from stethoscopes of health staff of KATH

Bacteria isolates obtained	No. (%) isolates	95% confidence interval
Staphylococcus capitis	31 (52.4)	39.4-65.4
Staphylococcus saccharolyticus	16 (27.1)	15.5-38.7
Staphylococcus schleiferi	1 (1.7)	0.0-5.1
Kytococcus sedentarius	2 (3.4)	0.0-8.1
Aerococcus urinae	3 (5.1)	0.0-10.8
Micrococcus luteus	4 (6.8)	0.2-13.4
Gamella morbillorum	2 (3.4)	0.0-8.1
Total	58(39.7)	29.3-44.5

62.3% (N=91) of the stethoscopes were colonized with <20 CFUs per membrane, while 5.6% (N=6) carried >100 CFU per membrane. All the isolates were nonpathogenic or opportunistic microbes, mainly coagulase-negative staphylococci.

4.2.2.1: Participants' Demographic information in relation to stethoscope contamination

Participants' demographic information was related to stethoscope contamination (Table 4.6). The result showed a higher MCC among the stethoscopes from females (MCC=19.28) compared to male (MCC=12.82) participants, but the difference was statistically insignificant ($t = 1.095$, $df = 144$, $p>0.05$). As well, correlation observed with respect to age (Table 4.6) was not significant (*Pearson's Correlation* $= 0.137$, $p>0.05$).

Table 4.6: Relationship between Participants' demographic parameters and levels of bacterial contamination of stethoscopes

Parameters assessed	No. of stethoscopes examined	No. (%) of stethoscopes contaminated	Mean Colony Count(MCC)
Sex			
Male	71	25 (35.2)	12.82
Female	75	33 (44.0)	19.28
Total	146	58 (39.7)	16.14
Age			
20-24	36	19 (52.8)	12.61
25-29	65	20 (30.8)	12.83
30-34	33	15 (45.5)	21.82
35-39	1	1 (100.0)	8.00
40-44	2	0(0.0)	0.00
45-49	3	1 (33.3)	42.00
50-54	4	2 (50.0)	47.00
55-59	2	0 (0)	0.00
Total	146	58 (39.7)	15.45

As seen in table 4.7, stethoscopes from the O&G department had the highest levels of contamination (MCC=27.89), but the difference was not statistically significant even when compared to that of the department of surgery which had the lowest levels (MCC=7.88) (t = 1.693, df = 67, $p > .05$) (Table 4.8).

Table 4.7: Bacterial contamination (MCC) by department

Department	MCC	No. of stethoscopes examined(N)	Std. Deviation
EENT	8.00	1	0.000
O&G	27.89	35	51.880
Surgery	7.88	34	22.406
Medicine	12.88	41	24.924
Child health	13.60	35	32.376
Total	15.45	146	34.876

Table 4.8: Analysis of culture results for O&G and Surgery departments

	t-test for Equality of Means						
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Colony count(CFU/Membrane)	1.693	67	.095	17.062	10.0801	-3.0577	37.1821

Analysis of bacterial contamination by number of years practice of participants (Table 4.9) revealed a significant correlation although not a very strong one (*Pearson's Correlation*=0.165, $p<0.05$).

Table 4.9: Bacterial contamination (MCC) by Number of years of practice of participants

Number of years of practice(years)	No. of stethoscopes examined	No. (%) of stethoscopes contaminated	Mean Colony Count(MCC)
0-4	111	43 (38.7)	12.1
5-9	20	9 (45.0)	21.6
10-14	4	3 (75.0)	68
15-19	2	0 (00.0)	0
20-24	1	1 (100.0)	126
25-29	3	1 (33.3)	40
30-34	4	1 (25.0)	17
35-39	1	0 (0.0)	2
Total	146	58(39.7)	15.45

When results for professional status (Table 4.91) of participants were analyzed, nurses were found to have the highest levels of contamination (MCC=37.65) on their stethoscopes. Even when compared to midwives having the least levels (MCC=5.00), this finding was not significant ($t=0.848$, $df=23$, $p>0.05$).

Table 4.91: Bacterial contamination (MCC) by Professional status of participants

Professional status	MCC	Frequency (N)	Std. Deviation
Resident	13.40	20	39.332
Nurse	37.65	23	53.406
Midwife	5.00	2	7.071
House officer	12.71	65	31.342
Student	7.94	36	14.299
Total	15.45	146	34.876

4.2.2.2: Stethoscope usage, handling and maintenance in relation to stethoscope contamination

Stethoscope usage, handling and maintenance (cleaning) practices were related to bacterial contamination (colonization). Relating number of years of usage of stethoscopes to levels of contamination (Table 4.92), the highest levels of contamination was found on those whose number of years of usage were uncertain (MCC=20.9). For statistical relevance device which had been used >3 years which were the next highest contaminated (MCC=18.42) were compared with devices <1 year in usage which were the least contaminated (MCC=8.87). The difference was not significant ($t=1.106$, $df=59$, $p>0.05$)

Table 4.92: Bacterial contamination (MCC) by number of years of usage of stethoscopes

How old is/are the device	MCC	N	Std. Deviation
1-2	13.67	43	27.519
2-3	15.73	22	43.492
>3	18.42	38	39.658
Don't know	20.90	20	45.711
<1	8.87	23	14.904
Total	15.45	146	34.876

There was however a significant correlation when results for the average number of patients the devices were used on (Table 4.93) were analyzed (Pearson's correlation=0.248, $p<0.05$). The MCC on stethoscopes of participants who attended to an average of 16 patients was the highest (MCC=30.89). There was a significant decline in the levels of contamination as the average number of patients reduced; 10 patients (MCC=27.38), 8 patients (MCC=5.90) (Table 4.93)

Table 4.93: Bacterial contamination (MCC) by average number of patients devices were used on daily

Average number of patients device is used on daily	No. of stethoscopes examined	No. (%) of stethoscopes contaminated	Mean Colony Count(MCC)
3	50	18 (36.0)	8.96
8	42	16 (38.1)	5.90
10	16	8 (50.0)	27.38
16	38	16 (42.1)	30.89
Total	146	58(39.7)	15.45

When colonization was related to how often the stethoscopes were cleaned, the most bacterial colonization was found on stethoscopes that had never been cleaned (MCC=94.93), while the least was found on stethoscopes cleaned after each single use (MCC=0.63) (Table 4.94). Statistical analysis showed a significant difference in this outcome ($t = 12.311$, df =51, $p = 0.00$).

Table 4.94 Bacterial contamination (MCC) by frequency of stethoscope disinfection by participants

Frequency of stethoscope disinfection	No. of stethoscopes examined	No. (%) of stethoscopes contaminated	Mean Colony Count(MCC)
After single use	38	3(7.9)	0.63
Daily	57	22(38.6)	3.44
Never	15	14(93.3)	94.93
Weekly	15	6(40.0)	18.00
Twice weekly	2	2(100.0)	14.00
Once a while	16	8(50.0)	14.25

Monthly	3	3(100.0)	28.67
Total	146	58 (39.7)	15.45

When the cleaning agents were related to stethoscope colonization by bacteria, results showed the highest colonization among stethoscopes that were never cleaned with any agent (MCC=101.71). The lowest colonization was found among stethoscopes cleaned with 70% alcohol and savlon (MCC=4.33). MCC for devices cleaned with 70% alcohol (MCC=6.50), cotton (MCC=10.00) and savlon (MCC=6.86) were low (Table 4.95). Comparing means, there was a significant difference in levels of contamination between devices never cleaned and devices cleaned [70% alcohol and savlon (t =5.650, df =18, p =0.00), 70% alcohol (t = 15.409, df = 127, p =0.00), cotton (t =2.137, df =13, $p<0.05$), hibiscrub ($p<0.05$), savlon (t =3.368, df =14, $p<0.05$)]

Table 4.95: Bacterial contamination levels vs. agents used by staff for disinfection of stethoscopes

Disinfectants	MCC	N	Std. Deviation
70 % Alcohol % Savlon	4.33	6	4.803
70% Alcohol	6.50	115	18.299
Dry Cotton wool	10.00	2	.000
Hibiscrub	.00	2	.000
Savlon	6.86	7	7.647
Not applicable(never cleaned)	101.71	14	41.457
Total	15.45	146	34.876

4.2.2.3: Effectiveness of various disinfectant used in KATH; Evidence From Culture

As part of this study, different disinfection procedures including the use of 70% alcohol, savlon, hibiscrub, soapy water, and dry cotton wool, which were readily accessible to the health staff, were analyzed to find the most cost effective for use. Out of the 58 culture positive stethoscopes before any of these disinfection procedures were used, only 3 still remained culture positive. All 3 were from stethoscopes cleaned with dry cotton wool. The mean colony counts on them were however low with one having an MCC of 1 and the other two having 2 each. All the disinfection procedures proved effective as disinfectants, with the most effective being 70% alcohol (no positive out of 30 cultures), Savlon (no positive out of 29 cultures), hibiscrub (no positive out of 29 cultures), and soapy water (no positive out of 29 cultures), followed by dry cotton (3 positives out of 29 cultures).

CHAPTER V

5.0: DISCUSSION

Most hospital-acquired infections are primarily nosocomial and not autoinfections (Hoogkamp-Korstanje, *et al.*, 1982). Acquisition of these infections add to the morbidity, mortality, and economic costs of patients.

Many, if not all, hospital-acquired infections result directly or indirectly from colonisation of the patients' skin, gut or organ systems with hospital flora (Jarvis, 1996). The colonised flora result in infection when the normal body defences are impaired through underlying diseases, administration of immunosuppressing drugs or use of invasive devices. Development of rational control methods for nosocomial infections thus, requires identification of reservoirs of pathogens that colonise the patients.

Stethoscopes and otoscopes get contaminated by organisms colonising patients' skin and ear canal respectively, or those resident on the hands or outfits of the health care providers, or when they come in contact with blood and other biological secretions.

The universal use of the stethoscope and otoscope (in otology) and their direct contact with multiple patients makes them important potential factors in the dissemination of microorganisms from one patient to another. In hospitalised patients, this means an exposure of an already susceptible host to a higher microbial load and for the patients attending Out Patient Department, an exposure to the threatening antibiotic-resistant hospital-flora.

The present study assessed the possibility of stethoscopes and otoscopes used by staff in KATH serving as sources of nosocomial infections.

5.1: Contamination levels of otoscopes used in KATH

None of the otoscope earpieces analyzed in this study had microbial growth. This was not alarming since they were all disinfected thoroughly as a routine after each "patient use" by soaking them in savlon, after which they were swabbed with 70% alcohol.

5.2.0: Contamination levels of stethoscopes used in KATH

There was a lower rate of stethoscope contamination (39.7%) observed in this study compared to studies carried out by other individuals where rates were between 71% to 100% (Cohen, *et al.*, 1997; Zuliani-Maluf, *et al.*, 2002; Bernard, *et al.*, 1999; Jones, *et al.*, 1995; Marinella, *et al.*, 1997; Saxena, *et al.*, 2005; Smith, *et al.*, 1996; Wright, *et al.*, 1995). This was not surprising since KATH runs a well-publicized hand decontamination campaign with standard operating procedures (SOPs) on proper hand washing at every sink coupled with easy access to alcohol hand rubs. Studies have shown that personal medical device contamination levels are lower on device handled by individual who practice frequent hand decontamination (Larson, 1988, Uneke, *et al.*, 2009). 62.3% of the stethoscopes examined met the authorized norms of cleanliness (AFNOR, 1989), that is bacterial carriage <5 CFU/cm^2 or 20 CFU/membrane, while only 5.6% were heavily colonized (>100 CFU/membrane), with none of the stethoscopes carrying pathogenic species. These indicate that the stethoscopes used by staff of KATH though potentially playing a role in transmitting microorganisms in the hospital environment, may only play a minor role.

Most of the isolates (82.8%) were coagulase negative staphylococcus (CNS) in contrast to *Staphylococcus aureus*, which have been found on 15.8% to 89% of stethoscopes surveyed in other studies (Marinella, *et al.*, 1997; Saxena, *et al.*, 2005; Genné, *et al.*, 1996; Sengupta, *et*

al., 2000; Sood, *et al.*, 2000). There was no isolate of *Staphylococcus aureus* in this study. Until recently, infections due to CNS were regarded as endogenous in origin. However, there are now increasing reports on the endemic occurrence of distinct strains of CNS (Hübner & Kropec, 1995) including strains of *S. epidermidis*. Several outbreaks due to CNS have been reported in neonates and patients undergoing cardiac surgery (Hübner & Kropec, 1995). These findings conclude that isolation of CNS can no longer be considered innocuous and that potentially pathogenic organisms are carried on these stethoscopes.

5.2.1: Participants' Demographic information in relation to stethoscope contamination

In this study, there was no significant link between participant demographic characteristics and levels of stethoscope contamination. For instance when sex of participants was considered, although female participants had more stethoscopes contaminated (44%, N=33) and a higher MCC (19.28), this was found to be statistically insignificant upon analysis when compared to their male counterparts with contamination levels of 35.2% (N= 25) and MCC of 12.82. As well, correlation observed with respect to age was not significant (*Pearson's Correlation* = 0.137, $p > 0.05$).

In contrast to previous studies (Wright, *et al.*, 1995; Marinella, *et al.*, 1997), there was no significant interdepartmental variation in the levels of contamination. This may be attributed to the fact that with KATH being a teaching hospital, most of the participants in this study are students on clinical rotations, thus they are not permanently placed in particular departments; they rotate among the various departments and as such, carry the same practice around all the departments.

Although not strong, the correlation between number of years of practice of participants and contamination levels on the stethoscopes may most likely be as a result of complacency and relaxation in stringent precautions that set in once staff stay on the job for long. Although over 90% of them believed that personal medical devices might serve as a source of spread of nosocomial infections, as the years progress at work, they are tempted to believe that some of the required practices such as disinfection of stethoscopes are unnecessary.

There were only 23 nurses in this study compared to house officers (N=65) and students (N=36); however, they had the highest MCC (37.65). This outcome was however statistically insignificant. The observed disparity may be attributed to the fact that in a facility like KATH where there is a very high patient to physician ratio, checking of vital statistics of patients (including blood pressure) is carried out by nurses with doctors and other consultants having to do so only in a few cases for clarification. Nurses thus tend to use their stethoscopes on more patients and as such accumulate more microbes than their physician counterparts. The students as well attend to fewer patients.

5.2.2: Stethoscope usage, handling and maintenance in relation to stethoscope contamination

In relation to stethoscope usage, handling and maintenance, it was realized that the number of years the devices had been used had no significant bearing on their levels of contamination. Devices whose years of usage were uncertain were not considered for statistical analysis. This was because; they could be anywhere between zero and greater than 3years old. There was however a significant correlation between the average number of patients the devices were used on and the levels of stethoscope contamination.

Studies have shown that only 0-3% of health care providers clean their stethoscopes regularly (Breathnach, *et al.*, 1992; Wright, *et al.*, 1995; Gerken, *et a.l*, 1972). In the study by Uneke, 10% cleaned it when blood or human secretions soiled it; and only two cleaned it at intervals of one to two months. In the present study, over 60% (N=95) clean their stethoscope at least once daily with or without physical contamination while only 15 participants never cleaned theirs. This indicates that better stethoscope-cleaning practice exists among health care providers in KATH.

This current study demonstrates the importance of cleaning the stethoscope with a disinfectant. Compared to staff who never cleaned their stethoscopes, there was less bacterial colonization on stethoscopes of participants who used any of the disinfection procedures. An earlier study showed that bacterial colony counts were significantly reduced from the stethoscope diaphragm after cleaning with isopropyl alcohol, sodium hypochlorite or benzalkonium chloride (Marinella, *et al.*, 1997). Another related report indicated that cleaning the stethoscope diaphragm resulted in immediate reduction in the bacterial count: by 94% with alcohol swabs, 90% with nonionic detergent and 75% with antiseptic soap (Jones, *et al.*, 1995). In one study, cleaning with soap and water was found to be the simplest and most convenient method of disinfecting the stethoscope (Africa-Purino, *et al.*, 2000).

In the quest to find the most cost effective disinfection procedure to be used in KATH for these devices (for which reason cultures were obtained after device disinfection), all the procedures proved effective as disinfectants. The most effective being 70% alcohol (no positive out of 32 cultures); Savlon (no positive out of 32); hibiscrub (no positive out of 32 cultures) and soapy water (no positive out of 32 cultures), followed by dry cotton wool (3 positive out of 32 cultures). The most cost effective though is 70% alcohol. Reasons include,

it is; less expensive; readily available and rapidly bactericidal against vegetative organisms, and it is, virucidal and fungicidal, as well (Fraise , 1999). Its activity is probably related to its ability to denature proteins. It is suitable for disinfection of horizontal surfaces as it evaporates rapidly and tends to leave the equipment dry.

CHAPTER VI

6.0: CONCLUSION AND RECOMMENDATIONS

The negative culture results obtained from the otoscopes in this study indicate that otoscopes in KATH are not a likely source of nosocomial infections. To maintain this standard, precautions carried out concerning otoscopes management must be maintained. The same however cannot be said of the stethoscopes.

Although there was a low rate of contamination on the stethoscopes and the contamination levels on them were low, if they are given at least half the care given to otoscopes by disinfecting them at least after each day's work, they may be ruled out completely as potential sources of nosocomial infection in KATH. Proper hand washing and the use of alcohol hand rubs must still be encouraged since it had a large role to play in the low contamination levels encountered in this study.

6.1: Study Limitations

- There was lack of adequate relevant literature in Ghana and Africa and very little even internationally pertaining to the study to serve as sources of reference.
- Sampling was not done at once for all participants and this might have resulted in a Hawthorne effect (where subjects improve the specific aspect of their behavior simply because they know it is being studied).
- Sample collection was based on the assumption that the devices' surfaces were evenly contaminated. This might not be the reality.

- Most of the stethoscopes belonging to KATH were accessible to multiple staff, especially on the wards. Nosocomial infection spread in these cases might not only be through the devices' diaphragms but also through their earpieces from staff to staff. Analysis of these earpieces, which was not part of the objectives of this study might be required to fully assay the potential roll of stethoscope in nosocomial infection spread in KATH.

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APPENDICES

APPENDIX 1: Copy of Structured Questionnaire

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY AND
THE KOMFO ANOKYE TEACHING HOSPITAL, SCHOOL OF MEDICAL SCIENCES DEPARTMENT OF CLINICAL MICROBIOLOGY

QUESTIONNAIRE ON MICROBIAL ANALYSIS OF STETHOSCOPES AND OTOSCOPES USED BY STAFF AS SOURCES OF NOSOCOMIAL INFECTIONS IN KATH

STRUCTION:

ease tick [√] the appropriate box where necessary and provide brief answers where required. The researcher will be very grateful if u can help provide a candid response to the following questions.

Thank you.

1. Stethoscope code: ..... / Otoscope code: .....
2. Age of Physician: .....yrs. 3. Sex.... [ ] M [ ] F 4. Number of years of Practice.....yrs.
5. Department. .....
6. Professional Status.

   [ ] Student [ ] Resident [ ] Nurse [ ] House officer [ ] Consultant [ ] Other, please specify.....
7. Ownership of Stethoscope/Otoscope. [/] Personal [/] KATH [/] Other, please Specify.....
8. How many stethoscopes/otoscopes do you have? ...../.....
9. How long have you used the Stethoscope/Otoscope? [/] Under a year [/] 1-2yrs [/] 2-3yrs [/]>3yrs

   [/] Don't know
10. On an average, on how many patients do you use the stethoscope/otoscope daily?

    [/] 1-5 [/] 5-10 [/] 10-15 [/]>15
11. Have you ever received any instruction on cleaning of stethoscopes and other personal medical devices (such as patella .hammer, otoscopes etc) ? [ ] Yes [ ] No
12. How often do you clean your stethoscope/otoscope?

    [/] After each single use [/] Daily [/] Weekly [/] Monthly [/] Never

    [/] Other, please Specify.....
13. With ~~what~~ do you clean the devices?

    [ ] Dry cotton wool [ ] Soapy Water [ ] 70% alcohol [ ] Savlon [ ] Hibiscrub . [ ]

Other, please specify.....

14. Do you think personal medical devices such as stethoscopes and otoscopes can serve as a source of cross transmission of infection (and thus a source of nosocomial infection)? [ ] Yes [ ] No

APPENDIX 2: STERILIZATION OF MATERIALS AND MEDIA PREPARATION

2.1: HOT-AIR OVEN

Petri dishes were sterilized by dry heat at a temperature of 160°C held for 60 minutes to kill all microorganisms and bacterial endospores.

2.2: AUTOCLAVING

Media for bacterial cultures and distilled water for reconstitution of physiological saline were autoclaved at 121°C for 15 minutes.

2.3: PREPARATION OF CULTURE MEDIA

Appropriate masses of components were weighed and added to distilled/deionized water of required volume. Mixtures were heated with frequent agitation and boiled for one minute to completely dissolve the media. Media were autoclaved for 15 minutes at 121°C and were cooled to about 50°C before being poured into sterile Petri dishes.

APPENDIX 3: LABORATORY TESTS

3.1: GRAM TECHNIQUE

Method:

1. Dried smears were fixed with heat.
2. Fixed smears covered with crystal violet for 60 seconds.
3. Clean water was used to wash off the stain
4. Water was tipped off and the smears were covered with Lugol's iodine for 60 seconds.
5. Clean water was used to wash off the iodine.
6. Smears were rapidly decolorize (5 seconds) with acetone and washed immediately with clean water.
7. The smears were covered with neutral red stain for 2 minutes and washed off with clean water.
8. Blotting paper was used to gently blot away water from the Gram stained smears.
9. Gram stained smears were examined microscopically with the oil immersion objective to report the bacteria.

3.2: BIOCHEMICAL TESTS TO IDENTIFY BACTERIA

3.2.1: Catalase Test

Method:

1. 2-3 ml of hydrogen peroxide (3% H_2O_2) was pour into a test tube.
2. Using a sterile glass applicator, several colonies of the test organism were removed and immerse in the hydrogen peroxide solution.
3. Active bubbling indicated a positive catalase test whilst catalase negative test produced no bubbles.

Controls:

- Positive catalase control: *Staphylococcus aureus ATCC 25923*
- Negative catalase control: Known and characterized *Streptococcus pneumoniae* from KATH

.2.2: Coagulase Test

Method:

1. A drop of distilled water was placed on two separate slides.
2. A colony of the test organism (previously checked by Gram staining) was emulsified in each of the drops to form thick suspensions.
3. A loopful of plasma was added to one of the suspensions and mixed gently.
4. The suspension with the plasma was carefully observed for clumping of the organisms within 10 seconds.
5. Clumping of organisms indicated that the test organism was *Staphylococcus aureus* whilst no clumping of organisms indicated the absence of bound coagulase.

Controls:

- Positive coagulase control: *Staphylococcus aureus ATCC 25923*
- Negative coagulase control: Known and characterized *Staphylococcus epidermidis* from KATH

APPENDIX 4: RESULTS FROM STUDY

RESULTS FOR MICROBIAL ANALYSIS OF STETHOSCOPES AND OTOSCOPES USED BY STAFF AS SOURCES OF NOSOCOMIAL INFECTIONS IN KATH

CODE	AGE	SEX	NUMBER OF YEARS OF PRACTICE	DEPART	PROFESSIONAL STATUS	OWNERSHIP OF DEVICE	HOW MANY OF THE DEVICE DO YOU HAVE?	HOW OLD IS THE DEVICE ?	NUMBER OF PATIENTS DEVICE IS USED ON DAILY	EVER RECEIVED INSTRUCTIONS ON CLEANING OF DEVICE ?	HOW OFTEN?	WHAT DO YOU USE ?	THINK POSSIBLE SOURCE OF NOSOCOMIALS ?	RESULT
OB1701	38	F	10	EENT	Senior specialist	KATH	1	>3	10--15	No	After single use	70% alcohol,Savlon	Yes	Negativ
OB1702	38	F	10	EENT	Senior specialist	KATH	1	>3	10--15	No	After single use	70% alcohol,Savlon	Yes	Negativ
OBI703	38	F	10	EENT	Senior specialist	KATH	1	>3	10--15	No	After single use	70% alcohol,Savlon	Yes	Negativ
OBI704	38	F	10	EENT	Senior specialist	KATH	1	>3	10--15	No	After single use	70% alcohol,Savlon	Yes	Negativ
OBI705	31	F	5	EENT	Resident	KATH	1	Don't know	>15	No	After single use	70% alcohol,Savlon	Yes	Negativ
OBI706	31	F	5	EENT	Resident	KATH	1	Don't know	>15	No	After single use	70% alcohol,Savlon	Yes	Negativ
OBI707	31	F	5	EENT	Resident	KATH	1	Don't know	>15	No	After single use	70% alcohol,Savlon	Yes	Negativ
OBI708	31	F	5	EENT	Resident	KATH	1	Don't know	>15	No	After single use	70% alcohol,Savlon	Yes	Negativ
OBI709	52	F	23	EENT	Nurse	KATH	1	Don't know	1--5	Yes	After single use	70% alcohol,Savlon	Yes	Negativ
OBI710	52	F	23	EENT	Nurse	KATH	1	Don't know	1--5	Yes	After single use	70% alcohol,Savlon	Yes	Negativ
OBI711	52	F	23	EENT	Nurse	KATH	1	Don't know	1--5	Yes	After single use	70% alcohol,Savlon	Yes	Negativ
OBI712	52	F	23	EENT	Nurse	KATH	1	Don't know	1--5	Yes	After single use	70% alcohol,Savlon	Yes	Negativ
SB1701	31	F	5	EENT	Resident	KATH	1	Don't know	>15	No	After single use	70% alcohol,Savlon	Yes	Positiv
SB2301	32	M	4.5	O&G	Resident	Personal	1	2--3	>15	Yes	After single use	70% alcohol	Yes	Negativ

SB2302	24	F	2	O&G	Midwife	KATH	1	Don't know	5--10	Yes	After single use	70% alcohol	Yes	Positive
SB2303	31	F	4	O&G	Resident	Personal	1	1--2	>15	Yes	Daily	70% alcohol	Yes	Negative
SB2304	50	F	25	O&G	Nurse	KATH	1	>3	>15	No	Never		Yes	Positive
SB2305	24	F	2	O&G	Nurse	KATH	1	Don't know	>15	No	Daily	Cotton	Yes	Positive
SB2306	28	F	5	O&G	Nurse	KATH	1	Don't know	>15	No	Daily	70% alcohol	Yes	Negative
SB2307	32	F	10	O&G	Nurse	KATH	1	2--3	>15	No	Never		Yes	Positive
SB2308	28	M	2	O&G	House Officer	KATH	1	>3	5--10	Yes	After single use	70% alcohol	Yes	Negative
SB2309	31	F	8	O&G	Nurse	KATH	1	Don't know	>15	No	Weekly	70% alcohol	Yes	Positive
SB2310	30	F	7	O&G	Nurse	KATH	1	Don't know	5--10	Yes	Daily	70% alcohol	Yes	Negative
SB2311	42	F	15	O&G	Nurse	KATH	1	Don't know	1--5	Yes	Daily	70% alcohol	Yes	Negative
SB2312	27	F	1	O&G	House Officer	Personal	2	1--2	5--10	Yes	Daily	Hibiscrub	Yes	Negative
SB2313	54	F	32	O&G	Nurse	KATH	1	<1	>15	Yes	Daily	70% alcohol	Yes	Negative
SB2314	58	F	35	O&G	Nurse	KATH	1	<1	>15	No	Daily	70% alcohol	Yes	Negative
SB2315	34	F	11	O&G	Nurse	KATH	1	Don't know	10--15	No	Never	70% alcohol	Yes	Positive
SB2316	23	M	1	O&G	Student	Personal	1	<1	5--10	No	Daily	70% alcohol	Yes	Positive
SB2317	32	F	9	O&G	Nurse	KATH	1	<1	>15	No	Daily	Hibiscrub	Yes	Negative
SB2318	24	F	2	O&G	Student	Personal	1	1--2	5--10	No	Daily	70% alcohol	Yes	Positive
SB2319	33	F	10	O&G	Nurse	KATH	1	>3	>15	No	Never		Yes	Positive
SB2320	26	F	2	O&G	House Officer	Personal	2	<1	10--15	Yes	After single use	70% alcohol	Yes	Negative
SB2321	33	F	6	O&G	Resident	KATH	1	Don't know	>15	No	Weekly	70% alcohol	Yes	Negative
SB2322	42	F	19	O&G	Midwife	KATH	1	Don't know	>15	Yes	After single use	70% alcohol	Yes	Negative
SB2323	28	F	3	O&G	House Officer	Personal	1	1--2	>15	No	After single use	70% alcohol	Yes	Negative
SEB2301	52	F	32	O&G	Nurse	KATH	1	1--2	10--15	No	Never		Yes	Positive
SEB2302	23	M	2	O&G	Student	Personal	1	1--2	1--5	No	Weekly	70% alcohol	Yes	Negative
SEB2303	45	M	23	O&G	Nurse	KATH	1	Don't know	>15	No	Never		Yes	Positive

SEB2304	23	F	1	O&G	Student	Personal	1	<1	10--15	No	Daily	70% alcohol	Yes	Positive
SEB2305	28	F	1.5	O&G	House Officer	Personal	1	1--2	>15	Yes	twice weekly	70% alcohol	Yes	Positive
SEB2306	49	F	25	O&G	Nurse	KATH	1	<1	>15	No	Weekly	Savlon	Yes	Negative
SEB2307	28	F	3	O&G	House Officer	Personal	1	<1	>15	No	Daily	70% alcohol	Yes	Negative
SEB2308	27	F	1	O&G	House Officer	Personal	1	<1	5--10	Yes	Daily	70% alcohol	Yes	Negative
SEB2309	27	F	3	O&G	House Officer	Personal	1	>3	>15	No	Never		Yes	Positive
SEB2310	29	F	4	O&G	House Officer	Personal	1	1--2	5--10	No	After single use	70% alcohol	Yes	Negative
SEB2311	34	F	10	O&G	Nurse	KATH	1	Don't know	>15	No	Weekly	70% alcohol	Yes	Negative
SEB2312	48	F	25	O&G	Nurse	Personal	1	>3	5--10	No	Daily	70% alcohol	Yes	Negative
SB26O1	27	F	1	Surgery	House Officer	Personal	1	>3	5--10	No	Daily	70% alcohol	Yes	Negativ
SB26O2	52	F	30	Surgery	Nurse	KATH	1	Don't know	5--10	Yes	After single use	70% alcohol,Savlon	Yes	Negativ
SB26O3	23	F	0.25	Surgery	Student	Personal	1	<1	5--10	No	After single use	70% alcohol	Yes	Negativ
SB26O4	23	F	2	Surgery	Nurse	KATH	1	1--2	10--15	No	Never		Yes	Positive
SB26O5	20	F	1	Surgery	Student	KATH	1	Don't know	1--5	No	Never		Yes	Positive
SB26O6	27	M	1	Surgery	House Officer	Personal	1	>3	10--15	Yes	After single use	70% alcohol	Yes	Negativ
SB26O7	26	M	1	Surgery	House Officer	Personal	1	>3	1--5	No	After single use	70% alcohol	Yes	Negativ
SB26O8	28	M	0.7	Surgery	House Officer	Personal	1	>3	10--15	Yes	Never		Yes	Positive
SB26O9	26	M	1	Surgery	House Officer	Personal	1	>3	10--15	No	Weekly	70% alcohol	Yes	Negativ
SB2610	28	M	3	Surgery	House Officer	Personal	1	>3	1--5	No	After single use	70% alcohol	Yes	Negativ
SB2611	22	F	0.25	Surgery	Student	Personal	1	<1	1--5	No	Never		Yes	Positive
SB2612	21	M	1	Surgery	Student	KATH	1	Don't know	5--10	Yes	upon instruction	70% alcohol	Yes	Negativ
SB2613	26	M	1	Surgery	House Officer	Personal	1	>3	1--5	No	After single use	70% alcohol	Yes	Negativ
SB2614	26	M	1	Surgery	House Officer	Personal	1	>3	10--15	No	once a while	70% alcohol	Yes	Negativ
SB2615	28	M	1	Surgery	House Officer	Personal	1	>3	1--5	No	After single use	70% alcohol	Yes	Negativ
SB2616	21	F	0.25	Surgery	Student	Personal	1	<1	1--5	No	Never		Yes	Positiv

SB2617	33	M	7	Surgery	Resident	Personal	1	>3	1--5	No	After single use	70% alcohol	Yes	Negative
SB2618	30	M	3	Surgery	House Officer	Personal	1	>3	10--15	No	After single use	70% alcohol	Yes	Negative
SB2619	20	F	1	Surgery	Student	KATH	1	Don't know	1--5	Yes	Weekly	70% alcohol	Yes	Negative
SB2620	23	M	0.25	Surgery	Student	Personal	1	>3	1--5	No	After single use	70% alcohol	Yes	Negative
SB2621	22	M	1	Surgery	Student	KATH	1	Don't know	1--5	No	once a while	70% alcohol	Yes	Negative
SB2622	31	M	5	Surgery	Resident	Personal	1	>3	10--15	Yes	After single use	70% alcohol	Yes	Negative
SB2623	24	F	0.8	Surgery	Student	KATH	1	Don't know	1--5	No	After single use	70% alcohol	Yes	Negative
SB2624	23	F	1	Surgery	Student	KATH	1	1--2	1--5	No	After single use	70% alcohol	Yes	Negative
SB2625	24	M	1	Surgery	Student	Personal	1	1--2	1--5	No	After single use	70% alcohol	Yes	Negative
SB2626	20	M	0.25	Surgery	Student	Personal	1	1--2	1--5	Yes	Weekly	70% alcohol	Yes	Negative
SB2627	33	F	4	Surgery	Resident	Personal	1	1--2	1--5	No	once a while	70% alcohol	Yes	Negative
SB2628	27	M	1	Surgery	House Officer	Personal	1	1--2	1--5	Yes	once a while	70% alcohol	Yes	Negative
SB2629	29	F	3	Surgery	House Officer	Personal	1	2--3	5--10	No	Daily	70% alcohol	Yes	Negative
SB2630	27	M	2	Surgery	House Officer	Personal	1	1--2	1--5	No	Daily	70% alcohol	Yes	Negative
SB2631	28	M	3	Surgery	House Officer	Personal	1	1--2	5--10	No	Daily	70% alcohol	Yes	Negative
SB2632	29	M	3	Surgery	House Officer	Personal	1	2--3	1--5	No	once a while	70% alcohol	Yes	Negative
SB2633	55	F	34	Surgery	Nurse	KATH	1	1--2	>15	Yes	Weekly	Savlon	Yes	Negative
SB2634	30	M	5	Surgery	Resident	KATH	1	>3	1--5	No	After single use	70% alcohol	Yes	Negative
SB2635	20	F	1	Surgery	Student	KATH	1	Don't know	1--5	No	Weekly	Dry cloth	Yes	Negative
SB3101	30	M	0.7	Medicine	House Officer	Personal	1	<1	1--5	Yes	Daily	70% alcohol	No	Positive
SB3102	26	M	1	Medicine	House Officer	Personal	1	>3	1--5	Yes	Never	70% alcohol	Yes	Positive
SB3103	35	M	7	Medicine	Resident	Personal	1	>3	>15	Yes	Daily	70% alcohol	Yes	Positive
SB3104	30	F	2	Medicine	House Officer	Personal	1	2--3	5--10	No	Daily	70% alcohol	Yes	Positive
SB3105	24	M	0.25	Medicine	Student	Personal	1	<1	1--5	Yes	Daily	70% alcohol	Yes	Positive
SB3106	29	M	2	Medicine	House Officer	Personal	1	1--2	>15	No	Never		Yes	Positive
SB3107	27	M	2	Medicine	House Officer	Personal	1	>3	>15	No	After single use	70% alcohol	Yes	Negative
SB3108	28	F	1	Medicine	House Officer	Personal	1	<1	10--15	Yes	once a while	70% alcohol	Yes	Negative
SB3109	34	M	6	Medicine	Resident	Personal	1	1--2	5--10	No	Daily	70% alcohol	Yes	Positive
SB3110	26	M	1	Medicine	House Officer	Personal	2	<1	5--10	Yes	once a while	70% alcohol	Yes	Positive
SB3111	32	M	1	Medicine	House Officer	Personal	1	1--2	5--10	No	Daily	70% alcohol	Yes	Negative

SB3201	27	M	2	Medicine	House Officer	KATH	1	2--3	5--10	No	Daily	70% alcohol	Yes	Positive
SB3202	28	M	1	Medicine	House Officer	Personal	1	1--2	5--10	No	Monthly	70% alcohol	Yes	Positive
SB3203	30	M	4	Medicine	Resident	Personal	2	2--3	10--15	No	Daily	70% alcohol	Yes	Positive
SB3204	26	F	1	Medicine	House Officer	Personal	1	1--2	10--15	No	After single use	Savlon	Yes	Negative
SB3205	28	M	1	Medicine	House Officer	Personal	1	>3	5--10	No	once a while	70% alcohol	Yes	Positive
SB3206	27	F	0.7	Medicine	House Officer	Personal	1	>3	5--10	No	Weekly	70% alcohol	Yes	Positive
SB3207	23	F	1	Medicine	House Officer	Personal	1	2--3	5--10	No	Daily	70% alcohol,Savlon	Yes	Positive
SB3208	28	M	2	Medicine	House Officer	Personal	2	>3	5--10	Yes	twice weekly	70% alcohol	Yes	Positive
SB3209	27	M	1	Medicine	House Officer	Personal	1	1--2	5--10	No	Daily	70% alcohol	Yes	Negative
SB3210	27	F	1	Medicine	House Officer	Personal	1	2--3	>15	No	Daily	70% alcohol	Yes	Negative
SB3211	26	M	1	Medicine	House Officer	Personal	1	>3	5--10	No	Daily	70% alcohol	Yes	Positive
SB3212	31	M	4	Medicine	Resident	Personal	1	1--2	5--10	No	After single use	70% alcohol	Yes	Positive
SB3301	28	M	1	Medicine	House Officer	Personal	1	2--3	5--10	Yes	Daily	70% alcohol	Yes	Negative
SB3302	27	F	1	Medicine	House Officer	Personal	1	1--2	5--10	No	Daily	70% alcohol	Yes	Negative
SB3303	27	F	2	Medicine	House Officer	Personal	1	1--2	>15	No	Daily	70% alcohol	Yes	Positive
SB3304	27	F	1	Medicine	House Officer	Personal	1	>3	5--10	No	Daily	70% alcohol	Yes	Negative
SB3305	28	F	1	Medicine	House Officer	Personal	1	2--3	1--5	No	After single use	70% alcohol	Yes	Negative
SB3306	30	M	3	Medicine	Resident	Personal	2	1--2	5--10	No	Daily	70% alcohol	Yes	Positive
SB3307	27	M	1	Medicine	Nurse	KATH	1	<1	10--15	No	Never	70% alcohol	Yes	Negative
SB3308	27	F	0.8	Medicine	House Officer	KATH	1	Don't know	5--10	No	Daily	70% alcohol	Yes	Positive
SB3309	20	F	0.25	Medicine	Student	Personal	1	<1	1--5	Yes	Daily	Savlon	Yes	Positive
SB3310	26	M	1	Medicine	House Officer	Personal	1	<1	10--15	No	once a while	70% alcohol	Yes	Positive
SB3311	34	F	6	Medicine	Resident	Personal	1	2--3	>15	No	After single use	70% alcohol	Yes	Negative
SB3312	26	M	1	Medicine	House Officer	Personal	1	1--2	>15	No	After single use	70% alcohol	Yes	Negative
SB3313	28	M	1	Medicine	House Officer	Personal	1	1--2	1--5	No	Daily	70% alcohol	Yes	Positive
SB3314	27	M	1	Medicine	House Officer	Personal	1	1--2	1--5	Yes	Daily	70% alcohol	Yes	Negative
SB3315	27	F	1	Medicine	House Officer	Personal	1	2--3	1--5	No	After single use	70% alcohol	Yes	Negative
SB3316	30	M	1	Medicine	House Officer	Personal	1	>3	1--5	Yes	After single use	70% alcohol	Yes	Negative
SB3317	29	M	1	Medicine	House Officer	Personal	1	2--3	5--10	Yes	Daily	70% alcohol	Yes	Negative
SB3318	27	F	2	Medicine	House Officer	Personal	1	2--3	5--10	No	After single use	70% alcohol	Yes	Negative
SB3401	23	M	1	Child Health	Student	Personal	1	1--2	1--5	Yes	once a while	70% alcohol	Yes	Positive

SB3402	33	F	7	Child Health	Resident	Personal	1	1--2	10--15	Yes	Daily	70% alcohol	Yes	Positive
SB3403	30	F	4	Child Health	House Officer	Personal	1	2--3	5--10	No	After single use	70% alcohol	Yes	Negative
SB3404	23	M	0.25	Child Health	Student	Personal	1	1--2	1--5	No	Daily	70% alcohol	Yes	Negative
SB3405	28	F	5	Child Health	Nurse	KATH	1	Don't know	1--5	Yes	Weekly	Savlon	Yes	Positive
SB3406	24	M	2	Child Health	Student	Personal	2	1--2	1--5	Yes	Daily	70% alcohol	Yes	Negative
SB3407	27	F	6	Child Health	Student	Personal	1	>3	10--15	No	Daily	70% alcohol	Yes	Negative
SB3408	25	M	1	Child Health	Student	Personal	1	2--3	1--5	No	Monthly	70% alcohol	Yes	Positive
SB3409	22	F	0.25	Child Health	Student	Personal	1	>3	1--5	Yes	Daily	70% alcohol	Yes	Positive
SB3410	24	F	0.25	Child Health	Student	Personal	1	1--2	1--5	Yes	once a while	70% alcohol	Yes	Positive
SB3411	25	F	0.8	Child Health	House Officer	Personal	1	>3	>15	No	Daily	70% alcohol	Yes	Negative
SB3412	23	F	0.25	Child Health	Student	Personal	1	<1	1--5	Yes	once a while	70% alcohol	Yes	Positive
SB3413	25	F	1	Child Health	House Officer	Personal	2	>3	>15	No	Weekly	70% alcohol	Yes	Positive
SB3501	23	M	1	Child Health	Student	Personal	1	1--2	1--5	No	After single use	70% alcohol	Yes	Negative
SB3502	25	M	1	Child Health	House Officer	Personal	2	2--3	5--10	Yes	Daily	70% alcohol	Yes	Negative
SB3503	32	F	6	Child Health	Resident	Personal	2	>3	>15	Yes	Monthly	70% alcohol	Yes	Positive
SB3504	23	M	0.3	Child Health	Student	Personal	1	1--2	5--10	No	Daily	70% alcohol	Yes	Negative
SB3505	33	M	7	Child Health	Resident	Personal	1	>3	>15	No	Daily	70% alcohol	Yes	Negative
SB3506	27	F	2	Child Health	Student	Personal	1	<1	1--5	No	After single use	70% alcohol	Yes	Negative
SB3507	23	M	0.25	Child Health	Student	Personal	1	1--2	1--5	No	once a while	70% alcohol	Yes	Positive
SB3508	33	F	8	Child Health	Resident	Personal	2	2--3	>15	Yes	Never		Yes	Positive
SB3509	23	F	0.3	Child Health	Student	Personal	1	1--2	1--5	No	once a while	70% alcohol	Yes	Positive
SB3510	24	M	1	Child Health	Student	Personal	1	1--2	1--5	Yes	once a while	70% alcohol	Yes	Positive
SB3511	23	F	0.3	Child Health	Student	Personal	2	1--2	1--5	No	Weekly	70% alcohol	Yes	Positive
SB3512	24	F	1	Child Health	Student	Personal	1	1--2	1--5	No	Daily	70% alcohol	Yes	Negative
SB3513	31	F	5	Child Health	Resident	Personal	1	1--2	>15	No	once a while	Savlon	Yes	Positive
SB3514	25	M	2	Child Health	Student	Personal	1	1--2	1--5	No	once a while	70% alcohol	Yes	Negative
SB3515	24	M	1	Child Health	Student	Personal	2	2--3	1--5	No	Daily	70% alcohol	Yes	Negative
SB3516	32	M	5	Child Health	Resident	Personal	1	>3	5--10	Yes	After single use	70% alcohol	Yes	Negative
SB3517	27	F	4	Child Health	House Officer	Personal	1	<1	>15	No	Daily	70% alcohol	Yes	Negative
SB3518	25	M	1	Child Health	Student	Personal	1	<1	>15	No	Daily	70% alcohol	Yes	Negative
SB3519	28	F	2	Child Health	House Officer	Personal	1	>3	5--10	Yes	After single use	70% alcohol	Yes	Negative
SB3520	26	F	1	Child Health	House Officer	Personal	1	2--3	5--10	Yes	Daily	70% alcohol	Yes	Negative

SB3521	27	M	1	Child Health	House Officer	Personal	1	>3	5--10	No	After single use	70% alcohol	Yes	Negative
SB3522	30	F	3	Child Health	House Officer	Personal	1	>3	>15	No	After single use	70% alcohol	Yes	Negative

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
COLLEGE OF HEALTH SCIENCES
SCHOOL OF MEDICAL SCIENCES / KOMFO ANOKYE TEACHING HOSPITAL
COMMITTEE ON HUMAN RESEARCH PUBLICATION AND ETHICS

Our Ref: CHRPE/36/11

April 13, 2011

Prof. Yaw Adu-Sarkodie
Department of Clinical Microbiology
KNUST- Kumasi

Dear Sir,

LETTER OF APPROVAL
Protocol Title*: "Microbial Analysis of Stethoscopes and Otoscopes Used by Staff as Sources of Nosocomial Infections in Komfo Anokye Teaching Hospital - KATH"*

Proposed Site: Komfo Anokye Teaching Hospital/Microbiology Department
Sponsor: Microbiology Department Fund

Your submission to the Committee on Human Research Publication and Ethics on the above named protocol refers.

The Committee has considered the ethical merit of your submission and approved the protocol. The approval is for a fixed period of one year, renewable annually thereafter. The committee may however, suspend or withdraw ethical approval at anytime if your study is found to contravene the approved protocol.

Data gathered for the study should be used for the approved purposes only. Permission should be sought from the committee if any amendment to the protocol or use, other than submitted, is made of your research data.

The Committee should be notified of the actual start date of the project and would expect a report on your study, annually or at close of the project, whichever one comes first. It should also be informed of any publication arising from the study.

Thank you Sir, for your application.

Yours faithfully,

Osomfuor Prof. Sir J. W. Acheampong MD, FWACP
Chairman