KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

COLLEGE OF HEALTH SCIENCES

SCHOOL OF MEDICAL SCIENCES

DEPARTMENT OF CLINICAL MICROBIOLOGY

TOPIC: EPIDEMIOLOGICAL INVESTIGATION AND PROFILING OF ANTIMICROBIAL SUSCEPTIBILITY PATTERNS OF BURN WOUND ISOLATES IN A TERTIARY TEACHING HOSPITAL

THIS THESIS IS SUBMITTED TO THE DEPARTMENT OF CLINICAL MICROBIOLOGY IN PARTIAL FULFILLMENT OF REQUIREMENT FOR THE AWARD OF DEGREE OF MASTER OF PHILOSOPHY (MPHIL) IN CLINICAL MICROBIOLOGY

BY

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DECLARATION

I hereby do declare that with the exception of references to works done by other authors which have been properly cited, all experimental work described in this thesis was carried out by me. I do further declare that this thesis has not been accepted or presented either in part or full anywhere for a degree.

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DEDICATION

This thesis is dedicated to my parents, Mr. and Mrs. Sintim Asare and my siblings, Mr. Richard Amankwa, Mr. Prince Asare Amankwa, Miss. Priscilla Amankwa, Mr. Daniel Amankwa and Miss. Vonique Serwaa Amankwa. God richly bless you for your unflinching support.

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LIST OF ABBREVIATIONS

A&E	Accident and Emergency
BICU	Burns Intensive Care Unit
CNS	Coagulase Negative Staphylococcus
HIC	High Income Countries
KIA	Kligler Iron Agar
KATH	Komfo Anokye Teaching Hospital
LMIC	Low and Middle Income Countries
PTSD	Post Traumatic Stress Disorder
HAI	Hospital Acquired Infection

ABSTRACT

Burns is the destruction of the skin barrier caused by scalds, chemicals, electricity, radiation and friction provides a suitable medium for the growth of pathogens, delaying wound healing and may result in development of deep scars and contractures. Burn wound infection is the leading cause of morbidity and mortality in burn patients worldwide. The study aimed at the epidemiological investigation the bacteriological profile and antimicrobial susceptibility patterns of burn wound isolates. Swabs were taken from burn wounds of patients admitted to ward D2C and Burns Intensive Care Unit (BICU) from December 2014 to November 2015. Samples were processed at the Microbiology Laboratory for culture and sensitivity. Bacteria isolated were identified using their morphological characteristics, Gram staining reaction and biochemical tests. The antimicrobial susceptibility testing was done using Kirby-Bauer disc diffusion method. Questionnaire were also administered to study participants to obtain information on demography, kind of first aid received, antibiotics received prior to culture and sensitivity. A total of 86 patients comprising 45 patients from old burns ward D2C and 41 patients from Burns Intensive Care Unit (BICU) participated in the study. Males were 51(59.3%) and females 35 (40.7%). Age of participants ranged from 0-56+ years. *Pseudomonas aeruginosa* was the commonest pathogen isolated 26(30.2%), followed by *Pseudomonas spp.* 21(24.4%), *Escherichia coli* 17(19.8%), *Klebsiella spp.* 12(14.0%). Coagulase Negative Staphylococcus accounted for 2(2.3%). Overall prevalence of infection in the current study was 90.7%. Burn wound infection continues to be a major challenge in Burn centers. Hence, regular surveillance of commonly identified pathogens in the ward and their antimicrobial susceptibility will guide proper empiric selection of antibiotics for management of burn wound.

CHAPTER ONE: INTRODUCTION

1.0 Background

Burn wound infection continues to be a major issue of concern globally taking a greater toll on developing countries (De Macedo and Santos, 2006) where infection of wound sites is a major cause of post-operative illness and common cause of death in burn patients accounting for quarter of nosocomial infections (Nicols, 2001). About 50% of burn related infections are caused by gram negative bacteria (Mason *et al.,* 1986). When burn occurs, the wounds are initially sterile; however, there is gradual colonisation of the wound (Church *et al.,* 2006). Following burns in general, there is wound formation and delay epidermal maturation increasing the likelihood of sepsis in persons with infected wound (Singer and McClain, 2002). About 73% of post burn death occurring within five days has been reported to be sepsis related (Sewunet *et al.,* 2013). With high prevalence of infection and changing bacteriological profile of isolates, it is necessary to assess bacteria pathogens in each burn centre. Based on the microbiology surveillance, empiric antibiotic may be commenced in clinically systemic infected patients until specific culture organisms are identified and sensitivity available for treatment (Giaquinto-Cilliers et al., 2014).

Burns are a major public health issue globally, resulting in an estimated 265,000 deaths and 19 million disability-adjusted life years lost annually (Forjuoh 2006; WHO 2014; Ahuja and Bhattacharya 2004). This burden falls disproportionately on Low and Middle-Income Countries (LMICs), which are least equipped to provide timely and comprehensive care (Gupta *et al.,* 2014).

1.1 Problem Statement

Despite recent advances in burn care and management involving early excision and grafting, burn wound infection continues to be a major issue in burn centers. Burn wound infection is a major cause of morbidity and mortality particularly in LMICs (Sedat*et al.*, 2005). It has been estimated that 30-75% of burn-related deaths among those who survive initial injury are the consequence of infection (Bang *et al.*, 1998; Gudaviciene and Rimdeika, 2004; GiaquintoCillier*set al.*, 2014). To prevent these deaths, timely and appropriate antibiotic therapy is required (Macedo and Santos 2005). In order to provide the right drug at the right time, burn centers have characterized the bacteriologic profile within their hospital to guide empiric treatment (Yasemin *et al.*, 2013; Dhar *et al.*, 2007; Revathi *et al.*, 1998). Several studies have identified commonly occurring bacteria in their setting and their antimicrobial susceptibility patterns in order to allow early treatment of imminent septic episodes with appropriate empirical systemic antibiotics whiles awaiting culture results to start individualized treatment (Nasser *et al.*, 2003). There is therefore a need for burn centers to have knowledge of the pathogens common in their setting as well as their susceptibility to the antibiotics readily available.

1.2 Study Rationale

Since burn wound infection patterns vary from one hospital to the other, regular surveillance at burn centres is needed to effectively manage burn patients. This current study of bacteriological profile of burn wound isolates, an important component of comprehensive burn care has not been performed at Komfo Anokye Teaching Hospital Burns Intensive Care Unit (KATH BICU) and old Burns ward D2C. With results obtained from this study, empiric antibiotic usage and associated risk of growing antibiotic resistant strains of pathogens can be minimized. Also, the results would be useful for guiding empiric antibiotic therapy and potentially reducing the death and disability associated with burn wound infection.

1.3 Research Questions

1. What are the common bacteria associated with burn wounds in the Burns Unit?
2. What are the antimicrobial susceptibility patterns of burn wound isolates in the Burns Unit?

1.4 Objectives

1.4.1 General objective:

- The study aims at determining the bacteriological profile and antimicrobial susceptibility patterns of isolates from burn wounds.

1.4.2 The specific objectives are:

- To identify the common bacteria isolates from burn wound
- To identify the antibiotics that are sensitive to the burn wound isolates
- To determine the prevalence of bacterial infection
- To determine the predominant age, sex and aetiology of burn

CHAPTER TWO

LITERATURE REVIEW

2.0 Burns

Burn injuries are of public health importance in both developed and developing countries (Agbenorku, 2013a). It is associated with several complications such as functional disability, severe scarring and contractures of the affected body part (Agbenorku, 2013a). Burn injuries affect the skin to a large extent (Norman and Judkins, 2004). Burns are caused by scalds (hot liquids), heat, radiation, open flame, electricity and hot water bottles (Jabir *et al.,* 2013).

Burns is a leading cause of morbidity and mortality all over the world (Poulos *et al.,* 2009). Burns prevalence varies in both developing and developed countries due to socioeconomic and cultural differences.

2.1 Types of Burns

Classification of burns can be done depending on its depth (1st, 2nd and 3rd degree burns). Another form of burns commonly referred to as inhalational injury is caused by breathing smoke and hot fumes (Wise & Levine, 2015). There are three types of burns namely; First degree (superficial) burns - only the skin outer layer is affected; there is change in colour (darkening of skin in black persons and redness in whites), swelling, pain and dryness. These burns heal within three to six days. Second degree (partial thickness) burns - both the outer layer and layer beneath are destroyed; there is blistering and swelling and pain. Most of these burns heal within two to three weeks while others may exceed three weeks. Third degree (full thickness) burns - the full thickness of the skin is destroyed. There may be extensive damage to tendons and bones, major organs and blood vessels. In the third degree burns, pain may not be felt due to nerve damage. The burnt area may be charred, dark brown, waxy, raised and leathery (Torpy, 2009).

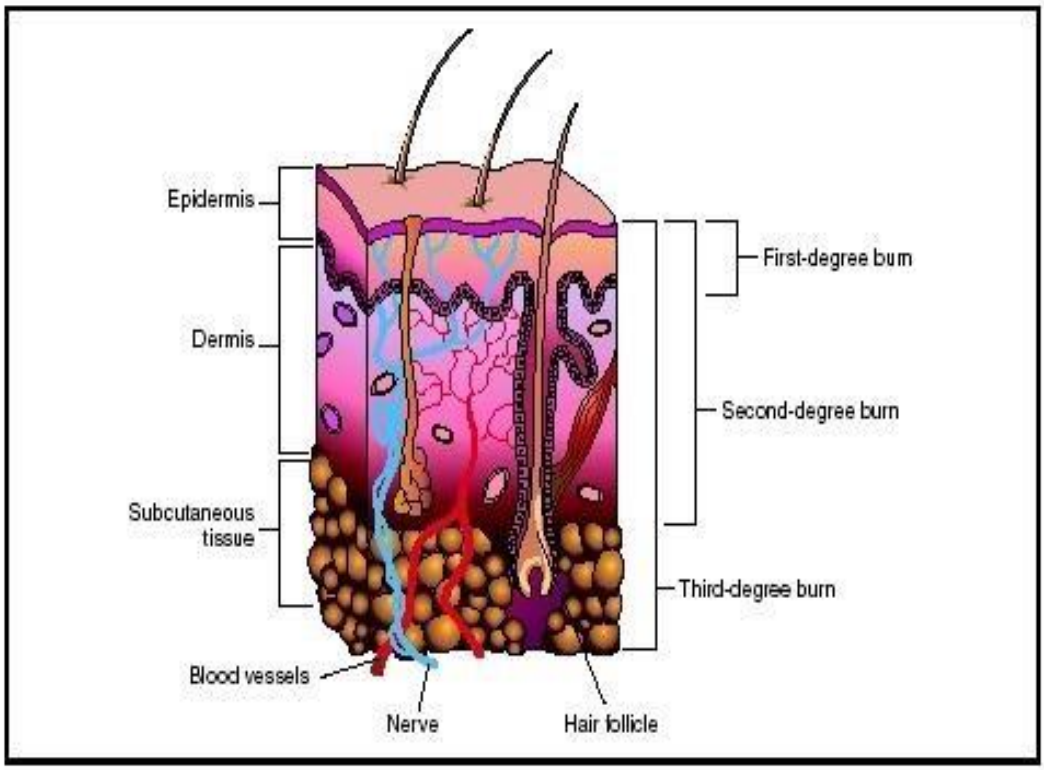


Fig 1: Burn wound classification (Source: www.healthofchildren.com/B/Burns.html)

2.2 The Skin

The skin is the largest organ of the body and acts as a barrier against infection (DeBoer and O' Connor, 2004; Wysocki, 2002). It also maintains fluid homeostasis and thermoregulation (DeBoer and O' Connor, 2004; Wysocki, 2002). Any breach on the integrity of the skin exposes the skin to infection (DeBoer and O' Connor, 2004; Wysocki, 2002). Other functions of the skin include neurosensory, immunological and metabolism such as Vitamin D metabolism (DeBoer and O' Connor, 2004; Wysocki, 2002). The skin has a soft underlying tissue comprising fat layers, fascia and muscle making up the bulk of the tissue in the body and acts as a tough, flexible, structural barrier against microorganisms(DeBoer and O' Connor, 2004; Wysocki, 2002).

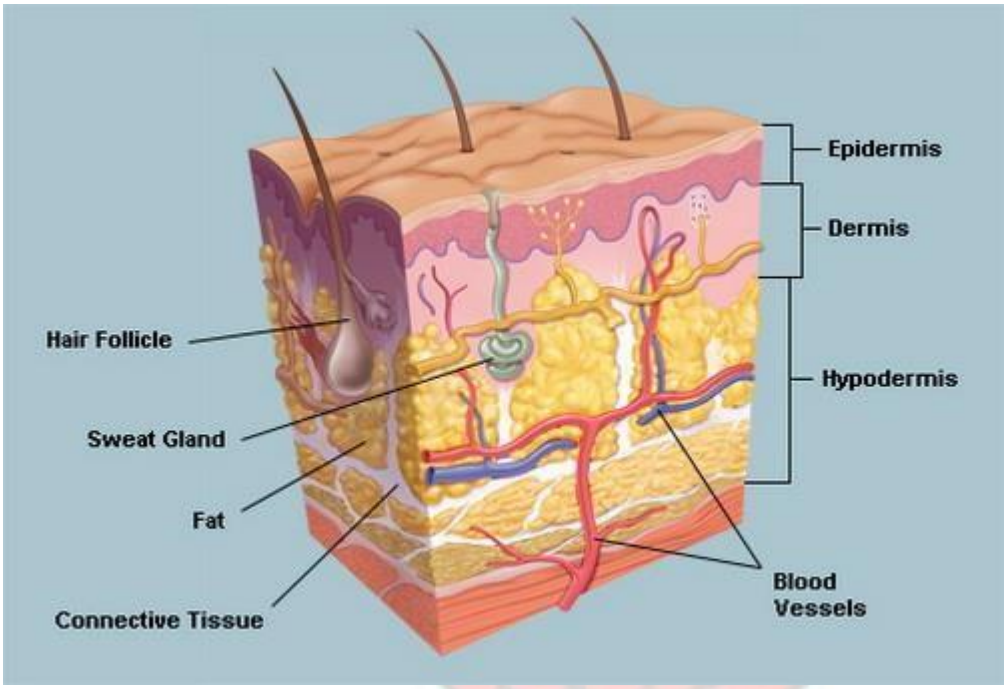


Fig. 2: Diagram of the skin (www.google.com)

2.3 Burns Epidemiology

Burns are rated the fourth most common trauma following traffic accidents, falls and intentional violence with an estimated 90% occurring in Low and Middle Income Countries (LMICs) (WHO, 2004; Institute for Health Metrics and Evaluation, 2010; Murray and Lopez, 2006, Peck and Pressman,2013). There are 6.1 burns related deaths per 100,000 population annually in Africa whereas in High Income Countries (HICs), there is 1.0 burn related deaths per 100,000 population (WHO, 2008). It is estimated that about 2.5 million people suffer thermal injury in the US and need to be attended to medically every year (Deitch, 1990).

The 2004 global incidence of fire-related injuries was estimated to be 1.1 per 100,000 population with Southeast Asia and America recording the highest and lowest rates respectively (WHO, 2004).An estimated 6-7 million persons suffer burns injury annually in India with the worse affected in age groups from 15-40 years (Gupta *et al.*, 2010). Usually, burns injuries requiring medical attention is about 20 times higher in China and Western Pacific than America

(WHO, 2004).Aside road traffic accidents, burns are the second leading cause of death in Iran in persons below 15 years (Roudsari, 2006). An assessment of injuries in Iran reported burns as common cause of home related accident occurring in 40% of injuries in all age groups (Mohammadi*et al.,* 2005). Intentional burns are reported to range from 2.9 to 21 per 100,000 per year in different provinces of Iran (Othman and Kendrick, 2010). In Pakistan, burns are the 11th leading cause of premature deaths and second leading cause of disability (Farooq *et al.,* 2011).In India, about 50,000 burn injuries are estimated to be fatal (Sarma, 2011) out of 100,000 (Keswani *et al.,* 2000) to 2 million burns that occur annually (Davies, 1990).Burns incidence in children in Africa has been reported to be three times the world average for their age group (Hyder*et al.,* 2004).

2.4.0 Burn Wound Infection

2.4.1 *General Background*

Burn wound infections are leading causes of morbidity and mortality globally (Appelgren*et al.,* 2002). Patients with burn injury are at a higher risk of nosocomial infection as well as catheter-related infection, suppurative thrombophlebitis, pneumonia due to their immunecompromised state with the exposed skin (Wurtz *et al.,* 1995; Mosier and Pham, 2009). Much progress have been made in cases involving burn injuries such as resuscitation, operations, infection control, control of hypermetabolic responses as well as strategic rehabilitation over the past six decades (Monafo, 1992). Despite these remarkable improvements, sepsis continues to be the leading cause of death in burn centres (Sharma *et al.,* 2006). When burn occurs, gram positive bacteria especially staphylococcus found in the sweat glands and hair follicles largely colonize the wound within the first 48 hours (Church et al., 2006). These organisms are able to survive the temperature of the injury. The susceptibility of these pathogens to antimicrobials is to a large extent dependent on the nature of their cell wall and membrane (Church et al., 2006).

2.4.2 *Organisms Causing Burn Wound Infection*

Burn wounds are susceptible to a wide range of infections drawn from several factors. When burn occurs, disruption of the skin barrier causes the release of vast protein exudates that provide a medium for bacterial colonization (Soares et al., 2006; Ahuja et al., 2009; Vindenes et al., 1998; Alexander et al., 2002; Church et al., 2006). The normal skin floras consists of staphylococci, propionibacteria, corynebacteria and yeasts (Mims et al., 2002). This may vary in number from a few hundred to greater numbers over thousands per square centimetre in moist areas such as the groin and axillae (Mims et al., 2002). Though these normal flora act as competitive inhibitors of pathogenic microbes, breach of the skin through leg ulcers, burns, surgical, traumatic wounds allows wider colonization of the bruised skin surface by pathogenic bacteria (Mims *et al.,* 2002). When an ulcer is colonized, inflammation does not usually occur, however, infection of the surrounding tissue may be caused by lateral spread of the colonizing organisms (Dryden, 2009). Pathogens usually isolated include *Pseudomonas aeruginosa*, *Klebsiella spp*., *Staphylococus aureus*, coliform bacilli. Fungi such as *Candida albicans* and *Aspergillus fumigatus* also cause infections (Revathi *et al.,* 1998; Skoll *et al.,* 1998; Lawrence, 1994; Nudegusio *et al.,* 2004, Shahid and Malik, 2005). It is therefore necessary that clinically, colonisation be distinguished clearly from infection, as the former does not require antibiotics but the latter does (Dryden, 2009). Studies have reported coagulase negative staphylococcus, *Staphylococcus aureus* and *Enterococcus spp* as common gram positive bacterial isolates and *Pseudomonas aeruginosa*, *Escherichia coli*, *Klebsiella pneumoniae*, *Proteus spp.* and *Acinetobacter spp*. as common gram negative bacterial isolates

(Yasemin *et al.,* 2013;Dhar *et al.,* 2007; Revathi *et al.,* 1998). However, these isolates have varied antibiotic susceptibility patterns between centers and over time (Yasemin *et al.,* 2013; Dhar *et al.,* 2007; Revathi *et al.,* 1998).

2.5 Pathophysiology of Burn Infection

Burn wounds are susceptible to a wide array of colonization and infection by microbes. The granulation tissue in burn wound creates a rich culture medium for the growth of various organisms as the exposed skin is replaced by a protein rich, avascular environment that creates a suitable niche for microbial colonization. The migration of immune cells is also hampered contributing to the septic process (Bayram et al., 2013). The depression of local and systemic host cellular as well as humoral immune responses play a critical role in infectious complications of severe burn patients (Ghai *et al.*, 2015). Increased days of hospitalization, devitalization of tissue, immunosuppression, large cutaneous bacterial load, bacterial translocation from the gastrointestinal tract, overcrowding in ward causing cross infection all increase burn wound infection (Bairy and Shivananda 1997).

Wound infection depends on immunosuppression, wound local environment and the virulence of the pathogen which depends on the extent of course of infection. (Otta *et al.*, 2015). When the burn is surface is colonized, microorganisms begin viable tissue penetration depending on their invasiveness, local wound factors as well as the state of the patient's immunosuppression. More so if the sub-eschar tissue is invaded, there is likelihood occurrence of disseminated infection (Srinivasan *et al.*, 2009).

2.6 Burn Wound Sepsis

Burn wound sepsis which is a complication of burn infection accounts for 50-60% of burn injury death. The denatured protein in the burn wound eschar provide a suitable medium for the growth of the bacteria causing vascular block resulting in decreased microcirculation which further hampers the host defence mechanisms. With this the concentration of administered antibiotics that reaches the burns site is minimal delaying wound healing (Order et al., 1965). When a body gets infected, natural chemicals are released into the bloodstream to help fight

infections. However infection develops if the body develops inflammatory response to its own infection fighting chemicals. There is an initial septic shock. If a burn patient is not attended to, the patient may enter into a septic shock. Septic shock is characterized by drop in blood pressure which may result in organ failure and death. Symptoms experienced by patients includes abnormal heart function, breathing difficulty, confusion, abdominal pain and confusion (Barber *et al.,* 2006). Factors accounting for sepsis of burn victims include the following: disruption of skin barrier, normal bacterial flora becoming opportunistic infection and the immune system being compromised (Jones *et al.,* 1990).

2.7 Nosocomial Infections

Nosocomial infection/Hospital Acquired Infections (HAI) are common in burn patients as the exposed skin provides suitable environment for growth of microbes. Several factors account for the acquisition of nosocomial infection which include change in the specific and non-specific immune responses of the body, presence of devitalized and vascularized tissue, invasive diagnostic and therapeutic processes, as well as increase length of hospital stay (Oncul *et al.,* 2009; Kumar *et al.,* 2011). The exposed skin following thermal injury is prone to infection and can be contaminated with resistant organisms serving as a source of prolonged infection affecting other burn patients (Falk *et al.,* 2000). There is however issue concerning the institution of systemic antibiotics to burns patients. Ugboro *et al.* (2004) in their study reported Systemic Antibiotic Prophylaxis does not control burn wound sepsis but however encourage the growth of Pseudomonas in burn wounds. They therefore advised topical antibiotics with wound debridement and good environmental hygiene as treatment protocol to reduce nosocomial strains of bacteria and more so prevent cross infection (Ugboro *et al.* 2004). HAI are usually associated with invasive procedures through medical devices or surgical procedures (Anton *et al.,* 2010). As reported by Leseva et al. (2013), *Staphylococcus aureus,*

A. baumannii and *Pseudomonas aeruginosa* were the most common nosocomial pathogens in their burns center.

2.8.0 Effects of Burns Injury

2.8.1 Physiological Effects

Burns are associated with severe scarring and contracture (Agbenorku, 2013a). Functionally patients are also affected; involves amputation of affected body parts (Agbenorku, 2013a). Generally, the debilitating sequelae impounds on the victims wellbeing daunting his selfesteem (Agbenorku *et al.,* 2010c; Peck, 2011). Physical appearance is very crucial; hence any injury to the face affects the burns victim (Agbenorku *et al.,* 2010c; Peck, 2011). Morbidity associated with burns injury leaves much to be desired (Agbenorku *et al.,* 2010c). Scars maybe classified as hypertrophic or keloids and may require a number of surgeries to correct some of the defect (Fordjuoh, 2006). Extensive burns to tissues may affect other body systems (Fordjuoh, 2006). Keloids prevalence of 4% -9% has been reported with burns in children and adults (Fordjuoh, 2006). Fordjuoh (2006) reported a 17.4% burns related functional disability mainly keloids in a study on Ghanaian children (Fordjuoh, 2006). Health related quality of life in persons with functional disability following burns injury is low (Esselman*et al.,* 2006; Dyster-Aas*et al.,* 2007).

2.8.2 Psychological effects

Scarring may cause stigmatization and more often than not, they may present with Post Traumatic Stress Disorder (PTSD) and depression (Baur*et al.,* 1998). PTSD accounts for 1345% of cases related to burns injury with pre-depression, pain anxiety, symptom type and severity and burn injury severity as related risk factors (Van Loey and Van Son, 2003). Depression also occurs in 13-23% of burns patients (Van Loey and Van Son, 2003). Pre-burn depression coupled with being female and facial disfigurements are risk factors associated with

depression in burns patients (Van Loey and Van Son, 2003). Burns do not only affect patients physically but also have a great toll on them (Menzies, 2000; Van Twillert*et al.,* 2007; McRobert, 2012; Ellen *et al.,* 2004). Psychologically burns patients often develop a negative self-image, depression and anxiety (Menzies, 2000; Van Twillert*et al.,* 2007; McRobert, 2012; Ellen *et al.,* 2004). Their inability to go back into the state in which they were before the injury massively affects their well-being (Menzies, 2000; Van Twillert*et al.,* 2007; McRobert, 2012; Ellen *et al.,* 2004). Hence it is very expedient that, the psychological needs of burns patients are met during the rehabilitation period (Menzies, 2000; Van Twillert*et al.,* 2007; McRobert, 2012; Ellen *et al.,* 2004).

2.9.0 Management of burn wound infection

Most antimicrobials have been developed or prepared to treat infection in burns and also for prophylactic use (Starley*et al.,* 1999). There is a need for specialized care to reduce burns mortality and morbidity (Church *et al.,* 2006). Due to the associated morbidities and mortalities, a more strategic and aggressive approach should be employed to reduce the incidence (Archibong, 1997; Graham *et al.,* 2012; Mondozzi and Harper, 2001).

In some settings, the burn victim is made to receive treatment which otherwise complicates the burn wounds causing infection (Atiyeh*et al.,* 2009; Sinha *et al.,* 2011; Archibong*et al.,* 1997). Sometimes at the scene of accidents, various substances which are applied to burn wound surfaces complicates the burn wound causing infection, increasing the burn wound surface area and exposing patients to a wide range of infection and even death (Olaitan*et al.,* 2004). Some of these first aid substances include cow dung, mud, tooth paste, amongst others which impacts negatively on the management of these burn cases (Abubakar *et al.,* 2015). More often than not, most of these patients make a late presentation to the hospitals. Most people get to the health facilities after the traditional systems fail them, especially when the burns is extensive

(Olaitan*et al.,* 2004). Wound cultures provide insight to the bacteria causing the infection (Mago, 2009; Alireza and Enayat, 2007). Measures that can be implemented to prevent burn wound infection include aseptic techniques, sterile dressing materials and gloves which should be readily available (Sharma *et al.,* 2005). Bacterial colonization and antimicrobial susceptibility patterns should inform healthcare providers on the antibiotic therapy to be administered to burns patients (Sewunet*et al.,* 2013).

2.9.1 Facing the Challenge of Burn wound infection

Practicing good personal hygiene in burns centers and enforcing hygiene policies in burn centres is a step in the right direction in dealing with burn wound infection. More so, some centers have resolved to use bed linens impregnated with antimicrobial substances to prevent colonization of new patients with nosocomial infections (Leseva et al., 2013). Better nursing practices including aseptic measures in handling patients such sterilization and disinfection, regular hand-washing before and after attending to patients and usage of broad spectrum antibiotics are all factors to reduce HAI (Taneja et al., (2004).

CHAPTER THREE

MATERIALS AND METHODS

3.0 Study setting

Komfo Anokye Teaching Hospital (KATH), named after the legendary priest Okomfo Anokye, was established in 1954 and is located in Kumasi, the second largest city of Ghana.

The hospital was further upgraded to a teaching hospital to train medical doctors in 1975 (Kwame Nkrumah University of Science Technology, School of Medical Sciences). It is the only tertiary hospital in the middle belt of the country and hence doubles as a referral centre for The Northern, Upper West and East and Brong – Ahafo, Central, Eastern and some parts of the Volta Region. The hospital currently has a thousand (1000) bed capacity aside the Accident and Emergency (A&E) to cater for the increasing number of patients. Annually, the hospital attends to about 679,050 out- and in-patients (http://www.kathhsp.org/).

The hospital has two burns units; the old Burns Intensive Care Unit (BICU) (currently referred to as Burns Ward D2C) established in 2001 and the new, KATH Burn Centre (BICU) established in 2009.The BICU is located within the Accident and Emergency (A&E) Block. The new BICU consists of 6 rooms fully equipped with sophisticated equipment to fully manage severe burn cases. The A&E is a 160 bed capacity fully equipped block and houses the BICU together with the Plastic Surgery Unit, Neurosurgery, Trauma and Orthopaedics and Emergency Medicine. Since its establishment, the BICU has seen a remarkable and drastic change in the management of its patients resulting in decreased mortality compared to the old burns unit as reported in a study by Agbenorku (2013a).

3.1 Study design

This cross sectional study involved the collection of wound swabs from burns patients from December 2014 to November 2015. Questionnaires on demography such as age, sex, occupation, level of education and clinical data were collected through a structured questionnaire and from the medical record at admission the study sites; BICU and Burns

Ward D2C.

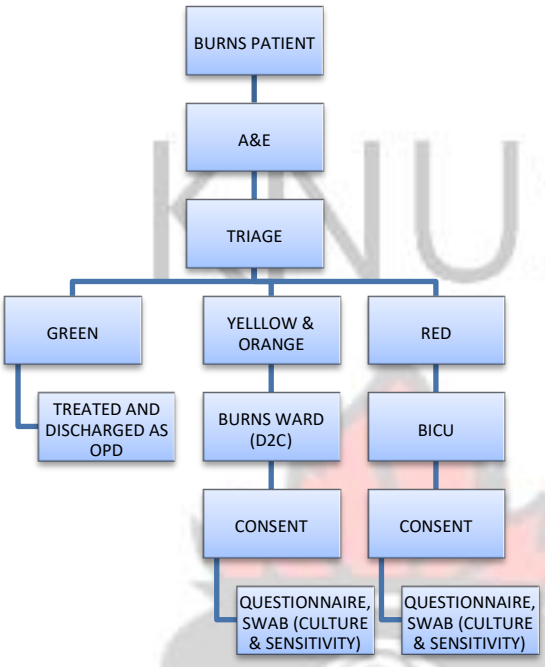


Fig 3: Schematic representation of study design

3.2 Study Population

The study included all burn patients, who were admitted during the study period at BICU and Burns Ward D2C. There was no age restriction and the participation of the subjects was voluntary and informed written consent obtained from each of them.

3.2.1 Inclusion criteria

- Subjects who were admitted at BICU and Burns Ward D2C during the study period and gave their written consent to participate in the study.

3.2.2 Exclusion criteria

- Subjects with burn injury who were not treated in the BICU and Burns Ward D2C.
- Subjects who did not give their consent for the study.

3.3 Sample Size determination

With 95% Confidence Interval (CI) and 5% significance level, the needed sample size to detect an assumed 5% prevalence rate of burns wound infection was estimated as follows:

$$n = \frac{Z^2 \rho q}{d2}$$

Where; n = the desired sample size, z = the standard normal deviation 1.96, p = the proportion of event of interest be 6%, q = 1.0-p, d = degree of accuracy desired at 0.05. From, the formula, an estimated number of 86 participants were enrolled onto the study.

3.4 Sample collection

Following removal of old dressing of burns patients, the surface of the burns wound was cleaned with normal saline to prevent contamination. Each sample was collected by swabbing the wound with a sterile cotton- tip swab stick. Rotating the swab stick between the fingers, the swab stick was moved across the entire wound surface. The swab stick was quickly put in Stuart transport medium. The labeled sample was then transported to the microbiology laboratory for culture and sensitivity test.

3.5.0 Laboratory procedures

3.5.1 Day 1: Media inoculation

The sample was inoculated on Blood agar and MacConkey agar aerobically at 35-37^{o}C for 16-24 hours.

3.5.2 Day 2: Morphology and Grams Staining

Inoculated media were removed from the incubator following overnight incubation and morphological characteristics of colonies noted and Gram staining done. Gram staining was

done to identify pathogens based on their Gram staining reaction as follows according to standard protocols (Cheesbrough, 2006). A smear was prepared by picking a colony ad emulsifying with normal saline on a clean slide. The smear was heat fixed by passing it rapidly with the smear on the uppermost through flame. The smear was covered with crystal violet for 1 minute and stain washed off with clean water. The smear was covered with Lugol's iodine for 1 minute and stain washed off with clean water. Decolourisation was done within few seconds with acetone alcohol and washed with clean water. The smear was covered with Neutral red for 1 minute and stain washed off with clean water. The back of the slide was wiped clean and placed in a drying rack for the smear to air dry. Microscopy was done first with x40 to check the staining and finally with x100 oil immersion to report bacteria and cells (Gram positives stain Purple and Gram negatives stain Red), (Cheesbrough, 2006).

3.6.0 Biochemical tests

Depending on the bacteria pathogen isolated and the morphological characteristics, the ideal biochemical test was performed.

3.6.1 Coagulase Test

The test is used to distinguish pathogenic and non-pathogenic species of Staphylococcus. Coagulase positive staphylococcus are pathogenic while coagulase negative staphylococcus are non-pathogenic. The Slide test was performed by picking a slide. A drop of saline was placed at the ends of the slide. The organism was emulsified in the saline after which a loopful of plasma was added and mixed gently while looking closely for clumping within 10 seconds. *Staphylococcus aureus* which produces the enzyme coagulase which converts fibrinogen to fibrin from other species such as *Staphylococcus epidermidis* which does not produce coagulase (Cheesebrough, 2006).

3.6.2 Indole Test

The Indole test was performed to aid in the identification of *Escherichia coli*. The test was performed by inoculating the test organism into a tryptophan broth. This was incubated overnight at 35-37ºC. Indole production was detected following the overnight incubation by adding Kovac's reagent which contains 4(p)-dimethylaminobenzaldehyde which reacts with the indole showing a cherry red coloured ring (Cheesebrough, 2006).

3.6.3 Oxidase Test

The oxidase test was performed to aid in the identification of *Pseudomonas.* Filter paper was soaked with few drops of oxidase reagent. Test organism was smeared on the filter paper. Oxidase producing organism oxidizes the phenylenediamine in the reagent showing a deep purple colour (Cheesebrough, 2006).

3.6.4 Kligler Iron Agar (KIA)

The KIA test was performed to aid in the detection of *Klebsiella spp. and* other Enterobacteriaceae. The test was performed by using a straight wire to pick the test organism and then first stabbing the butt and streaking along the slope in a zigzag pattern. This was incubated afterwards at 35-37ºC overnight. Being Lactose fermenters, there is yellowing of the slope and butt (Cheesebrough, 2006).

3.6.5 Citrate Test

A citrate producing organism is based on the ability of the organism to utilize citrate as the only source of carbon. The test is performed by picking the test organism and then streaking the slope first and finally stabbing the butt and incubated overnight at 35-37ºC. A positive citrate test is seen as bright blue (Cheesebrough, 2006).

3.6.5 Urease Teast

The urease test is performed by inoculating the test organism in a medium containing urea and phenol red indicator. The test is performed by picking the test organism and then streaking the slope first and finally stabbing the butt and incubated overnight at 35-37^{o}C.A Urease producing organism breaks down the urea to produce ammonia and carbon dioxide. Ammonia causes the medium to be alkaline, this is seen in the change of colour of the indicator to pink (Cheesebrough, 2006).

3.7Antibiotic susceptibility tests

Kirby-Bauer disc diffusion method was employed to determine the susceptibility of the bacteria isolate to antibiotics according to standard protocols (Cheesbrough, 2006). The following antibiotics were used;

Gentamicin(10µg),Amikacin(30µg),Ceftazidime(30µg),Ciprofloxacin(10µg),Meropenem(10µg),Chloramphenicol(10µg),Cefuroxime(30µg),Ceftriaxone(30µg),Ampicillin(10µg), Cotrimoxazole (25µg), Cefotaxime(30µg). It was carried out as follows; a colony was picked and inoculated in alkaline peptone water. A sterile loop was used to pick the inoculum and inoculated onto nutrient agar (sensitivity plate). Streaks were made across the entire surface of the nutrient agar. Depending on the gram stain reaction of the bacteria isolated, the specific gram positive or gram negative antibiotic disc was placed on the nutrient agar ensuring it made contact to the surface of the media. Sensitivity plates were incubated overnight at 3537^{o}C. Reading of the plates was done following the overnight incubation. Zone of inhibition was measured and compared to standard susceptibility charts provided by the manufacturer. Depending on the diameter measured, pathogen(s) isolated may be reported as sensitive or resistant to the antibiotics (Cheesbrough, 2006).

3.8 Data Entry and Analysis

Data entry and analysis was done using Statistical Package for Social Sciences (SPSS version 20 (SPSS, Inc., Chicago, IL, USA). The quantitative data was analyzed using descriptive statistics summarized and displayed on graphs and charts.

3.9 Ethical Considerations

Ethical clearance was obtained from the Kwame Nkrumah University of Science and Technology School of Medical Sciences/Komfo Anokye Teaching Hospital Committee on Human Research, Publication and Ethics, Kumasi.

CHAPTER FOUR

RESULTS

4.1 Demography of patients

4.1.1 Sex distribution of participants

A total of 86 patients participated in the study comprising of males, 51(59.3%) and females, 35(40.7%) as shown in **Table 1**.

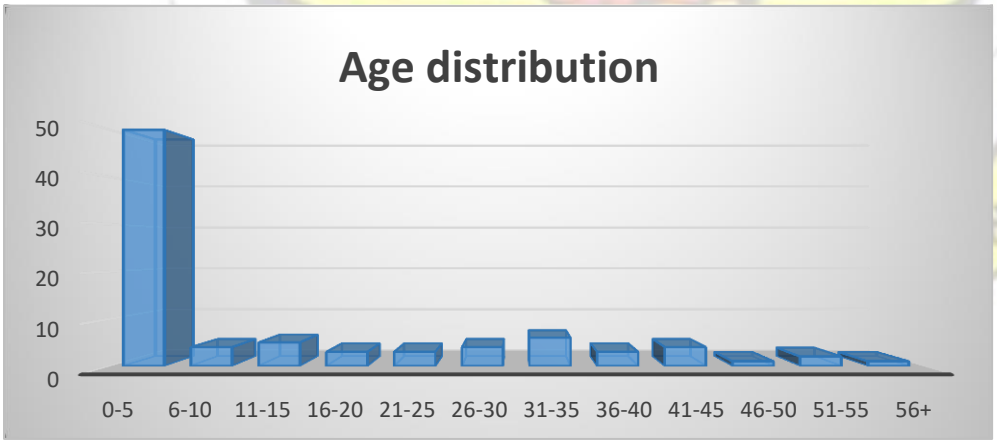
Table 1: Sex distribution of participants

Sex distribution	N (%)
Male	**51(59.3)**
Female	**35(40.7)**
Total	**86**

4.1.2 Age distribution of participants

Persons aged 0-5 years suffered mostly from burns, (58.1%) followed by age 31-35years (7.0%) with years 46-50 and 56+ years both recording (1.2%) as seen in **Figure 4**.

Figure 4: Age distribution of participants



4.1.3 Educational background of participants

The **Table 2** below shows the educational background of the participants with persons who have not received any form of formal education recording 44.2% while Junior High School and Tertiary both recorded, 4.7%.

Table 2: Level of education of participants

Level of education	N (%)
None	**38(44.2)**
Pre-School	**16(18.6)**
Primary	**15(17.4)**
Junior High School	**4(4.7)**
Senior High School	**9(10.5)**
Tertiary	**4(4.7)**
Total	**86(100)**

4.1.4 Occupation of participants

The **Table 3** below shows the occupation of the participants. Majority of the participants were children (56.9%) and hence are unemployed followed by Pupil/Student (13.9%), Artisan/Mechanic (12.8%), Civil Servant and Caterer/Chop bar Operator (4.7%), Trader (3.5%), Farmer (2.3%) and Driver (1.2%).

Table 3: Occupation of participants

Occupation	N (%)
Artisan/ Mechanic	11(12.8)
Pupil/Student	12(13.9)
Civil Servant	4(4.7)
Farmer	2(2.3)
Trader	3(3.5)
Child	49(56.9)
Driver	1(1.2)
Caterer/ Chop bar Operator	4(4.7)
Total	86(100)

4.2 Aetiology of Burns

The **Figure 5** shows the aetiology of burns with scalding being the commonest aetiology comprising hot water 30(34.9%), hot soup 8(9.3%) and hot oil 6(7.0%). Open flame burns caused by either petrol or fire, 26(30.2%) followed by gas explosion 12(14.0%) and contact burns4 (4.7%).

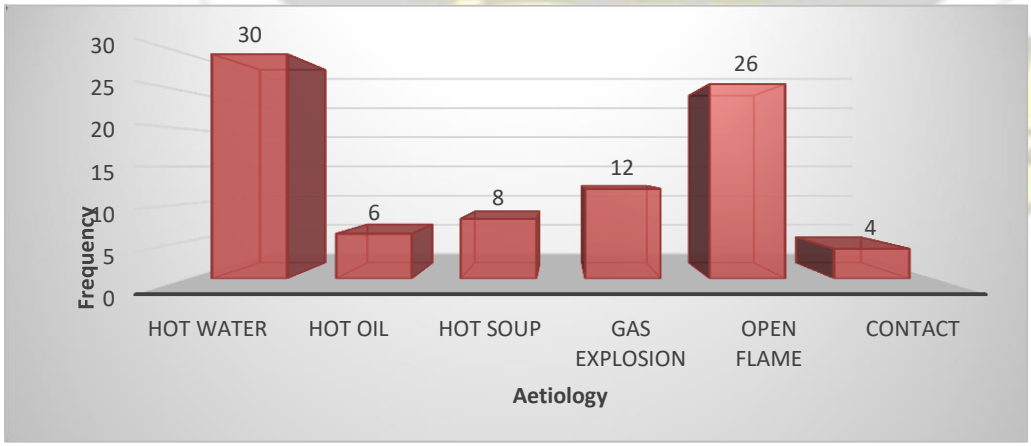


Figure 5: Aetiology of burns

4.3 Substances used as first aid

The **Figure 6** below shows that out of the 86 patients, 76(89%) did not receive any form of first aid, 4(5%) received brine as a form of first aid, egg, 2(2%), gentian violet, 2(2%), grounded snail shell 1 (1%) and honey 1(1%).

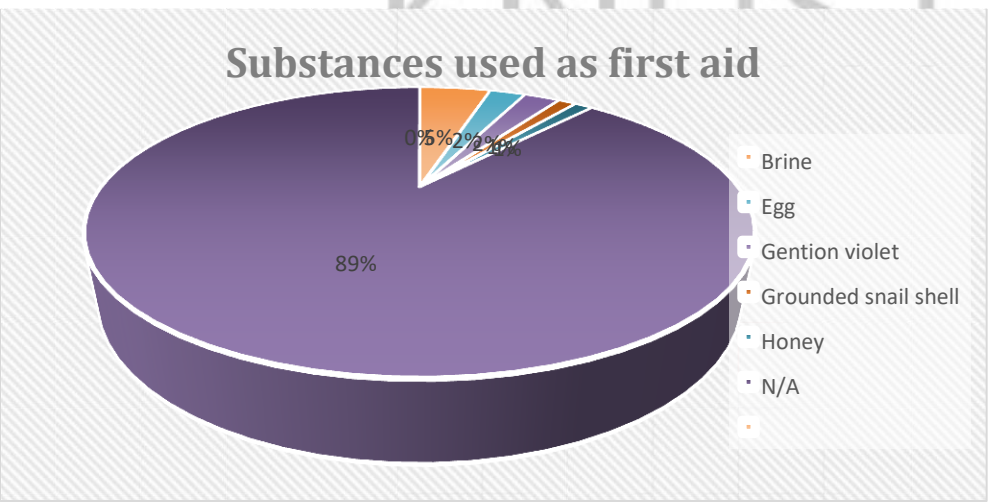


Figure 6: Substances used as first aid

4.4 Pathogens Isolated

The **Figure 7** shows the pathogens isolated. *Pseudomonas aeruginosa* was the commonest pathogen isolated 26(30.2%), followed by *Pseudomonas spp.* 21(24.4%), *Escherichia coli* 17(19.8%), *Klebsiella spp.* 12(14.0%). Coagulase Negative Staphylococcus accounted for 2(2.3%).

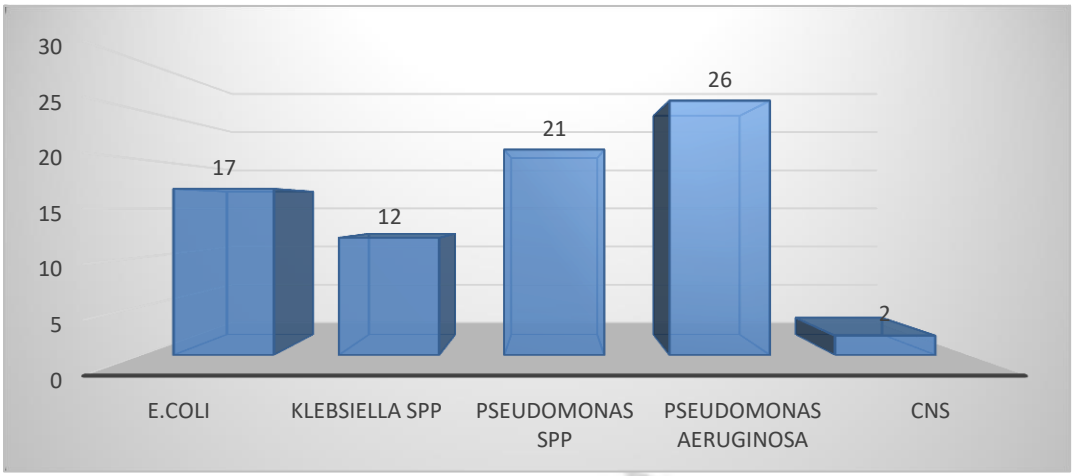


Figure 7: Pathogens isolated

4.5: Prevalence of infection

The **Table 4** below shows the total prevalence of infection of 90.7%, with *Pseudomonas aeruginosa* recording the highest prevalence, 30.7%

Table 4: Prevalence of infection

	Number of isolates	**Percentage (%)**
Pseudomonas aeruginosa	26	30.2
Pseudomonas spp.	21	24.4
Escherichia coli	17	19.8
Klebsiella spp.	12	14.0
Coagulase Negative Staphylococcus	2	2.3
Total	78	90.7

4.6 Ward distribution of pathogens

The **Table 5** shows the distribution of pathogens at the wards D2C and BICU. *Pseudomonas aeruginosa* was the most common isolate associated with both wards.

Table 5: Ward distribution of pathogens

	BICU	D2C	TOTAL
Pseudomonas aeruginosa	10	16	26
Pseudomonas spp.	9	12	21
Escherichia coli	9	8	17
Klebsiella spp.	8	4	12
CNS	0	2	2
Total	41	45	86

4.7Antibiotics administered before Culture and Sensitivity

The **Figure 8** below shows Cefuroxime (51%) was the antibiotic mostly administered to the burns patients followed by Ciprofloxacin (12%), combination of Amoksiklav and Ceftriaxone (9%) and Ceftriaxone only (9%).

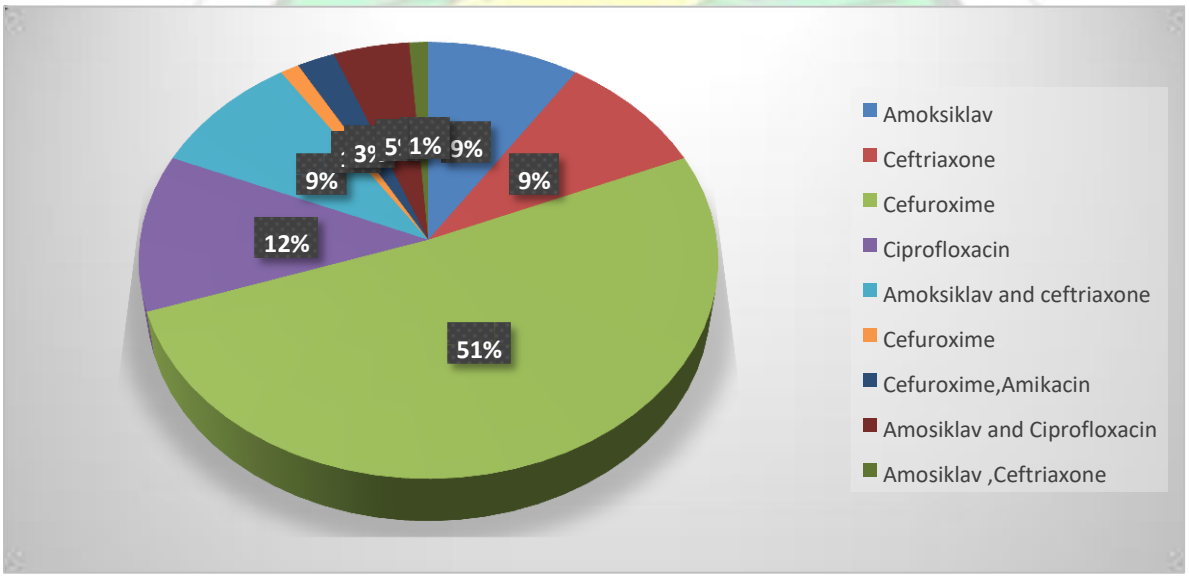


Figure 8: Antibiotics administered before Culture and Sensitivity

4.8 Organisms and their sensitivity patterns

The **Figure 9** below shows the sensitivity patterns of the various isolates to antibiotics.

Meropenem showed the highest sensitivity to all the pathogens isolated.

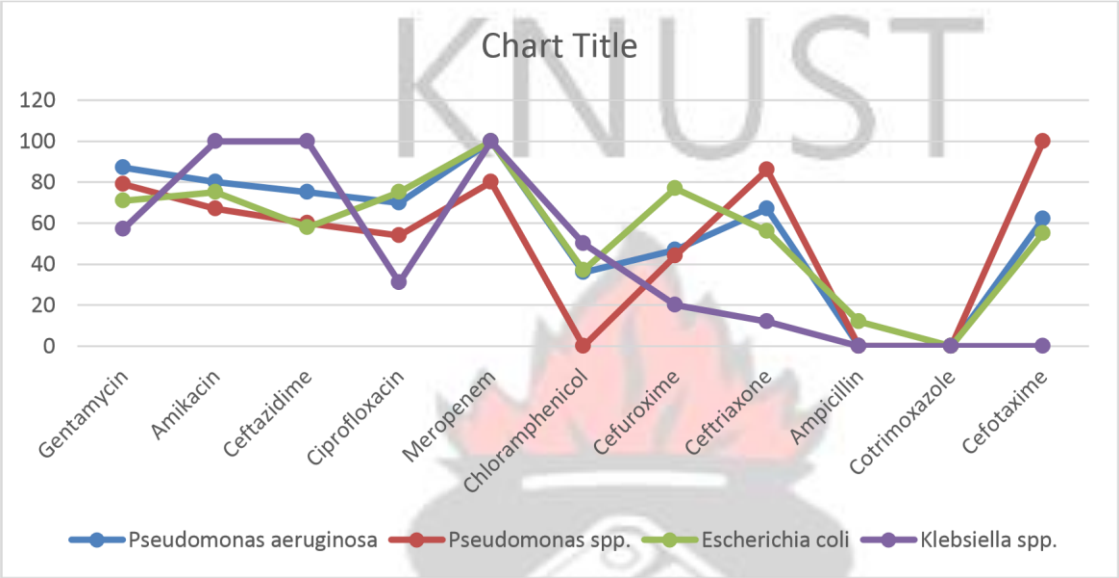


Figure 9: Organisms and their sensitivity patterns

5.0 DISCUSSION

In the current study *Pseudomonas aeruginosa* was the commonest pathogen isolated (30.2%), followed by *Pseudomonas spp* (24.4%), *Escherichia coli* (19.8%) and *Klebsiella spp* (14.0%). The current study revealed *Pseudomonas aeruginosa* as the commonest isolate in the Old Burns Ward D2C and *Pseudomonas spp.* as the commonest isolate in the BICU. *Pseudomonas aeruginosa* has been noted as the commonest cause of invasive burn wound infection. The current study revealed *Pseudomonas aeruginosa* as the commonest isolate in the old Burns Ward D2C. This is consistent with studies by Yousefi-Mashouf and Hashemi (2006) reported *Pseudomonas aeruginosa* as the predominant infection causing pathogen in their Burns Center. Similar finding was also reported by Dash *et al.* (2013) with *Pseudomonas aeruginosa* was a predominant isolate (49.4%) in a tertiary care hospital in India.

The current study reveals *Pseudomonas spp.* as the commonest isolate in the BICU. Kulkarni et al. (2015) reported *Pseudomonas spp.* as the predominant bacteria causing burn wound infection in their study setting at Kalaburgi region in India. Saleh and Noshad (2014) also reported Pseudomonas as the common causative pathogen in their burns Centre. Sharma & Hans (1996) and Agnihotri et al. (2004) reported a high incidence of *Pseudomonas spp.* isolated in their study. Pseudomonas spp. (33.6%) was identified as the commonest isolate in the study by Lakshmi et al., (2015). Similar findings on *Pseudomonas spp.* as the commonest burns isolate have been reported (Ekrami and Kalantar, 2007; Agnihotri *et al.*, 2004). From the current study, Coagulase Negative Staphylococcus (CNS) accounted for 2.3% of organisms isolated from the burn wound. This finding is similar to a study by Mama et al., (2014) in which they reported a 14.5% CNS isolated from wounds. CNS being a normal skin flora and common contaminant of wound most often may be isolated (Mama et al., 2014).

The only Gram positive isolate was Coagulase Negative Staphylococcus while Gram negative bacteria identified were *Pseudomonas aeruginosa, Pseudomonas spp., Klebsiella spp, Escherichia coli*. The findings from the current study is consistent with studies by Revathi et al., (1998), Shahzad et al., (2012) and Mundhada et al., (2015)Lashkmi et al., (2015). Form the current study, *Escherichia coli* 17(19.8%) and *Klebsiella spp.* 12(14.0%) were also identified. Agnihotri et al. (2004) reported *Klebsiella spp.* prevalence of (3.9%) in their five year retrospective study of aerobic burn wound infection. In their three year review of antibiogram of burn isolates, Bayram et al., (2013) reported 10% prevalence of *Escherichia coli*.

From the current study, most of the isolates were sensitive to Meropenem (B- lactam antibiotic) and Amikacin (an aminoglycoside). Meropenem was similarly being reported by Guggenheim et al. (2009) in a similar burn study as the most sensitive antimicrobial compared to other antimicrobials. The current study is also consistent with findings by Bayram et al., (2013), Lashkmi et al., (2015). Mundhada et al., (2015) reported similar findings in their study that gram negatives were susceptible to Imipenem (B-lactam antibiotic) and Amikacin (an aminoglycoside).

Prevalence of infection in the current study was 90.7% indicating that burn wound infection continues to be a major challenge burn centers face as infection is associated with delayed wound healing and increased length of hospital stay. This finding is consistent with a study by Melake *et al.* (2015) in which they reported burn wound infection prevalence of 36% (Melake at al., 2015).

The current study showed 11% of patients who received some form of first aid in the form of grounded shells, eggs, honey. This finding is consistent with a study by Abubakar *et al.*, (2015) who in their study reported that some of these first aid substances such as cow dung, mud amongst others maybe important source of infection to the burns patients, hence the need for

public education and sensitization on burns and the requisite form of first aid that can be administered to reduce infection of burn wound.

The current study showed children aged 0-5 years suffered from burns the most. Under development of the cognitive function of children and their tendency to move about during their early developmental stage causes them to pull and push objects which may contain very hot liquids causing them to sustain severe burns injuries (Agbenorku, 2013).This finding is consistent with most studies by Agbenorku, 2013; Dissanaike et al., 2009; Natterer et al., 2009 who have reported a high incidence in this same age group. Kemp et al. (2014) also reported 58% burns injury resulting from scalds, 72% of burns occurring in children less than 5years with highest prevalence occurring in 1 year olds with commonest scalding agent being hot beverage, 55%.

In the current study, 59.3% of the patients were males and 40.7% were females. Similar findings have been reported by studies conducted at other burns centers. Iqbal & Saaiq, (2011) recorded 66.84% males and 33.15% females in their study. Ogundipe et al. (2009) also recorded a male dominance of 52.2% than females 47.8%. Gupta et al. (2011) also reported that out of 892 patients, 485 (54%) were males and 407 (46%) were females.

From the current study, scalding (51.2%) was noted as the commonest aetiology of burns suffered by mostly children. This is consistent with study by Delgado et al. (2002) in which they reported scalding as the most common cause of burns in children under 5 years. The study revealed hot water as the leading scalding agent. This is consistent with study by Agbenorku, (2013) in which hot water accounted for the highest aetiology (68.1%) followed by hot soup (15.6%), hot oil (9.2%). Similar findings have been reported (Iqbal and Saaiq, 2011; Mahalakshmy *et al.,* 2011).

High resistance to antibiotic may be due to self-medication, inappropriate antibiotic use as a result of unavailability of guideline regarding drug selection (Mama *et al.,* 2014). From the

current study, it may be concluded that some of the patients may have already developed resistance to antibiotics that were administered to them. Subsequently, antibiotics administered to them prior culture may possibly affect bacteria growth and resistance. Paruk *et al.* (2012) in their study in intensive care units in South Africa reported that inappropriate antibiotics administered to patients were associated with poor patient outcome.

5.1 LIMITATIONS

Burn patients are not readily available unlike other conditions where larger number of patients may be enrolled within the same time frame.

5.2 CONCLUSION

Pseudomonas aeruginosa and *Pseudomonas spp.* were the most common pathogens isolated in this study. Meropenem, a B-lactam antibiotic, was identified as the most sensitive antibiotic. Overall prevalence of burn wound infection in the current study was 90.7%. Scalding was the commonest aetiology of burn in the study and was mostly suffered by children aged 0-5years. Males had high predominance of burn injuries compared to females.

5.3 RECOMMENDATIONS

1. Regular antimicrobial surveillance of the KATH Burns Centers (BICU and Ward D2C) should be promoted to guide empiric choice of antimicrobials for burn treatment at KATH.
2. This research is recommended to other burn centers in order to elicit the corresponding results to help them in the management of burn wound infections.
3. There should be close supervision of children in their early stages of development to ward off any burn occurrences.

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APPENDIX 1

QUESTIONNAIRE

TOPIC: EPIDEMIOLOGICAL INVESTIGATION AND PROFILING OF ANTIMICROBIAL SUSCEPTIBILITY PATTERNS OF BURN WOUND ISOLATES IN A TERTIARY HOSPITAL

QUESTIONNAIRE No……

PATIENT NAME:……..FOLDER NO:……..

DATE:…… WARD……..

A. DEMOGRAPHY

1. Sex: Male [] Female []
2. Age (in completed years) ___ ___
3. Level of education: No formal education [] Pre- school [] Primary [] JHS [] SHS [] Tertiary []Post – tertiary education [] Other []
4. Occupation: Unemployed [] Student [] Government worker [] Artisans [] Farmer [] Business [] Petty trader []
5. Where do you live?.....
6. Community status: Urban [] Rural area []

B. CLINICAL INFORMATION

7. a) Aetiology of burns: Scalds [] Open flame [] Chemical [] Electrical [] Frictional burns [ ] Inhalational injury [ ] Others [ ]

   b)What the intent of the burns? Intentional [] Unintentional? []
8. Anatomical sites affected: Head & Neck [ ] Anterior Trunk [ ] Posterior trunk [ ] Right Upper limb [ ] Left Upper limb [ ] Left lower limb [ ] Right lower limb [ ]

Perineum [ ] Whole body [ ]

9. Total Burned Surface Area…….

10. What was the location of burns occurrence?.....

11. Was first aid given? Yes [] No []

12. What first aid was given? Water [] Palm oil [] Gention violet [] Mercurochrome [] Mud [] Cow dung [] Cassava/Corn dough [] Tooth paste [] Honey [] Traditional medicine [] Others []

13. Date of occurrence……

14. At what time of day did the burns occur?Morning (6.00- 11.59) [] Afternoon (12.00- 4.00) [] Evening (4.01- 8.00) [] Night (10.00- 12midnight)[] Dawn (12.01- 5.59 am) []

15. Time between the burns occurrence and reporting to the hospital? ……

16. What was the cause of delay? Poverty(Money) [] Traditional medicine [] Distance – far away [] Referral [ ]

17. Antibiotics received…….

C. OUTCOME OF LABORATORY INVESTIGATION

18. Name of pathogen isolated……..

19. Antibiotics that are sensitive to the isolate…….

20. Antibiotics that are resistant to the isolate……

APPENDIX 2: IMAGES OF SOME BURNS PATIENTS

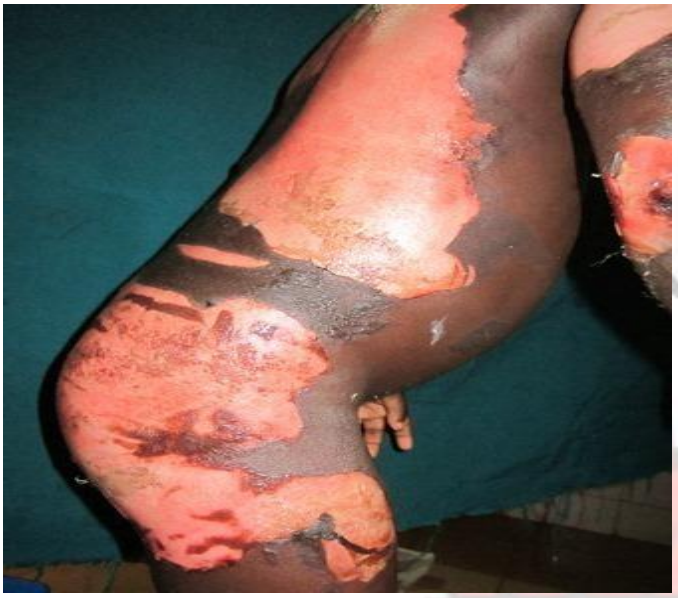

Plate 1: Scalding caused by hot water

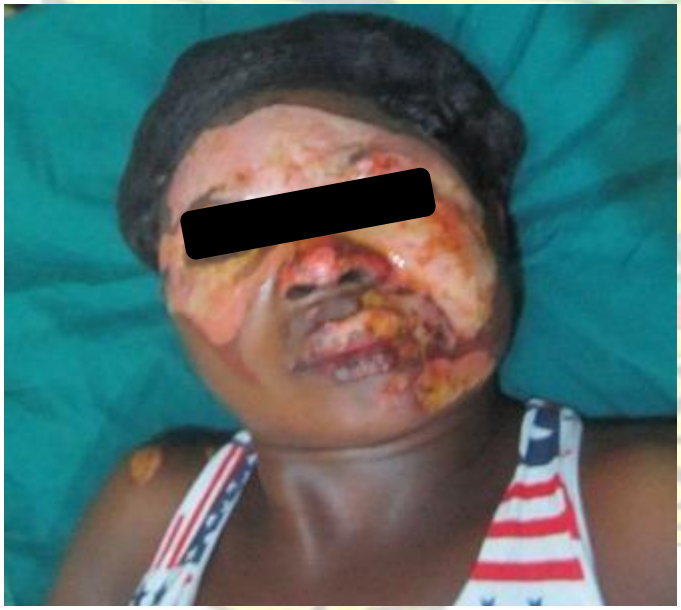

Plate 2: Burns to the face caused by gas explosion