

**UNIVERSITY OF GHANA**  
**COLLEGE OF HEALTH SCIENCES**  
**SCHOOL OF PUBLIC HEALTH**



**FACTORS ASSOCIATED WITH SURGICAL SITE INFECTION  
AT UNIVERSITY OF GHANA HOSPITAL, ACCRA, GHANA.**

**A DISSERTATION SUBMITTED TO THE UNIVERSITY OF  
GHANA, LEGON IN PARTIAL FULFILMENT OF THE  
REQUIREMENT FOR THE AWARD OF MASTERS IN PUBLIC  
HEALTH IN EPIDEMIOLOGY AND DISEASE CONTROL.**

**BY**

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## DECLARATION

I, Dan Bazaadut hereby declare that, except the duly acknowledged references, this dissertation is wholly my work produced under supervision and has never been previously submitted to the University of Ghana or elsewhere for another degree or published elsewhere in part or whole.

STUDENT'S SIGNATURE:

DATE: 24/6/2025

SUPERVISOR: PROF. FRANCIS ANTO

SIGNATURE:

DATE: 22/09/2025



## DEDICATION

*“An unexamined life is not worth living.”* Socrates (circa 399 CE)

This work is one of the life experiences I have always desired. The exposure to a critical academic thought process. It satisfies a deep need. For this I am eternally grateful to God.

So, I wish to dedicate it first to God for giving me life and health and peace of mind to finish it.

Next to my teachers for guiding me through this work.



## ACKNOWLEDGEMENT

I wish to acknowledge the management and staff of University Hospital, Legon for graciously providing me access to their hospital information system to mine and extract data for this study. I also wish to express my sincere gratitude to all the teaching assistants and staff at the School of Public Health who helped me navigate the path to producing this work.



## Abstract

### **Background**

Surgical site infections (SSI) are the most common healthcare-associated infections in hospitals in low- and middle-income countries, and the second most common in Europe. SSI are the most preventable cause of morbidity and mortality. Aseptic technique and infection control practices are the major avenues to reduce the incidence of SSI. Accurate assessment and adequate risk factor modification is the other modality for reducing the risk of SSI. This study 'estimated the prevalence of SSI in Legon hospital and some risk factors that may affect the chances of a patient developing a SSI

### **Methods**

A cross-sectional study was conducted from January 2021 to October 2023. In total, 388 client folders that had complete information was extracted using an in-built information extraction tool of the HIS. Demographic information was summarized with descriptive statistics while inferential statistics (Chi<sup>2</sup> and logistic regression) was used to test associations between factors and SSI. The results were presented as tables.

### **Results**

A total of 388 folders were analyzed. The median age was 26yrs with a range of 1-81years. The largest age ground was 20–30-year-olds (58.3%). Females made up 52.6% (n=204) of the population and the highest proportion of participants had secondary education (71.9%, n= 279). Most patients, 65.2%, had their procedure as in-patients and of these 85.8 % stayed between one and three days. Most wounds, 64.4%, lasted between eleven and thirty days. The prevalence of SSI was 20.1% (95%CI= 16.4-24.4). Logistic regression showed that age > 10yrs was associated with 1.02 increased odds of SSI ( $p = 0.003$ ). Pearson Chi<sup>2</sup> tests showed clean wound had an increased risk SSI as compared to contaminated wounds ( $\chi^2 (1) =10.91, p = 0.001$ ). Again, logistic regression showed duration of wound 11-30 days was a positive predictor of SSI ( $p < 0.001$ ).

### **Conclusion**

The study showed that the prevalence of SSI is relatively high in the facility. It also found that older age, clean wounds and infections in wounds after 11days was associated with SSI

### **Keywords**

Surgical site infection, healthcare associated infection, prevalence

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## List of abbreviations

1. ACS-NSQIP.... American College of Surgeons National Surgical Quality Improvement Program
2. ADL.....Activities of Daily Living
3. CDC..... Center for Disease Control and Prevention
4. HCAI..... Health Care Associated Infections
5. HIS..... Hospital-management Information Systems
6. ICD 10.....International Classification of Diseases, tenth edition
7. ICP.....Infection Control Policy
8. LMICS..... Low- and Middle-Income Countries
9. NOTES.....Natural Orifice Translumenal Endoscopic Surgery
10. OPD.....Outpatient Department
11. SAP..... Surgical Antimicrobial Prophylaxis
12. SDG..... Sustainable Development Goals
13. SSA..... Sub-Saharan Africa
14. SSI..... Surgical Site Infection
15. WA.....West Africa
16. WHO..... World Health Organization



## CHAPTER ONE

### 1.0 INTRODUCTION

#### 1.1 Background of the study

Background of the Study Surgical site infections (SSIs) represents one of the most prevalent and serious complications following surgical procedures worldwide, significantly undermining patient outcomes and straining healthcare systems, particularly in resource-limited settings (Bediako-Bowan et al., 2020; Hodonou et al., 2023; Mehtar et al., 2020).

**“SSI is as infections occurring at or near a surgical incision within 30 days of an operative procedure or within one year if an implant was used”** (Horan et al., 2008, Teresa C. Horan, 2016, Horan et al., n.d.).

They remain a leading cause of postoperative morbidity and mortality. (Leaper & Edmiston, 2017;) Although advancements in surgical techniques, sterilization, and antibiotic prophylaxis have substantially reduced the global burden of SSIs in high-income countries, their incidence remains disproportionately high in low- and middle-income countries (LMICs), where infrastructural limitations, gaps in infection control protocols, and human resource constraints persist (Allegranzi et al., 2016).

Globally, SSIs account for approximately 20% of all healthcare-associated infections (HCAIs), with prevalence estimates ranging from 1% to over 25% depending on the region and quality of data surveillance (Baker et al., 2016; Challita et al., 2024). In LMICs, studies consistently show higher rates of SSIs due to systemic barriers such as limited availability of sterile equipment, lack of continuous training in infection prevention and control (IPC), inconsistent adherence to surgical antibiotic prophylaxis protocols, and suboptimal surveillance systems

((Berhe et al., 2025, Chimhini et al., 2022, (Mehtar et al., 2020))). A multicenter meta-analysis conducted across 95 LMICs found that the pooled incidence rate of SSIs was approximately three times higher than in high-income countries, underscoring a need for context-specific interventions (Rickard et al., 2020)

In the Ghanaian healthcare system, SSIs represent a persistent but under-researched challenge, particularly in secondary and tertiary care facilities. A retrospective study conducted at the Tamale Teaching Hospital revealed a strong association between prolonged surgical duration, comorbidities such as diabetes mellitus, and poor postoperative wound hygiene with increased risk of SSIs (Gyilbagr et al., 2025). Furthermore, the lack of standardized IPC protocols and insufficient postoperative follow-up contribute to the underestimation and delayed management of these infections. While the Ghana Health Service has made considerable efforts to integrate infection prevention into national surgical safety strategies, implementation gaps remain, particularly at facility-level units that lack robust monitoring and reporting mechanisms (Alhassan et al., 2021).

Legon Hospital, situated within the University of Ghana's health services system in Accra, provides a unique setting for this study due to its evolving surgical capacity, mixed patient demographics, and relatively centralized urban location. The hospital serves both the university community and surrounding urban populations and has seen increasing surgical activity over the past decade. However, despite its growing surgical profile, there is limited published research assessing postoperative outcomes, particularly in relation to infection control. Anecdotal evidence and internal quality audits have pointed to an emerging trend of SSIs, especially in abdominal, orthopedic, and gynecological procedures. Given that SSIs can result in extended hospital stays, increased use of antibiotics, higher healthcare costs, and elevated patient mortality, addressing their incidence at Legon Hospital is both a clinical and policy imperative.

The rationale for conducting this study is grounded in the urgent need to generate empirical data that can inform the development of targeted, evidence-based interventions to reduce SSIs within this institution and similar health facilities across Ghana. As the hospital expands its surgical services, understanding the underlying factors contributing to SSIs is essential to improving patient safety, guiding resource allocation, and aligning hospital practices with the international best standards in surgical care. Additionally, findings from this study will contribute to the growing body of literature on hospital-acquired infections in West Africa, where data remain scarce and fragmented. By identifying modifiable patient-level, procedure-related, and institutional risk factors, this research will support clinical decision-making, enhance IPC training, and serve as a foundational step towards establishing an SSI surveillance framework at Legon Hospital.

## 1.2 Statement of the Problem

Surgical site infection remains a major cause of healthcare-associated infections across the world, with a global pooled incidence of 2.5%, with the WHO Africa region having the highest incidence of 2.7% (Mengistu, et al., 2023). A review of 412 records of surgical cases at the Legon Hospital covering the period January 2021 to October 2023 revealed 65 cases of surgical site infection giving a prevalence of 5.64% per annum which is much higher than that reported for the WHO Africa region by Mengistu and colleagues.

Pre-operative, intra-operative, post-operative, and post-discharge factors are all known to contribute to surgical wound infection. Pre-operatively, the surgical pathology itself can be infected. During the procedure itself, surgical wounds can get contaminated because of poor aseptic techniques during scrubbing and skin preparation, sub-optimal sterilization of instruments and surgical material like sutures, aerosol-borne pathogens from the surgical team and sweat from uncovered facial areas of surgeons and sometimes flying insects that land on

the wound. After discharge from the hospital wound contamination and subsequent infection are usually the result of poor care of wound dressing.

Surgical site infection prolongs both physical and psychological pain, hospital stay and its attendant risks of acquiring nosocomial infections, increases the financial burden and causes loss of productive work time. Prolonged hospital stay causes anxiety, loss of productive work hours, and excess costs in commuting between home and hospital by relatives. There is also a loss of income to the health institutions because of reduced surgical output. This study seeks to identify factors associated with surgical site infection of surgical wounds at the University of Ghana Hospital to facilitate the development of appropriate guidelines specific to the facility.

### 1.3 Research Questions

1. What is the prevalence of surgical site infections at Legon Hospital from 2021-2024?
2. What are the patient related factors associated with surgical site infections at the Legon Hospital?
3. What are the health facility factors associated with surgical site infection at the Legon Hospital from 2021-2024?

### 1.4 Objectives of the Study

#### 1.4.1 General Objective

To assess the prevalence of surgical site infections and determine the demographic, clinical, procedural, and institutional factors associated with their occurrence among surgical patients at Legon Hospital, Accra.

#### 1.4.2 Specific Objectives

1. To estimate the prevalence of surgical site infections at Legon Hospital from 2021-2024
2. To determine association between surgical site infection and patient-related factors.

3. To assess health facility factors associated with surgical site infection from October 2021-December 2023 at the Legon Hospital

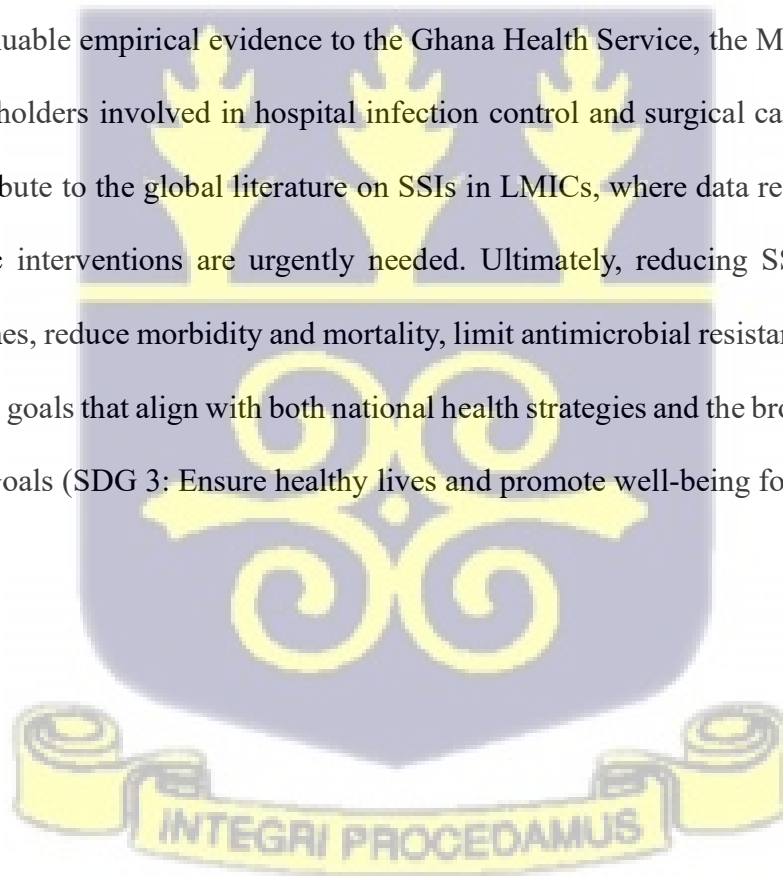
## 1.5 Significance of the Study

Surgical site infections (SSIs) continue to present a major public health challenge, particularly in low- and middle-income countries (LMICs), where healthcare systems often struggle with inadequate infection surveillance infrastructure, limited resources, and inconsistent adherence to evidence-based surgical protocols. Despite global guidelines and prevention frameworks, SSIs remain among the most prevalent healthcare-associated infections worldwide, accounting for up to 60% of postoperative infections in some LMIC settings (Allegranzi et al., 2016). In sub-Saharan Africa, the reported incidence of SSIs ranges between 10% and 26%, which is significantly higher than the 2% to 5% range observed in most high-income countries (Mukagendaneza et al., 2019). These infections not only jeopardize patient recovery and survival but also increase hospital readmissions, prolong hospital stays, and impose substantial financial burdens on both patients and healthcare systems.

In Ghana, data on SSIs is fragmented and often limited to isolated institutional audits or narrowly focused surveillance exercises. There is a lack of robust, locally generated evidence that captures the multifactorial causes of SSIs across patient demographics, surgical wound categories, institutional practices, and perioperative care quality. This gap limits the ability of hospital administrators, surgical teams, and policymakers to implement context-specific, data-driven interventions aimed at reducing SSI rates. Legon Hospital, a growing urban healthcare facility in Accra with a rapidly expanding surgical portfolio, serves a diverse patient population. However, no comprehensive study has yet examined the burden and determinants of SSIs within its context. Understanding the prevalence and predictors of SSIs in this setting is essential for informing infection prevention strategies, optimizing surgical outcomes, and improving overall patient safety.

The present study addresses a critical knowledge gap by systematically investigating both patient-related and procedure-related risk factors that contribute to SSIs at Legon Hospital. Specifically, it will explore associations between demographic characteristics, surgical wound classification, duration of hospitalization, type of admission, diagnostic concordance, and institutional practices. Such multidimensional analysis will not only enhance the understanding of SSI epidemiology in a Ghanaian urban hospital but also inform tailored policy interventions aligned with WHO's global guidelines for SSI prevention ( Berríos-Torres et al., 2017).

Additionally, findings from this study could support hospital-level quality improvement initiatives such as strengthening surgical safety checklists, improving preoperative screening protocols, and enhancing antimicrobial stewardship programs. Moreover, the study's results will provide valuable empirical evidence to the Ghana Health Service, the Ministry of Health, and other stakeholders involved in hospital infection control and surgical care delivery. They may also contribute to the global literature on SSIs in LMICs, where data remains sparse and context-specific interventions are urgently needed. Ultimately, reducing SSIs will improve surgical outcomes, reduce morbidity and mortality, limit antimicrobial resistance, and decrease healthcare costs goals that align with both national health strategies and the broader Sustainable Development Goals (SDG 3: Ensure healthy lives and promote well-being for all at all ages).



## 1.6 Conceptual framework

Figure 1: Conceptual framework of factors associated with surgical site infection

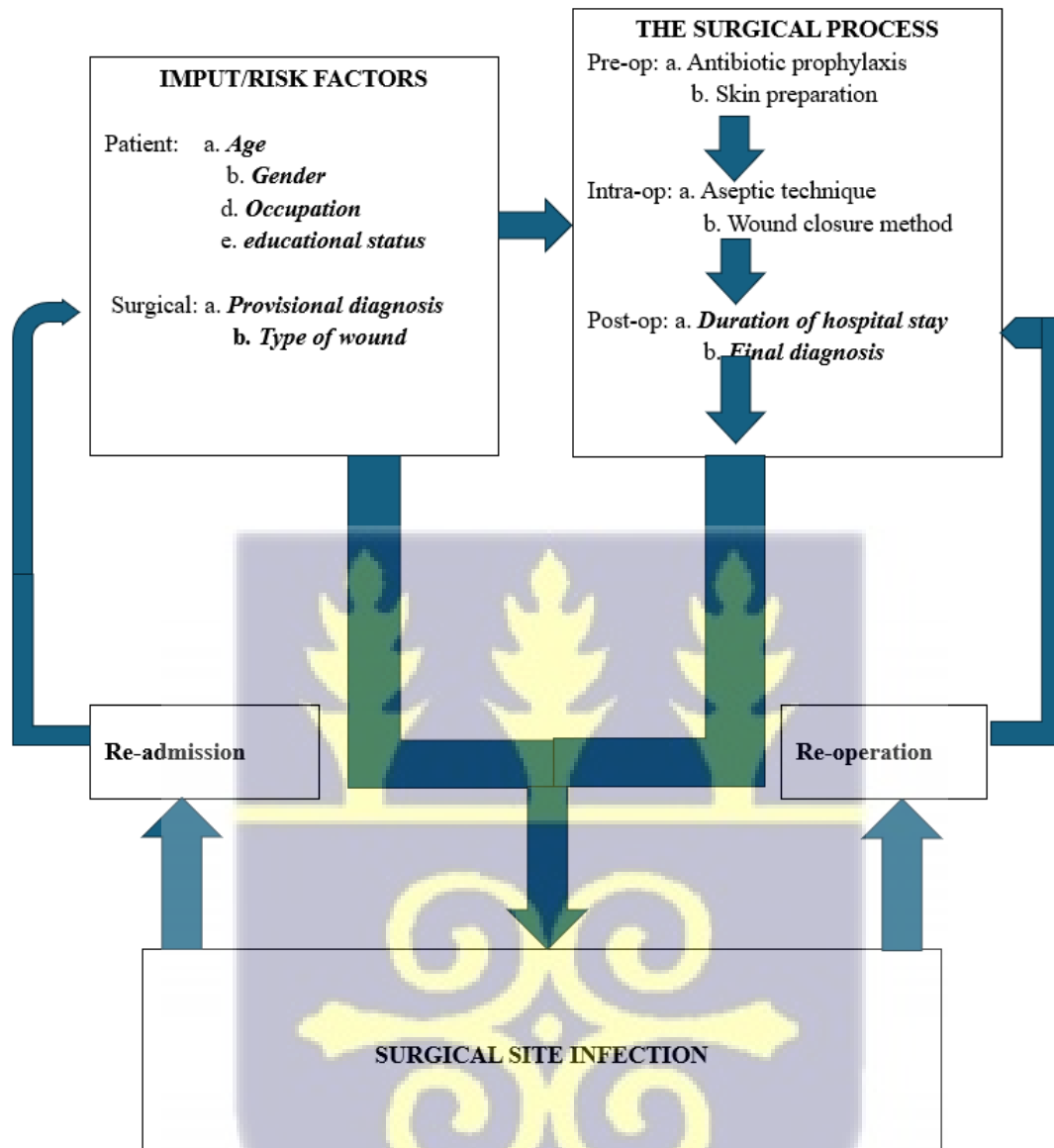


Figure 1.6: Conceptual framework.

### 1.6.1 Narrative to Conceptual Framework

Surgical site infections are one the negative outcomes that result from the confluence of risk factors for the same and the surgical process. Thus, health facilities take great measures to reduce them to the minimum. When patients acquire surgical pathology, factors intrinsic to the patient like their age, sex, gender, occupation, and educational status influence the probability

of developing surgical site infections. This study investigates these patient-related factors in Legon Hospital. This study also evaluates two surgical factors to ascertain their effect on the development of SSI. The first is the pre-op surgical diagnosis itself and its variance with the post-op diagnosis. The surgical pathology ab initio can mean the surgical wound is infected from the start. If that is not recognized from the onset, adequate measures may not be taken to prevent an SSI. Again, the surgical diagnosis itself influences the speed of wound healing and so some diagnoses have a higher risk than others to result in SSI. The second surgical factor investigated is the infection state of the skin and underlying tissues at the site of the surgical incision. The skin may be well prepared, but the diseased structure may be infected. The result is that the wound at the end of surgery is infected.

The surgical process is a linear three-phase set of events that are defined in relation to the actual surgical procedure. The first phase termed the pre-operative period is the set of actions and events used to prepare the patient for the procedure. Among other activities, the actions relevant to preventing SSI are the use of prophylactic antibiotics and the preparation of the skin site where the surgical incision would be placed. The second phase of the surgical process is the actual surgical event. The factors involved relate to the surgeon, the equipment used, the air quality and general state of cleanliness of the theatre and the method of wound closure. The third and final phase of the surgical process is also the period that the diagnosis of SSI can be made. The diagnosis is purely clinical. The requirement is the persistence of the wound beyond 30 days after the skin wound has been closed by any surgical wound closure method. In some instances, the pre-op diagnosis is revised because of disparate intra-operative findings. The concordance of pre- and post-op diagnosis is investigated in the study. A natural prelude to the diagnosis of SSI is prolonged wound healing that may delay discharge from the hospital, hence duration of hospital stay is also investigated in this study.

To resolve or treat an SSI, re-admission and even possible re-operations may be required. In the former case, the unresolved wound before the diagnosis of SSI simply prolongs the hospital stay. If the patient is discharged and presents after 28 days with a wound, re-admission is a real possibility depending on the severity. After a re-admission, a re-operation may be considered if the indication exists and happens to be the only way to resolve the SSI. That then is the reason for increased morbidity. Re-operations carry a higher risk of morbidity/mortality as the native anatomy would have been distorted by the initial operation and the partial healing process.



## CHAPTER TWO

### 2.0 LITERATURE REVIEW

#### 2.1 Global Overview of Surgical Site Infections

Surgical site infections (SSIs) remain a significant cause of postoperative morbidity and mortality worldwide. As defined by the Centers for Disease Control and Prevention (CDC),

**‘It is the presence of clinical signs of inflammation in or near a surgical site within 30 days after and inclusive of the day of surgery, or when a surgical prosthesis has been used, within one year after the surgical event’**(Teresa C. Horan, 2016).

They are among the most common healthcare-associated infections, accounting for up to 60% of hospital-acquired infections in low- and middle-income countries (LMICs). The World Health Organization (WHO) has emphasized the importance of implementing evidence-based guidelines to prevent SSIs, including the use of surgical safety checklists and appropriate antimicrobial prophylaxis. (Sefah et al., 2022;).

Despite these recommendations, adherence to preventive measures remains suboptimal in many LMICs. Factors such as limited resources, inadequate training, and lack of institutional protocols contribute to the high incidence of SSIs in these settings. Furthermore, the variability in SSI rates across different regions underscores the need for context-specific interventions.

Across sub-Saharan African (SSA) countries and third-world countries, SSI rates vary widely between countries and between the various levels of sophistication of hospitals. A prospective cross-sectional study in Lagos University Teaching Hospital spanning one year found that 17.4% of wounds were infected at or after 30 days (Bolaji Mofikoya et al, 2011). In a similar prospective study that recruited 386 patients in a tertiary care center in Western Nigeria, the overall incidence rate was found to be 13.0% (Amoran et al., 2014). A systematic review of

articles in West Africa shows that the pooled incidence rate of 14.8% (95% CI:15.5-16.2). This study found 95 articles, 11 met the inclusion criteria, 9 out of 45 countries with a huge contribution of 5 out of the 9 coming from Nigeria (Ngaroua et al., 2016).

## 2.2 Epidemiology of SSIs in Ghana

In Ghana, SSIs pose a significant challenge to surgical care delivery. Studies conducted in various teaching hospitals have reported SSI prevalence rates ranging from 11% to 40%, depending on the type of surgery and patient population. In Ghana, several studies report varying prevalence and incidence rates. A 2020 study involving 3267 patients in the largest referral hospital in Ghana, over 30 days yielded an incidence rate of 10% SSI rate (Bediako-Bowan et al., 2020). For instance, a study at Korle Bu Teaching Hospital found an SSI rate of 11% among surgical patients, with associated increases in hospital stay and healthcare costs. Another study that conducted a point-prevalence survey of ten hospitals using the protocols of the European Center for Disease Prevention and Control involving 2107 patients showed the most common hospital-acquired infection was SSI at 32.6% (Labi et al., 2019).

Similarly, research at Komfo Anokye Teaching Hospital reported an overall SSI prevalence of 40%, highlighting the burden of these infections in Ghanaian healthcare facilities. (Ameyaw, 2014; Bediako-Bowan et al., 2020)

The high incidence of SSIs in Ghana is attributed to multiple factors, including inadequate infection control practices, limited adherence to surgical protocols, and challenges in antimicrobial stewardship. These issues are compounded by systemic constraints such as resource limitations and infrastructural deficits.

## 2.3 Effect of Sex on SSI

Many studies suggest that male sex was a significant risk factor for SSI. A univariate of data from over 6000 patients from four Swiss hospitals showed male sex is a significant risk

factor( $p=0.01$ ) but when controlled for confounding factors like comorbidities and peri-operative factors in a multivariate analysis, there was no association between the male sex and SSI (OR=1.1[CI:0.8-1.4]) (Zwicky et al., 2022). However, a study in a teaching hospital in India concluded that the male sex had a higher risk of developing SSI. A cohort of 180 patients who had surgery in a general surgical ward over 3 months in 2007 was followed. The SSI rate among males was a statistically significant 29% versus the 10% rate in females (Kikkeri et al., 2014;). Using data from the German National Nosocomial Infection Surveillance System, excluding procedures that are limited to any one sex, infrequently performed procedures and adjusting for confounders like comorbidities, the overall incidence rate ratio and the adjusted odd ratio for males was significantly higher for males (Aghdassi et al., 2019). Another group of researchers using the same data set as Aghdassi et al found that the effect of sex varied with different types of procedures: women had lower aOR for SSI in abdominal surgeries (2.92 vs. 4.37), no gender-specific differences existed for vascular and orthopedic procedures and finally, women had a higher AOR than men for cardiac operations(5.50 vs 3.02) (Aghdassi et al., 2019; Langelotz et al., 2014). More locally, a study done in Tamale, Ghana using exclusively patients who had emergency abdominal surgery between June 2010 and June 2015 also affirmed the finding that male sex was more likely to develop a SSI. The Pearson coefficient after multiple regression yielded  $\beta=0.05$  (Tabiri et al., 2018).

## 2.4 Effect of Altemier classification of wound

Originally described in 1958, the Altemier class of surgical wounds seems to highly correlate with the incidence of SSI, with clean wounds having the lowest and dirty wounds having the highest SSI rates. This is borne out by many studies and robust data from the CDC (Ortega et al., 2012). Generally, clean wounds have a lower incidence of SSI as compared to the other three classes of wounds. The same pattern of rates of SSI is seen in all three planes of SSI as shown by a study using the American College of Surgeons National Surgical Quality

Improvement Program's (ACS-NSQIP) data set. Over 600,000 cases were analyzed and the findings for superficial SSI rate were 1.76%, 3.94%, 4.75% and 5.16% for clean, clean-contaminated, contaminated and dirty wounds respectively. For deep SSI the numbers were 0.54%, 0.86%, 1.31% and 2.1% respectively. Finally, for organ/space SSI the rates were 0.28%, 1.87%, 2.55% and 4.54% for the respective classes (Ortega et al., 2012; Yin et al., 2023). A recent study in Sierra Leone by Lakoh S et al using data from a tertiary and a secondary hospital finds that clean, clean-contaminated and contaminated wounds have 25.6%, 30.8% and 43.6% SSI rates respectively. The purpose of the classification of wounds is for the surgeon to be able to predict the bacterial load in the wound and subsequently institute pre-emptive aseptic measures and give appropriate antibiotic therapy. This was developed by the American National Academy of Science and the National Research Council in 1964. This research model was further refined by the CDC and the following acceptable rates of superficial SSI were proposed: 1%-5% for clean, 3%-11% for clean-contaminated, 10%-17% for contaminated and above 27% for dirty wounds (Herman et al., 2025). In most hospitals and electronic data collection systems in West Africa, adherence to data collection by the American protocols is lacking. In the absence of a data collection tool that rigorously classifies wounds based on ACS-NSQIP standards, some workers are advocating for new classification systems. They also argue that at the time the Altemier classification system was developed, laparoscopic surgery was not universally available. A new system that considers the unique nature of the laparoscopic incision and other modern approaches like Natural Orifice Transluminal Endoscopic Surgery (NOTES) (Eisenberg, 2012) has been advocated for. There is a paucity of data that is based on the traditional wound classification system used by CDC in Ghana and W.A. Because all wound classes do have an infection rate, i.e. none has a zero SSI rate, there have been attempts at simplifying the classification into low, medium and high risk. This study adopts one of the novel systems and classifies wounds as either 'clean' or 'not clean'.

## 2.5 Duration of hospital stay and SSI

This study will examine the relationship between the sum (or total) duration of hospital stay and the incidence of SSI. The total duration of stay is the sum of both pre-op and post-op hospital stays. Various works have had varied conclusions of the effect of both periods as well as the sum of both. Using multivariate analysis, a hospital-based cross-sectional study, in Dilla University Referral Hospital found statistically significant adjusted odds ratios for total hospital days were significantly associated with increased odds of developing an SSI. Total stays of 7-14 days had aOR=5.51[CI:1.52-19.91]. The odds were even higher for stays > 14 days with AOR=8.18[CI:1.84-36.75] (Birhanu et al., 2022). Another retrospective cross-sectional study in Tamale, Ghana using linear regression analysis found a strong positive correlation between total hospital stay and prevalence of SSI ( $p < 0.001$ ) (Apanga et al., 2014; Bediako-Bowan et al., 2020) A cross-sectional study in the Orthopedic Department of King Khalid University Hospital, Saudi Arabia came to the same conclusion that total hospital stay was a statistically significant independent factor in the genesis of SSI (Awwad et al., 2021). In contrast to the above studies, an observational cohort study in two tertiary referral centers in Switzerland found that the duration of pre-op hospital stay had no significant effect on SSI, but the length of post-op stay was significantly related to the development of an SSI (Mujagic et al., 2018). A Brazilian study in 2017 arrived at the opposite conclusion. This study used data from 16882 patients between 2008 and 2011 in a non-concurrent cohort study. It found that a pre-op stay of more than 24 hours was significantly associated with SSI among other factors

## 2.6 SSI and Day Surgery

There seems to be less incidence of SSI in day surgery than in-hospital surgery. A retrospective study in India examining this effect was conducted using data generated by a single surgeon over a 10y period. Patients were grouped into two, day surgery and in-hospital surgery. The overall SSI rate was 1.6% and there was a significant inter-group difference favoring day

surgery ( $p=0.045$ ) (Chin et al., 2017). Day surgery has been increasingly demanded by clients largely because of cost and the development of excellent anesthetic agents and new surgical techniques like laparoscopic techniques.

The classical example is laparoscopic cholecystectomy, the first major surgery that has changed from being an in-hospital procedure to an ambulatory procedure. In a retrospective cohort study of 66,566 commercially insured cases of cholecystectomies in the USA, the rate of SSI in day-case laparoscopic cholecystectomies was found to be 0.64% as compared to the open procedure that resulted in 4.93% SSI rate. Warren et al. (2017) also concluded in their study that the laparoscopic approach led to less risk of cholecystitis/obstruction than the open approach [HR 1.58[95% CI:1.27-7.52] for laparoscopic procedure versus HR=4.29[95% CI:2.45-7.52] for the open procedure (Warren et al., 2017). Other workers did not find any advantageous relationship between same-day surgery and the risk of infection. In a cohort study of 177,818 patients between 2005 and 2014, there was no difference between the total frequency of adverse events, but when these events occurred, the same-day surgery patients who had knee arthroplasty had a higher infection rate than the inpatient counterparts (Basques B et al., 2017). This same-day surgery effect on SSI is also observed with general surgical procedures that only require alternative anesthetic techniques. Another such study comparing the SSI rate outcomes for the clean procedure of thyroidectomy did not find any difference between day cases and in-patient cases. One hundred and twelve consecutive cases of thyroidectomy were followed, and the SSI rate was 2.6%. This rate was not statistically different from the rate for the same procedure in the same population (Dionigi et al., 2008). A much more controlled study that looked at outcomes of ambulatory versus in-hospital surgeries for a single procedure, single-surgeon also suggests no advantage on one over the other type of patient. Such a study on same-day arthroplasty by a single surgeon on a cohort of 243 consecutive day-surgery patients was matched with the same number for gender, age, ASA score and BMI. It was found that there

was no statistically significant difference in wound infections at 90 days post-op (Darrith et al., 2019). Some other studies suggest that day surgeries in some special circumstances result in an increased risk of SSI. Using data from patient surveys and hospital's electronic medical records, Hoffman M et al concluded that day-case multi-level spine surgery increases the risk of SSI as compared to inpatient cases (Hoffman et al., 2023).

## 2.7 SSI and educational status

A cross-sectional study in Pakistan showed that generally the higher the educational status, the less likely a patient would develop an SSI (Faiz Ullah KhanYu Fang, 2020). Another hospital-based cross-sectional using data from 249 patients over six months in Ethiopia found a positive correlation between higher educational status and lower risk of developing SSI (Mezemir et al., 2020). Again, another study in South Ethiopia used systematic random sampling of all patients who had surgery in a teaching hospital in 2018 and generated complete data for 261 patients. The study found that being illiterate had a statistically significant chance of developing an SSI (AOR=4.25; [95% CI:1.52-14.08]) (Ngaroua et al., 2016). In a specialist hospital in Cotonou, Benin an analytical cross-sectional study, it was determined that higher educational status was associated with less chances of SSI ( $p=0.003$ ) using Pearson Chi-square tests (Dégbey et al., 2023).

## 2.8 SSI and Occupation

There is a variation of occupations to be explored. In this study in the hospital that attends to the university population, the population is divided into students, staff and others. The effect of being a student versus other occupations was also associated with less likelihood of developing SSI in the Pakistani study. The study design was a prospective observational cross-sectional in a large public sector hospital, a total of 412 patients were recruited (Faiz Ullah KhanYu Fang, 2020).

## 2.9 Patient-Related Risk Factors

Several patient-related factors have been identified as contributing to the risk of SSIs. Comorbidities such as diabetes mellitus, obesity, anemia, and immunosuppressive conditions like HIV have been associated with increased susceptibility to postoperative infections. For example, a systematic review of orthopedic surgeries in Africa found that patients with diabetes or HIV had higher rates of SSIs, emphasizing the need for preoperative assessment and optimization of these conditions (Ikegwuonu et al., 2024).

Additionally, demographic factors such as advanced age and low socioeconomic status may influence SSI risk, potentially due to delayed healthcare-seeking behavior and limited access to quality surgical care.

## 2.10 Procedure-Related Risk Factors

Procedure-related factors play a crucial role in the development of SSIs. The classification of surgical wounds (clean, clean-contaminated, contaminated, or dirty) significantly impacts infection risk, with contaminated and dirty wounds exhibiting higher SSI rates. The duration of surgery is another critical factor; prolonged operative times have been linked to increased infection rates due to extended exposure and the potential for microbial contamination. In Ghana, a study focusing on abdominal surgeries highlighted the impact of operating room practices on SSI incidence. Specifically, frequent door openings during procedures were associated with a higher risk of infection, underscoring the importance of maintaining a controlled surgical environment. (Bediako-Bowan et al., 2020)

## 2.11 Institutional Practices and Infection Control

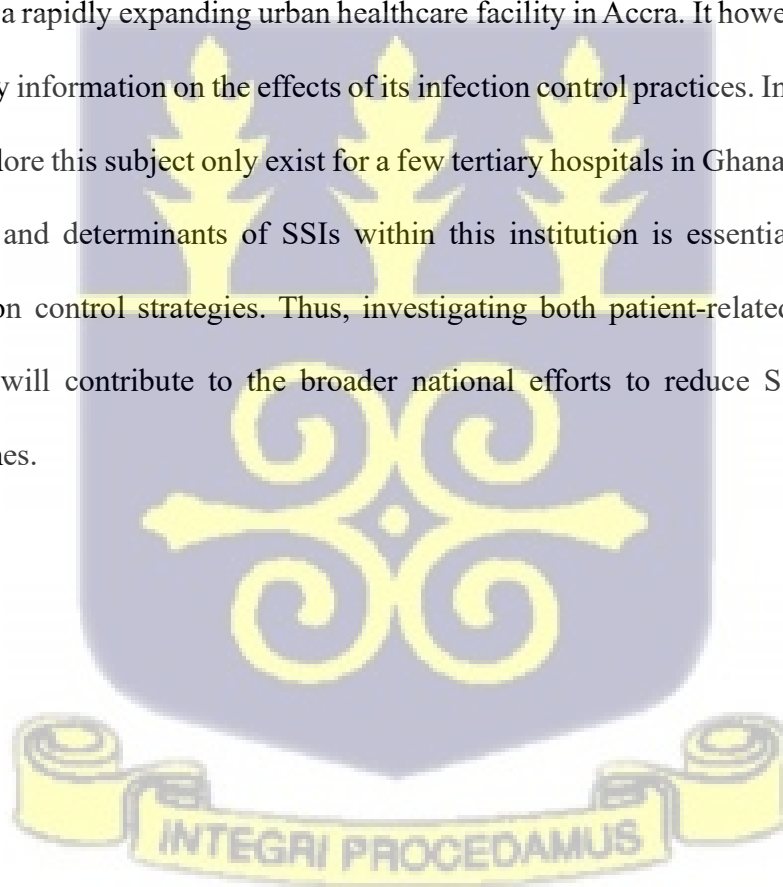
Institutional practices, including adherence to infection prevention protocols and antimicrobial stewardship, are vital in reducing SSI risks. However, studies in Ghana have revealed suboptimal compliance with surgical antimicrobial prophylaxis (SAP) guidelines. For example,

an audit at Ho Teaching Hospital reported only 2.5% overall compliance with national SAP guidelines, primarily due to inappropriate antibiotic selection and extended prophylaxis duration. (Sefah et al., 2022)

The implementation of the WHO Surgical Safety Checklist has been advocated as an effective measure to enhance surgical safety and reduce SSIs. While some Ghanaian hospitals have adopted this tool, challenges persist inconsistent application and staff engagement. Addressing these issues requires targeted interventions, including staff training, regular audits, and the development of context-specific protocols.

## 2.12 Gaps in the Literature and Relevance to Legon Hospital

Legon Hospital a rapidly expanding urban healthcare facility in Accra. It however has a specific lack of summary information on the effects of its infection control practices. In addition, similar studies that explore this subject only exist for a few tertiary hospitals in Ghana. Understanding the prevalence and determinants of SSIs within this institution is essential for developing tailored infection control strategies. Thus, investigating both patient-related and procedure-related factors will contribute to the broader national efforts to reduce SSIs and improve surgical outcomes.



## CHAPTER THREE

### 3.0 METHODS

#### 3.1 Study design

A descriptive cross-sectional study was conducted at the Legon Hospital to determine the prevalence of surgical wound infection at the facility using data extracted from the hospital's Health Management Information System. Data including patient biodata and treatment outcome covering the period from January 2021 to December 2024 were extracted from the Hospital's Health Management Information System to assess the effectiveness of surgical processes in the management of surgical wounds.

#### 3.2 Study area

The study was conducted at Legon Hospital, a rapidly developing secondary-level healthcare facility situated within the Greater Accra Region of Ghana. The hospital is also open to all the suburban population that surrounds the University of Ghana. It is a referral hospital situated at the apex of a major highway to the Eastern Region of Ghana and receives referrals from a wide area apart from the population of the Greater Accra Region.

The hospital provides a range of medical and surgical services and serves a diverse patient population (predominantly students, staff faculty and dependents of the University), including both elective and emergency surgical cases. Its surgical unit comprises general surgery, obstetric and gynecological surgery, orthopedic procedures, and minor outpatient interventions.

Legon Hospital has implemented several infection control measures; however, there remains limited empirical data regarding the burden and determinants of SSIs within the facility.

### 3.3 Study population

The target population will consist of post-operative patients who undergo surgical procedures at Legon Hospital during the study period. The study will include both inpatients and day-surgery patients, across various surgical departments. Inclusion will be restricted to patients aged 18 years and older who have undergone clean, clean-contaminated, contaminated, or dirty surgical procedures and are available for post-operative follow-up within 30 days of surgery, as per the Centers for Disease Control and Prevention (CDC) guidelines for SSI surveillance (CDC, 2017).

### 3.4 Inclusion and Exclusion Criteria

#### Inclusion criteria:

- i. Patients who have undergone a surgical procedure at the University of Ghana Hospital.
- ii. Patients were available for post-operative review.
- iii. Patients with complete data

#### Exclusion criteria:

- i. Patients with a diagnosis that was incongruent or inconsistent with any known surgical procedure.
- ii. Patients discharged against medical advice.

### 3.5 Sample Size Determination

The sample size was estimated using the Cochran formula for proportions, considering a 95% confidence level, a 5% margin of error, and a presumed SSI prevalence rate of 15% based on existing literature from Rwanda with similar settings (Birhanu et al., 2022; Niyomugabo et al., 2024). The formula is given as:

$$n = \frac{Z^2 \cdot p(1 - p)}{e^2}$$

Where:

- $n$  = required sample size
- $Z$  = Z-value (1.96 for 95% confidence level)
- $p$  = estimated prevalence (0.15)
- $e$  = margin of error (0.05)

A similar cross-sectional study by Birhanu et al yielded a prevalence of 19.3% ( $p=0.193$ ). Using this as a guide,  $p=0.193$ . A 95% confidence interval gives a Z-score of 1.96. The desired margin of error is 5%, thus  $e=0.05$ . By substitution in the above formula, the minimum number of subjects required is 239. The actual sample size acquired from the records and used in this study is 390.

### 3.6 Data Collection Methods

Data were extracted from the electronic medical records as an EXCEL spreadsheet. Data extracted included age, sex, educational status, occupation, wound classification, pre-and-post-operative diagnosis concordance, length of hospital stay, type of surgical service day surgery vs. inpatient. These data were then converted to .dta files for analysis in STATA.

### 3.7 Study Variables

**Dependent Variable:**

Occurrence of Surgical Site Infection (yes/no) defined using CDC criteria.

**Independent Variables:**

Patient-related factors: age, sex, educational level, occupation.

Procedure-related factors: type of surgical wound (clean, clean-contaminated, contaminated, dirty), duration of surgery, day surgery vs. inpatient surgery, pre-and post-operative diagnosis concordance.

Institutional factors: length of hospital stay.

### 3.8 Data Analysis

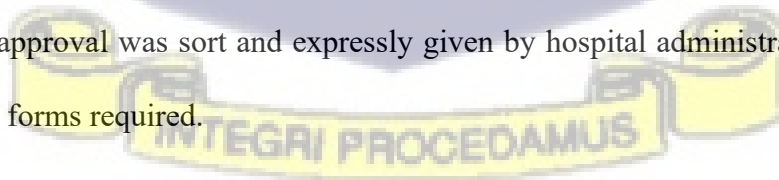
Data were analyzed using STATA version 16. Descriptive statistics such as means, frequencies, and proportions was used to summarize demographic and clinical characteristics. Bivariate analysis using Chi-square tests and independent t-tests were used to determine associations between categorical independent variables and the occurrence of SSIs. Variables showing significance at the bivariate level ( $p < 0.05$ ) were entered into a multivariate logistic regression model to determine adjusted odds ratios and identify independent predictors of SSIs. Confidence intervals was set at 95%.

### 3.9 Ethical Considerations

Ethical clearance was obtained from the University of Ghana Hospital Ethics Review Board. Written permission was obtained from the administration of Legon Hospital. Data confidentiality was maintained through de-identification and password-protected digital storage.

### 3.10 Consent

Administrative approval was sort and expressly given by hospital administration after filling out the standard forms required.



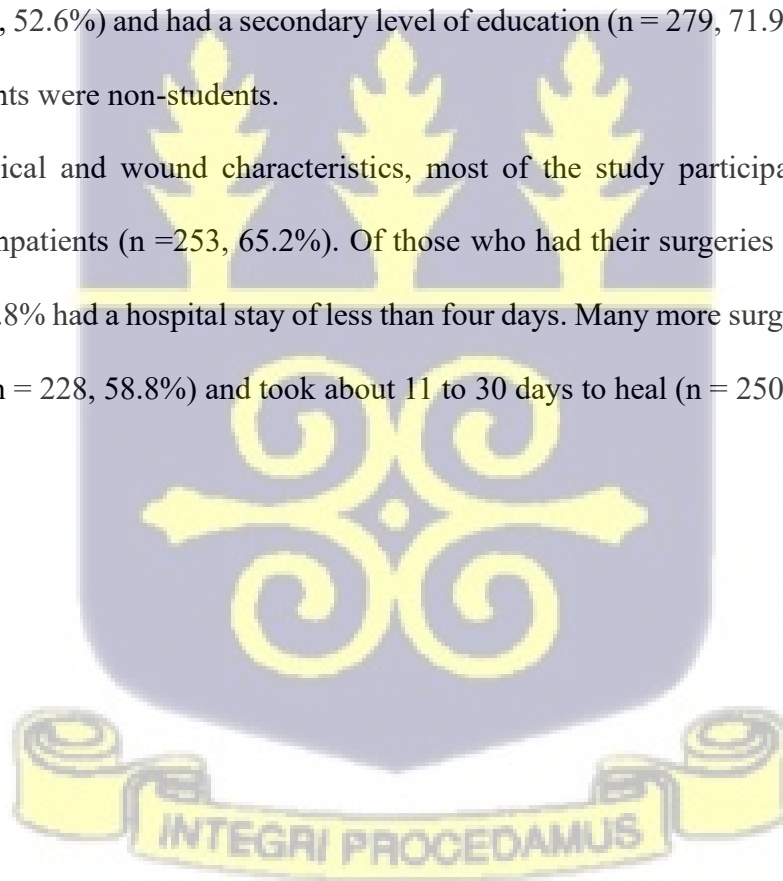
## CHAPTER FOUR

### 4.0 RESULTS

#### 4.1 Background and clinical characteristics of study participants

A total of 388 patients were eligible for the study. As indicated in Table 1, the ages of the participants ranged from 1 – 81 years, with the median being 26 years. Most participants were female (n = 204, 52.6%) and had a secondary level of education (n = 279, 71.9%). About 53.6% of the participants were non-students.

Regarding surgical and wound characteristics, most of the study participants had surgical procedures as inpatients (n =253, 65.2%). Of those who had their surgeries as inpatients 198 representing 85.8% had a hospital stay of less than four days. Many more surgical wounds were contaminated (n = 228, 58.8%) and took about 11 to 30 days to heal (n = 250, 64.4%).

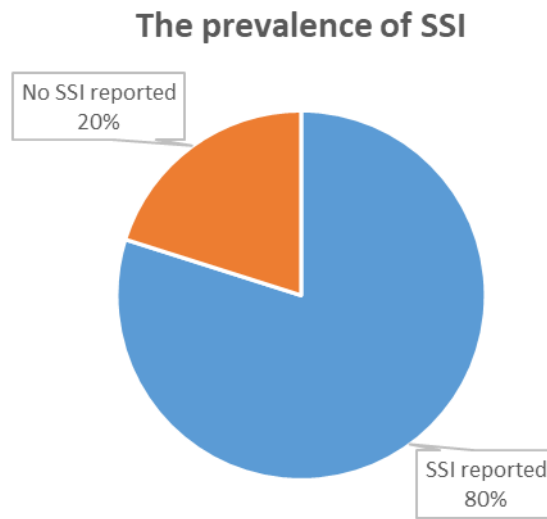


**Table 1: Background and clinical characteristics of study participants**

Characteristics	Frequency	Percentage (%)
<b>Age</b>	<i>Median = 26 years, Range =1 – 81y</i>	
1-9 years	18	4.6
10 – 19 years	28	7.2
20 – 30 years	226	58.3
40-59 years	87	22.4
60 years and above	29	7.5
<b>Sex</b>		
Males	184	47.4
Females	204	52.6
<b>Educational level</b>		
No formal education	22	5.7
Primary	56	14.4
Secondary	279	71.9
Tertiary	31	8.0
<b>Type of admission</b>		
Day surgery	135	34.8
Inpatient surgery	253	65.2
<b>Surgical wound classification</b>		
Clean	160	41.2
Contaminated	228	58.8
<b>Length of Hospital stay* (n = 253)</b>	<i>Median = 2 days, Range =1 – 57 d</i>	
1-3 days	198	85.8
4 days or more	55	14.2
<b>Duration of wound</b>		
7-10 days	66	17.0
11-30 days	250	64.4
More than 30 days	72	18.6

## 4.2 Prevalence of Surgical Site Infections

Of the 388 study participants, 78 had a surgical site infection (20.1% [95% CI 16.4%- 24.4%]).



**Figure 4.2: Prevalence of SSI**

## 4.3 Distribution of SSIs among study covariates

The prevalence of SSI increased significantly with age ( $p = 0.02$ ), with the highest prevalence in individuals aged 60 years and above (37.9%). SSI also differed significantly among the duration of wound healing categories ( $p < .001$ ), with the highest prevalence in those whose wound took more than 30 days to heal (97.2%).

Higher prevalence of SSI was found among patients who had inpatient surgical procedures (21.3%), clean surgical procedures (28.1%), stayed on admission for 4 days or more (29.1%) and were females (20.6%). However, these were not statistically significant.

**Table 2: Prevalence of SSI among participants' background and clinical characteristics**

Characteristics	SSI n (%)	No SSI n (%)	Test of association
<b>Age</b>			
1-10 years	0 (0)	18 (100)	$p = 0.003$
10 – 19 years	5 (17.9)	23 (82.1)	
20 – 30 years	42 (18.6)	184 (81.4)	
40-59 years	20 (23.0)	64 (77.0)	
60 years and above	11 (37.9)	18 (62.1)	
<b>Sex</b>			
Males	36 (19.6)	78 (80.4)	$\chi^2 (1) = 0.63, p = 0.08$
Females	42 (20.6)	310 (79.4)	
<b>Educational level</b>			
No formal education	5 (22.7)	17 (77.3)	$\chi^2 (3) = 4.34, p = 0.28$
Primary	16 (28.6)	40 (77.4)	
Secondary	49 (17.6)	230 (82.4)	
Tertiary	8 (25.8)	23 (74.2)	
<b>Type of admission</b>			
Day surgery	24 (17.8)	111 (82.2)	$\chi^2 (1) = 0.70, p = 0.40$
Inpatient surgery	54 (21.3)	199 (78.7)	
<b>Surgical wound classification</b>			
Clean	45 (28.1)	115 (71.9)	$\chi^2 (1) = 10.91, p = 0.001$
Contaminated	33 (14.5)	195 (85.5)	
<b>Length of Hospital stay* (n = 253)</b>			
1-3 days	38 (19.2)	160 (80.8)	$\chi^2 (1) = 2.51, p = 0.113$
4 days or more	16 (29.1)	39 (70.9)	
<b>Duration of wound</b>			
7-10 days	0 (0)	66 (100)	$p < .001$
11-30 days	8 (3.2)	242 (96.8)	
More than 30 days	70 (97.2)	2 (2.8)	

#### 4.4 Bivariate analysis

As indicated earlier, Pearson's chi-square tests or Fisher's exact tests were performed to examine the association between surgical site infections and potential explanatory variables. Age, wound classification, and wound duration show statistically significant associations with SSI ( $p < 0.05$ ) and were therefore retained in the multivariable analysis. Other variables, including sex, length of hospital stay, education level, and type of admission (inpatient vs day surgery) were not significantly associated with SSI ( $p > 0.05$ ) and were excluded from the multivariable model.

#### 4.5 Multivariate analysis

Binary logistic regression was conducted to assess the effect of age on the likelihood of developing SSI, while adjusting for wound classification and duration. The initial model (Model I) examines the unadjusted association between age and SSI. Individuals aged 1-9 years were excluded from this analysis as no SSI was reported among them. Compared to participants aged 10-19 years, the odds of SSI were not significantly different in those aged 20-39 years (OR = 1.05, 95% CI [0.38, 2.92],  $p = 0.09$ ), 40 – 59 years (OR = 1.37, 95% CI [0.46, 4.08],  $p = 0.57$ ) and 60 or above (OR = 2.81, 95% CI [0.83, 9.56],  $p = 0.10$ ). However, Model I was not statistically significant from a null model ( $\chi^2[3] = 5.52$ ,  $p = 0.14$ ). When adjusted for wound duration and wound classification, the new model (Model II) was statistically different from a null model ( $\chi^2[5] = 271.9$ ,  $p < 0.01$ ).

In Model II, participants aged 40-59 years had 27.3 times higher odds of SSI (aOR = 27.32, 95% CI [1.17, 6.761],  $p = 0.04$ ) compared to those aged 10-19 years, regardless of their wound classification or duration for healing. Participants aged 60 years and above had 83.5 times higher odds of SSI compared to their counterparts aged 10-19 years, and this was statistically

significant (AOR = 83.46, 95% CI [3.01, 2317.90],  $p = 0.01$ ). As can be seen, the AIC of model II is much smaller than model I, indicating a better fit.

**Table 4.5 Summary of Multivariate analysis**

**Table 3: Summary of multivariate analysis**

Variables	Model I	Model II
<b>Age</b>		
10-19 years	Ref	Ref
1-9 years	(empty)	(empty)
20 – 39 years	1.05 [0.38 – 2.92]	11.56 [0.64 – 208.80]
40 – 59 years	1.37 [1.46 – 4.06]	27.32 [1.67 – 639.76] *
60 years or above	2.81 [0.83 – 9.56]	83.46 [3.01 – 2317.90] *
<b>Wound classification</b>		
Contaminated		Ref
Clean		3.66 [0.95 – 14.07]
<b>Wound duration</b>		
11-30 days		Ref
7-10 days		Empty
More than 30 days		2160.98 [244.27 - 19117.85] **
<b>Model statistics</b>		
	I	II
$\chi^2$	4.58	271.0**
df	1	3
Log-likelihood	-187.80	-38.93
AIC	383.60	89.87
Goodness of fit test	$\chi^2(1) = 0.96$	$\chi^2(10) = 6.57$

(\*  $p < 0.05$ , \*\* $p < 0.01$ ).

## CHAPTER FIVE

### 5.0 DISCUSSION

#### 5.1 Introduction

The burden of SSI in LMIC remains poorly defined as compared to high-income countries(Rickard et al., 2020). What is more? The range of diseases called SSI is wide starting from the skin incision to deep organs or body spaces. Hence any study must have deliberately stated criteria to accurately identify the outcomes that constitute SSI. The HIS of Legon Hospital has an in-built data extraction tool that addresses this need. Factors are categorized into patient related factors and surgical process related factors. Surgical site infections are the most common health care associated (HCAI) and contribute to significant morbidity and mortality(Allegranzi et al., 2016). The hospital is a major referral center for surgical pathology for the urban population of Legon and surrounding areas as well as the south-eastern part of the Eastern Region.

#### 5.2 Main findings

Three hundred and eighty-eight client folders between Jan 2021 and October 2023 satisfied all criteria for inclusion. Seventy-eight subjects developed SSI over the study period (47months) representing 20.1% of subjects. This translates to 5.13 SSI per 100 procedures per year. Mehtar et al quote a range of 8%-30% for LMICS. Hence the findings of this study are slightly lower than most LMICS. Compared to high-income countries, this figure quite high. Baker et al in their prospective study of 29 community hospitals in Southeastern United States, they calculated a figure of 0.7 SSIs per 100 procedures per year(Baker et al., 2016).

Most clients were under 30 years, had had secondary education and were not students. Most patients had their procedures as in-patients and most wounds at the end of the procedure were classified as contaminated. In addition, most in-hospital stay was between one and three days. The prevalence of SSIs was highest in persons over 60yrs, more in females than males, commoner in persons with primary education than the other classes of education and higher in in-patient than day surgery cases. A retrospective cross-sectional study by Challita et al adduced similar results. They also found more females (58%) than men had SSIs. The median age of persons with SSIs in their study was 54yrs, lower than in this study and relatively higher proportion of clean surgeries (81%) developed SSIs than contaminated surgical wounds(Challita et al., 2024).

The bivariate analysis (Pearson's Chi-square or Fisher's exact test as needed) showed that age, surgical wound class and duration of wound had a statistically significant relation with the development of SSI. Age is a rather difficult factor to investigate in randomized control trials as children and elderly are often excluded. However, prospective cohort studies by Gould et al find that advancing age is associated with slower wound healing and hence higher incidence of SSI. These are supported by animal studies although it is quite difficult to replicate human wound healing in commonly used animals(Gould et al., 2015). A clinical experimental study by Engellant et al in which a 3.5mm wound is created on the oral hard palate of 212 subjects demonstrated unequivocally that younger adults heal faster than older adults, independent of sex, BMI, ethnicity and use of alcohol/cigarette,  $p < 0.001$ (Engellant et al., 2006). Altemier wound class is almost universally associated with SSI as demonstrated in this study, however the proportion of clean wounds that developed SSI is relatively high and points at an anomaly. Most likely the result of breaks in infection control protocols during wound dressing or use of antibiotics peri-operatively.

Client's gender, level of education, length of hospital stay, type of admission (day vs in-hospital) had no statistical significance in the outcome (i.e. the development of SSI). The effect of gender seems to be related to whether the wound is mucosal or dermal. Even though this study did not find any statistically significant association between gender and wound healing the powerful study by Engeland et al proved that mucosal wound healing is faster in females than males,  $p=0.008$  (Engeland et al., 2006). Data on level of education and wound healing has been difficult to come by. This study did not find a statistically significant relationship between length of hospital stay and SSI, but other more powerful studies find a positive correlation between the length of post-op stay and SSI. An observational cohort study by Mujagic et al with a similar SSI rate of 5.1% as this study found that there was a statistically significant relation between post-op length of stay and SSI (Mujagic E 1, 2018).

## 5.3 Interpretation of main findings

### 5.3.1 Demographics of the study sample

Students made up 53.6% of the sample studied and most patients were under 30 years. The cumulative frequency for persons under 30 years was 70.1% and persons 20-30 years alone made up 58.3% of this fraction. The data on age is not normally distributed with a tail to the right. The median age was 26 yrs. with a range of 1-81 years. Again, persons with secondary education certificate were the commonest as the students were still in university and so had not yet attained a degree. All these findings reflect the fact that most subjects are university students.

### 5.3.2 Admission status of study sample

Duration of hospital stay was not a statistically significant factor in this study as the reasons for admission are not directly related to the surgical process of surgical disease. Admission and hospital stay reflect the accommodation policy of the facility to cater to students as they have no access to home-caregivers when they undergo even the simplest surgical procedures. Hence most patients were In-patients (62.5%) and most of these clients were admitted for 1-3 days (85.8%). Any type of anesthesia other than local anesthesia is used as reason to admit, at least over-night. This is in line with optimum care expected of the facility. Another common reason for admission is pain which is maximal in the first 48-72 hours after surgery. This period is when inflammation is the major pathophysiologic process taking place at the surgical site. Studies that admit based on surgical pathology or the surgical process seem to suggest day surgery was associated with decreased odds of SSI (Apanga et al., 2014; Awwad et al., 2021; Birhanu et al., 2022).

### 5.3.3 Age and SSI

Binary logistic regression of age on SSI showed a statistically significant relationship. Thus, for a unit increase in age after age 10 years, there was an increased odds of 1.02 of a subject developing a SSI [LR  $\chi^2(1) = 8.88, p=0.003$ ]. SSI was non-existent in persons aged 1-10 yrs. in the sample studied. This increased sharply to 17.9% in persons 10-19yrs. and thereafter flattened out till age 59 years when there is another sharp rise in prevalence at 60 and above. The relative scarcity of SSI in children is attributed to several factors. First, children tend to have less complicated and prolonged procedures than adults as found in a study by (Khalid et al. (2022). Other workers also attribute the rapid healing process in children to a most prime immune system and faster collagen deposition process. The singular most important effect of wound healing is the closure of skin over the underlying tissues. When all potential age-related

confounders of healing is controlled for, the wounds of older persons heal slower than children, i.e. age has an intrinsic effect in slowing wound healing (Engeland et al., 2006). A third factor that may be responsible for relative paucity of SSI in children is the absence of debilitating comorbidities like the various metabolic diseases that affect immune function, blood supply and venous drainage of surgical wounds (Gould et al., 2015)). A fourth reason why children may have less SSI is their lower exposure to environmental agents that are known to slow wound healing like smoke (PM2.5) and alcohol. This is because by the fact of their age, they have not been exposed long enough or such social habits are virtually absent in children. Fifth, children do have a different skin microbiome from adults that confers a relative advantage in wound healing as compared to adults. The converse of these five factors is thought to be the reasons for the higher prevalence of SSI in persons over 60 yrs.

Most workers identify increasing age as a risk factor for development of SSI in high- and low-income countries to varying levels of significance. A prospective study by Kaye et al on 144,485 consecutive surgeries between February 1991 and July 2002 yielded an SSI rate of 1.2%. Further this study found that risk of SSI increased by 1.1% per year between ages 17yr and 65yr ( $p=0.002$ ) (Kaye et al., n.d.). Further, they found SSI rates decrease by 1.2% per year in persons  $>65$ yr ( $p=0.008$ )

#### 5.3.4 Wound class and SSI

This study found that wound class has a statistically significant relationship with the development of SSI ( $\chi^2(1)=10.91$ ,  $p=0.001$ ). This finding is a natural consequence of the fact that contaminated wounds have multiplying bacteria in the surgical site at the end of surgery.

The bacteria must be eliminated by the inflammatory cells and antibiotics before the wound healing process can start. Thus, the inflammatory phase of the wound is prolonged. If antibiotic-resistant bacteria infect the wound, the wound remains in the inflammatory phase

longer as the prescribed antibiotics are less efficient at ridding the site of bacteria. This is in contrast with clean wound in which the inflammatory cells must only clear dead native cells which have no ability to cause further cell death as bacteria are capable of. All things being equal, inflammation and healing follow the natural time course of events for the person's age. Most single site studies (de Carvalho et al., 2017) and systemic reviews of studies of SSI vs. wound contamination affirm this finding. (Yin et al., 2023, Ortega et al., 2012)

### 5.3.5 Duration of wound and SSI

The duration of the surgical wound is essentially the length of the post-operative period. This period has a physiologically determined normal. This normal is anything from 3-10 ( $\pm 3$ ) days. This study finds surgical wounds lasting less than 30 days but greater than 10 days are a statistically significant predictor of SSI using binary logistic regression. For every additional day on admission between 11 to 30 days, the odds of developing a SSI increased by 1.12 times [LR chi 2(1) = 12.2,  $p < 0.001$ ]. This suggests that wound duration itself, apart from being the defining factor, has a predictive relationship with the development of SSI. In both LMICs and high-income countries most studies bear out this fact. The single site study at Dilla University Referral Hospital finds among other factors that hospital stay of 7-14 days increased the odds of SSI by 5.51(95% CI=1.52-19.91). This value increases to 8.18(95% CI=1.84-36.75) if the duration is >14days(Birhanu et al., 2022). A study of only orthopedic surgical procedures at King Khalid University also concluded that length of hospital stay was a statistically significant factor in development of SSI ( $p < 0.05$ )(Awwad et al., 2021).

### 5.3.6 Sex and SSI

There is no significant statistical relationship between the development of a SSI and the gender of subjects. The outcomes of studies that look at sex and SSI is mixed. In some studies, there is a male preponderance (Aghdassi et al., 2019, Zwicky et al., 2022, Naveen Kikkeri Hanumantha Setty, 2014, Alp et al., 2014). In other studies, the risk was dependent on the type of surgery, being higher in female who underwent cardiac surgery than men, and higher in men than women when it was an orthopedic surgical procedure (Langelotz et al., 2014). Other studies suggest women have a higher risk of SSI. One such study that examines sternal wound infections after cardiac surgery found a higher risk of SSI in women than men (Lemaignen et al., 2015). In a third group there was no sex difference when certain types of surgical procedures are considered (Aghdassi et al., 2019). Though this study finds that males predominantly develop SSI, it was not statistically significant at 95% confidence level.

### 5.3.7 The effect of educational status

This study did not find any statistically significant relationship between educational status and the development of SSI using binary logistic regression. A retrospective study in the orthopedic center of a university hospital (in Cotonou, Benin) setting similar to this study found that level of education was a statistically significant factor in determining the odds of developing a SSI. It found that persons with higher education having a reduced chance of being affected (Dégbey et al., 2023). This outcome was arrived at in a multivariate analysis that included other factors: re-use of bandages, technical quality of dressings, pre-operative in-hospital stay and economic status of patients. When a multivariate model is examined using all six factors assessed in this study, educational status was not a statistically significant factor. A single site hospital-based study in Ethiopia found a significant relationship using bivariate analysis between SSI and educational status, the sample size of 249 gives it a similar power as this study (Mezemir et al.,

2020). It would appear then that the risk of getting a SSI has no particular affinity for any level of education as a stand-alone factor, other factors need to be present to make it relevant.

### 5.3.8 Admission status

SSI and admission status have no significant statistical relationship when subjected to Chi<sup>2</sup> analysis. In this study, admission status is a reflection of the need for post-analgesia, post-operative need for parenteral medication and comfort as explained earlier. Most subjects being students, the hospital policy tends to favor admission as they do not have caregivers in their various halls of residence like they would have had at home. So, there is very little association between surgical pathology and admission status. The findings of this study agree with this reality. Nonetheless, most studies find that day-surgery cases are less likely to end up infected than surgeries requiring admission (Mezemir et al., 2020; Mujagic E 1, 2018).

### 5.3.9 Length of hospital stay and SSI

Many clients stayed between 1 and 3 days suggesting the facility was used for the purpose of avoiding the need for nursing care in a hall of residence: Admission to ward the night before surgery, sleep-in on the day of surgery and discharge on the first post-op day when effects of anesthesia have worn off and pain is managed on oral medication is the usual protocol. This variable has three parts to it: number of pre-op days, the operative day itself and number of days post-op. As already discussed above, day surgery seems to be a protective factor in SSI. After surgery, patients would usually be discharged the same day (day of surgery) or after a day if the anesthetic technique used does not allow discharge or on the third day if the surgeon must inspect a clean wound. Subsequently, discharge depends on patient fitness and ADL (activities of daily living) status or need to remove stitches. One to three days post-surgical procedures represent the inflammatory phase of healing. This is the phase that requires

analgesia for moderate to severe pain and so often subjects would need hospitalization for parenteral pain relief. From the foregoing, days on admission less than 10 (the normal physiologic duration of surgical wounds) does not correlate with wound infection since it is considered the normal. Complications such as SSI become important when subjects need wound care after the physiologic threshold, whether they are discharged or not. A university hospital study in Dilla, Ethiopia found that there is an 8.18 (5%CI= [1.84-36.75]) fold increase in odds when patients are hospitalized for more than 14 days (Birhanu et al., 2022). Some studies specifically identify the length of pre-op stay as a risk factor for SSI(Rodrigues de Carvalho, et al., 2017,Mujagic, 2018).This probably reflects either the complexity of the surgical pathology or prolonged exposure to hospital pathogens that are more resistant to routine antibiotics. Contrary to the findings of this study, some retrospective studies reported that the total length of hospital stay is a significant factor in SSI(Awwad et al., 2021).

#### 5.4 Strengths and limitations of study

It is imperative to acknowledge the strengths and limitations of this study. The major strength of this study is the sample size (388) which far exceeds the calculated sample size (242). This improves the power of the output during analysis. A second major strength is that the various forms of the HIS for collection of sociodemographic, clinical and billing data are standardized and compatible with ICD 10 codes. Thirdly, we used rigorous analytical methods (logistic regression) and powerful analytical tools (STATA) to arrive at the findings discussed. Finally, the data extracted is unique to a special population dominated by educated people. Finally, we adhered strongly to patient data confidentiality, and participants' identity protection with the use of only folder numbers instead of names

Some weakness is inevitable in this type of study. As it is a retrospective study, it lacks the ability to control the input in a lot of variables that can be investigated as described in the

conceptual framework. The output at best would only represent a point in time that is in the past and so may not be representative of the current or be able to predict the future. Secondly, as it is a cross-sectional design, one cannot make causal inferences from the analysis. Thirdly, second limitation is the fact that it is a single-site study and may not be generalizable.

While recognizing the above limitations, we believe this work will make an impactful contribution to the fund of accurate findings needed for systemic reviews of difficult-to-study topic as this and contribute to improved care in the institution studied.



## CHAPTER SIX

### 6.0 CONCLUSIONS AND RECOMMENDATIONS

#### 6.1 Conclusions

The prevalence of SSI for the period January 2021 to October 2023 in Legon Hospital was estimated to be 20.1% [95%CI = 16.4%-24.4%]. Further, age > 10yrs, wound status (clean vs contaminated) and duration of wound > 10 days were found to have a statistically significant association with the outcome (SSI). Age and wound status are patient factors while the duration of the wound is a surgical-process related factor.

The conceptual framework postulated two types of factors whose confluence results in a SSI. The first set of factors relate to the surgical pathology and therefore is to the unique patient. Age greater than ten years was found to positively correlate to SSI with a unit increase in age after ten years being associated with an odds of 1.02 times rise in prevalence of SSI. Wound status or type of wound at the end of the operation had a statistically significant relationship with the development of SSI [ $\chi^2(1) = 10.91, p=0.001$ ]. Furthermore, higher fraction of clean wounds developed SSI than contaminated wounds and this finding was statistically significant [ $\chi^2(1) = 2.51, p = 0.001$ ]. This anomaly suggests post-op wound care had serious lapses that need to be addressed. The other patient-related factors did not have statistically significant effect on SSI. The other patient factors, namely educational status and gender had no statistical significance in the sample studied.

The second set of factors involve the surgical process: from pre-op management through the operation itself to the end of post-operative care. These factors reflect the surgical team and surgical infrastructure. Binary logistic regression showed wound duration >10days and

<30days was a statistically significant determinant of SSI [ $p<0.001$ ]. The other process factor examined, duration of hospital stay, was not statistically significant.

The surprising but highly relevant outcome arising out of this study is the finding that clean wounds have a higher and statistically significant SSI rate than contaminated wounds. This is the opposite of what is expected in a system that works well. This suggests protocols anywhere in the chain between pre-op and post-op management needs a review. Also surprising is the relative absence of SSI in children 10yrs and below. This cannot be a natural outcome of an essentially human intervention for an acquired or congenital pathology.

## 6.2 Recommendations

### 6.2.1 Future Research

Even though the research has brought valuable insights into the factors associated with SSI, further research is necessary to get a more concise picture. Future studies should employ multi-center, multi-region data to improve generalizability. A future study with a prospective design would not only generate more robust results that show causal relationship but would subtly improve the filling of all forms on the HIS.

The vexed question of the relationship between SSI and gender remains unanswered in this study as the bivariate analysis showed. It would be useful to design a case-control study or use a set of gender-neutral surgical procedures to investigate this question.

Finally, the surprising finding that a higher fraction of clean surgeries developed SSI than contaminated surgeries requires further investigation. This can mean one of two things: there is a serious violation of aseptic technique such that the routine non-use of antibiotics in clean surgeries leads to higher SSI rates or the routine use of powerful antibiotics in contaminated surgeries tilts the scales and decontaminates wounds better. A case control study of clean

surgeries in which one arm get antibiotics and the other follows the normal and acceptable practice of not giving antibiotics would help solve this question.

### 6.2.2 Practice at the facility

The surprising finding that clean wounds have a higher chance of been infected suggests a break in infection control protocols (ICP). It is suggested that surgical wounds be dressed at a separate physical location from other ulcers which are not surgical in origin. The second facility-based intervention is to re-assess the sterility of dressing material and check the effectiveness/preparation of dressing solutions. Finally, staff involved in wound care may need refresher courses in ICP to consolidate their knowledge.



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## Appendices

### Appendix 1: Data extraction tool for HIS.

DATA /REPORT REQUISITION FORM

DATE: .....

NAME .....

DEPT. /UNIT .....

Email Address: .....

Purpose: .....

TEL. NO. ....

Request Detail:

1.....

2.....

3.....

4.....

5.....

6.....

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8.....

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10.....

Signed:.....

Date submitted.....



Appendix 2: Ghana Health Service Ethical Clearance Certificate.



**GHANA HEALTH SERVICE**  
**ETHICS REVIEW COMMITTEE**

Research & Development Division  
Ghana Health Service  
P. O. Box MB 190  
Accra.  
Digital Address: GA-050-3303

Quote this number and date on all correspondence  
My Ref. No. GHS/ 25/399  
Your Ref. No. \_\_\_\_\_  
Date 08<sup>th</sup> August 2025

Dan Bazaadut  
University of Ghana  
P. O. Box LG 75  
Legon-Accra

The Ghana Health Service Ethics Review Committee has reviewed and given approval for the implementation of your Study Protocol.

GHS-ERC Number	GHS-ERC: 056/ 06/25
Study Title	Factors Associated with Surgical Site Infections at University of Ghana Hospital, Accra, Ghana
Approval Date	08 <sup>th</sup> August 2025
Expiry Date	07 <sup>th</sup> August 2026
GHS-ERC Decision	Approved

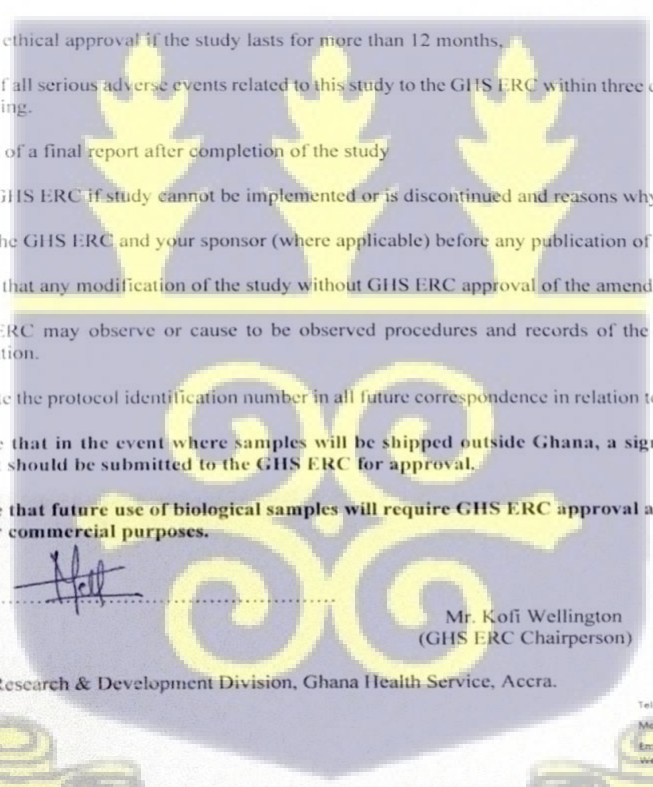
**This approval requires the following from the Principal Investigator**

- Submission of a yearly progress report of the study to the Ghana Health Service Ethics Review Committee (GHS ERC)
- Renewal of ethical approval if the study lasts for more than 12 months.
- Reporting of all serious adverse events related to this study to the GHS ERC within three days verbally and seven days in writing.
- Submission of a final report after completion of the study
- Informing GHS ERC if study cannot be implemented or is discontinued and reasons why
- Informing the GHS ERC and your sponsor (where applicable) before any publication of the research findings.
- Please note that any modification of the study without GHS ERC approval of the amendment is invalid.
- The GHS ERC may observe or cause to be observed procedures and records of the study during and after implementation.
- Kindly quote the protocol identification number in all future correspondence in relation to this approved protocol
- Please note that in the event where samples will be shipped outside Ghana, a signed Material Transfer Agreement should be submitted to the GHS ERC for approval.
- Please note that future use of biological samples will require GHS ERC approval and the samples cannot be used for commercial purposes.

SIGNED.....  
Mr. Kofi Wellington  
(GHS ERC Chairperson)

Cc: The Director, Research & Development Division, Ghana Health Service, Accra.

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**INTEGRI PROCEDAMUS**