THE PREVALENCE OF INFECTION, MICROBIOLOGIC PROFILE AND ANTIMICROBIAL SENSITIVITY PATTERN OF BURN WOUNDS AS SEEN AT KENYATTA NATIONAL HOSPITAL

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Dissertation submitted in part fulfillment of the requirements for the award of Master of Medicine in General Surgery of the University of Nairobi.

DECLARATION

I hereby certify that this is my original work and has not been presented for a degree in any other university.

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DEDICATION

To my mother Mrs. Elizabeth Kirui for her support during this process.

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ABBREVIATIONS

Cfu/g - Colony forming units per gram

E. coli – Escherichia coli

Hb - Hemoglobin

H/E – Hematoxylin and eosin

HIV – Human immunodeficiency virus

ISO – International organization for standardization

KNH – Kenyatta National Hospital

KNH - UoN/ERC – Kenyatta National Hospital, University of Nairobi Ethics and research committee

MRSA – Methicillin resistant Staphylococcus aureus

Spp - Species

SPSS- Statistical package for the social sciences

TBSA – Total body surface area

WBC – White blood cell

WHO – World Health Organization

Yr - year

ABSTRACT

Background:

Burn injuries are one of the most common and devastating causes of trauma, more so in developing countries. A majority of mortalities from burn injuries is due to sepsis.

Infection causing microorganisms in any burn facility change with time with emergence of new drug resistant strains. Therefore, heightened surveillance of burn wound microorganisms in burn facilities along with their susceptibility patterns is essential.

Objective:

The aim of this study was to determine the prevalence and microbiologic profile of wound infection and antimicrobial sensitivity of burn patients admitted at Kenyatta National Hospital.

Materials and Methods:

This was a cross sectional study involving burn patients admitted in KNH burns unit and ward 4D carried out over a period of three months from March 2018 to May 2018.

Swabs were collected using the Levine technique for microscopy culture and sensitivity from the burn wounds of the patients who met the inclusion criteria for the study. The results of were then correlated with the site, size, type and duration of the burns and the patients characteristics.

Data was be collected using a predesigned questionnaire and analyzed using IBM SPSS version 21. Means and standard deviations or medians and ranges were be calculated for continuous data while percentages were be calculated for categorical data.

The microbiologic pattern was be determined by calculating the frequency of occurrence of types of microorganisms. The antibiotic sensitivity pattern of micro-organisms cultured from burn wounds was be determined by calculating proportions of microorganisms above established cut-off values for antibiotic sensitivity.

Statistical significance was determined using a p value cut-off of < 0.05.

Results:

80 patients participated in the study. The infection rate among these patients was at 88.8% (n = 71). In the plastic surgical ward, the infection rate was 90.7% (n = 41) while among patients from the burns unit, the infection rate was 84.6% (n = 22).

The microorganisms cultured included: Proteus mirabillis at 34.2% (n = 26), Staphylococcus aureas at 18.8% (n = 15) and Pseudomonas aeruginosa at 10.5% (n = 8) these bacteria were cultured from both plastic surgical ward and the burns unit. Bacteria cultured only from the burns unit included, Staphylococcus pseudointermedius at 10.5% (n = 8), Escherichia coli at 7.9% (n = 6) and Actinobacter baumanii complex at 6.6% (n = 5).

The cultured bacteria was tested against various antibiotics with widely varying sensitivity and resistance these antibiotics.

Conclusion:

There is a high prevalence of infection among burn wounds of patients admitted at KNH.

There is variation in bacterial sensitivity to the antibiotics tested against, with a high level of resistance to some of the commonly used antibiotics in KNH.

INTRODUCTION

A burn is an injury to the skin or other organic tissue primarily caused by thermal or other acute trauma[17].

It occurs when some or all of the cells in the skin or other tissues are destroyed by hot liquids, solids or flames. It can also be due to radiation, electricity, friction or contact with chemicals[17].

Burn injuries are a significant cause of morbidity and mortality throughout the world. A majority of these occurring in middle and low income countries.

Burn injuries occur in all age groups and may range in severity from very minor injuries requiring no treatment to extremely severe injuries requiring highest level of intensive care and treatment[1-5].

Following the initial period of shock, sepsis is the main complication of burns [3, 6]. About 75% of the mortalities associated with burn injuries are related to sepsis rather than osmotic shock and hypovolemia. The situation being worse in developing countries[3-5, 7, 11, 12].

In KNH, majority of burn injury patients are admitted to the burns unit for acute management, from where they are transferred to ward 4D. This includes patients with:

- Inhalation injury.
- Electrical burns.
- Chemical burns.
- Burns that involve the face, hands, feet, genitalia, perineum or major joints.
- Circumferential burns to trunk or limbs.
- Burns associated with major trauma or significant co-morbidities.
- Partial thickness burns greater than 10% or full thickness burs more than 1% in any age group.

Other burn injury patients who require admission but don't fit the criteria for admission to the burns unit are admitted to ward 4D.

A retrospective study by Dr. Wanjeri Joseph found that a total of 1021 patients were admitted with burn injuries between January 1991 and December 1992 to KNH. This represented 25.6% of the total admissions to KNH during that period. 18.7% of the 347 patients studied had burn wound infection[15]. Infecting organisms included, Staphylococcus aureas (32%), Pseudomonas aeruginosa (21%) and Proteus species (11%).

In another study conducted in 2013 by Moses Gitau, of the 93 burn injury patients admitted at KNH that were recruited in the study; the overall rate of burn infection was 23.6% and the overall mortality rate was 14%[16].

The infection causing microorganisms in any burn facility change with time with appearance of drug resistant strains. This is influenced by the topical agents and the systemic antibiotics in use at the facility[14].

Infection with multi drug resistant pathogens increases morbidity, decreases treatment success, reduces hospital turn-over rate and increases the cost of patient care[14].

Therefore an in-depth knowledge of the organisms in that facility along with their drug susceptibility pattern is necessary[13, 14].

LITERATURE REVIEW

Epidemiology

According to WHO, burns account for an estimated 180 000 deaths annually. The majority of which occur in low and middle income countries. Almost two thirds of these mortalities occur in Africa and South-East Asia[2].

In 2004, about 11 million people worldwide were burned severely enough to require medical attention[2].

A total of 1021 patients were admitted with burn injuries between January 1991 and December 1992 to KNH[15].

According to the KNH records department, over the period of 8 months from January 2017 to August 2017, 238 burns injury patients were admitted to KNH burns unit. 171 of these patients were transferred to ward 4D. There were 51 mortalities in burns unit during this period.

During the same period, ward 4D admitted 380 patients of which 171 were from burns unit with the rest from casualty and the plastic surgery clinic. Of the 209 patients admitted straight to ward 4D 53 patients had burn injuries. There were 16 mortalities in ward 4D during this period.

A study in 2013 including 93 burn injury patients admitted to KNH found an infection rate of 23.6% and a mortality rate of 14%[16].

Classification of burns[3, 17]

Burns can be classified according to:

Cause

- Flame burns: damage from superheated, oxidized air.
- Scalds: damage from contact with hot liquids.
- Contact burns: damage from contact with hot or cold solid materials
- Chemical burns: contact with noxious chemicals
- Electric burns: from conduction of electrical current through tissues

Depth

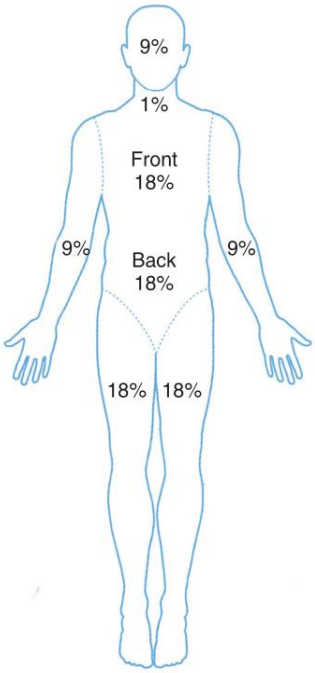
- First degree: injury localized to the epidermis
- Superficial second degree: injury to the epidermis and superficial dermis
- Deep second degree: injury through the epidermis and deep into the dermis
- Third degree: full-thickness injury through the epidermis and dermis into subcutaneous fat
- Fourth degree: injury through the skin and subcutaneous fat into underlying muscle or bone.

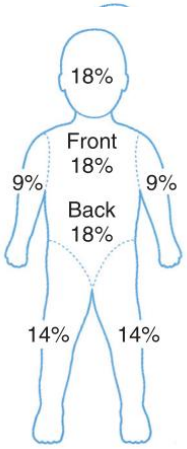
Burn size

Determination of the burnt surface area size estimates the extent of injury. Various methods can be used to estimate the size of burns. These include:

The “rule of nines”: Here, multiples of 9 are used to estimate TBSA burnt as follows[14].

Adult body	% of total
Part	BSA
Arm	9%
Head	9%
Neck	1%
Leg	18%
Anterior trunk	18%
Posterior trunk	18%





Child body	% of total
Part	BSA
Arm	9%
Head and neck	18%
Leg	14%
Anterior trunk	18%
Posterior trunk	18%

The “rule of nines” is inaccurate when used in children[19].

Smaller burns can be estimated by equating the area of the open hand of the patient to be approximately 1% TBSA, this is then transposed visually onto the wound for determination of its size. This method is used in evaluating burns of mixed distribution[14]. It is inaccurate in calculating burn surface area for medium sized burns[19].

The Berkow formula: this is used to accurately determine size of total body surface area burnt in children[17]

BODY PART	0-1 YEARS	1-4 YEARS	5-9 YEARS	10-14 YEARS	15-18 YEARS	ADULT
Head	19	17	13	11	9	7
Neck	2	2	2	2	2	2
Anterior trunk	13	13	13	13	13	13
Posterior trunk	13	13	13	13	13	13
Right buttock	2.5	2.5	2.5	2.5	2.5	2.5
Left buttock	2.5	2.5	2.5	2.5	2.5	2.5
Genitalia	1	1	1	1	1	1
Right upper arm	4	4	4	4	4	4
Left upper arm	4	4	4	4	4	4
Right lower arm	3	3	3	3	3	3
Left lower arm	3	3	3	3	3	3
Right hand	2.5	2.5	2.5	2.5	2.5	2.5
Left hand	2.5	2.5	2.5	2.5	2.5	2.5
Right thigh	5.5	6.5	8	8.5	9	9.5
Left thigh	5.5	6.5	8	8.5	9	9.5
Right leg	5	5	5.5	6	6.5	7
Left leg	5	5	5.5	6	6.5	7
Right foot	3.5	3.5	3.5	3.5	3.5	3.5
Left foot	3.5	3.5	3.5	3.5	3.5	3.5

The Lund and Browder chart: provides an estimate of burn TBSA for each body part based on the individual's age[18]

Area	Birth – 1yr	1-4 yrs	5-9yrs	10-14yrs	15yrs	Adult	Partial thickness 2^0	Full thickness 3^0	Total
Head	19	17	13	11	9	7			
Neck	2	2	2	2	2	2			
Anterior trunk	13	13	13	13	13	13			
Posterior trunk	13	13	13	13	13	13			
Right buttock	2.5	2.5	2.5	2.5	2.5	2.5			
Left buttock	2.5	2.5	2.5	2.5	2.5	2.5			
Genitalia	1	1	1	1	1	1			
Right upper arm	4	4	4	4	4	4			
Left upper arm	4	4	4	4	4	4			
Right lower arm	3	3	3	3	3	3			
Left lower arm	3	3	3	3	3	3			
Right hand	2.5	2.5	2.5	2.5	2.5	2.5			
Left hand	2.5	2.5	2.5	2.5	2.5	2.5			
Right thigh	5.5	6.5	8	8.5	9	9.5			
Left thigh	5.5	6.5	8	8.5	9	9.5			
Right leg	5	5	5.5	6	6.5	7			
Left leg	5	5	5.5	6	6.5	7			
Right foot	3.5	3.5	3.5	3.5	3.5	3.5			
Left foot	3.5	3.5	3.5	3.5	3.5	3.5			
Total									

The Lund and Browder chart is the most accurate method when used correctly[19].

Pathophysiology

Infection is the invasion and proliferation by one or more species of microorganisms anywhere within the body's usually sterile tissues[20].

Burn injury destroys the skin barrier that normally prevents invasion by microorganisms. Loss of this cutaneous barrier facilitates entry of the patient's own flora and other microorganisms from the hospital environment into the burn wound, making the burn wound the most frequent origin of sepsis in these patients.[3, 6, 11,12, 21, 22]
The frequency of infection parallels the extent and severity of the burn injury[3, 21].

Thermal injury also causes coagulative necrosis of tissues, this becomes a favorable niche for bacterial colonization and proliferation[3, 12, 21].

The eschar provides a devitalized, protein-rich environment, which further benefits bacterial proliferation through its exclusion from the systemic circulation and impaired local immune responses leading to the high susceptibility of the burn wound to infection[3, 9, 10, 21].

Initially, the immunologic response to severe burn injury is pro-inflammatory but later becomes predominately anti-inflammatory in an effort to maintain homeostasis and restore normal physiology. Cytokines and cellular responses mediate both of these phases[3].

Burn injury to the skin causes a massive release of humoral factors, including cytokines, prostaglandins, vasoactive prostanoids and leukotrienes [10, 23]. These factors accumulate at the site of injury resulting in a spillover into the systemic circulation, giving rise to systemic immunosuppression.

All arms of the immune system are involved in this immunosuppression.

Chemotaxis, phagocytic and bactericidal activity is reduced in neutrophils[10, 25]. Lymphocytes reduce their phagocytic activity and lymphokine production. The effect on T lymphocytes is to increase the number of suppressor cells and to decrease the number of helper cells. Natural killer cell activity is also diminished [7, 10, 21].

Secondary immunosuppression after burn injuries can also be attributed the endocrine system. There is an increase in levels of vasopressin, aldosterone, cortisol, glucagon, growth hormone, and

catecholamines. These directly affect lymphocyte proliferation, secretion of proinflammatory cytokines, natural killer cell activity, and suppressor T cells[21].

Thus, a burn patient is predisposed to infection at remote sites as well as at the site of the burn injury[3, 21].

Burn wound infection causes progression of the wound from a partial thickness to a full-thickness wound.

There is the further possibility of systemic dissemination, especially if the intra-eschar organisms exceed 10^5 cfu per gram of tissue leading to sepsis. Infection also causes delay or non-healing of the wound, gives rise to hypertrophic scars, graft loss, prolonged hospital stay and substantial increase in mortality[8, 9].

The severity of complications depends mainly on the infecting pathogen, the site of infection and patient characteristics[4].

Risk factors for the development of burn wound infection[3, 4, 9]

Risk factors for development of burn wound infection include factors attributed to the invading microorganism and the burnt patient.

Factors attributed to the microorganism include:

• Quantity of invading micro-organisms

• Virulence of the invading micro-organism

Patient factors that increase the risk of infection include[4, 8, 9]:

• Extremes of age

• Burns exceeding 30% TBSA

• Quality of the wound

• Invasive devices

• Prolonged open wounds

• Systemic antibiotics use

• Lengthy hospitalization

• Blood transfusions

• Number of days ventilated

• Co-morbidities (such as obesity, diabetes, immunosuppression, malnutrition, HIV).

Burns covering less than 10% TBSA and of partial thickness carry the lowest risk of infection and mortality, but these increase as the percentage TBSA and depth of burn increase.

Types of burn wound infection[9].

Contamination: This is the presence of non-multiplying bacteria on the wound. It is a transient phenomenon. Wound healing not delayed.

Colonization: The presence of multiplying bacteria within the wound, with no host reaction or pathogenic effects.

Burn wound infection: Multiplying bacteria in the wound, but not deeply invasive, resulting in regional and systemic effects.

Invasive infection: This is defined by:

- More than 10^5 cfu/g of tissue which on histology may show micro-invasion, deep invasion into viable tissue or micro-vascular and lymphatic involvement.
- A rapid change in burn wound appearance may be present.
- Invasion into sub-eschar tissue and systemic spread.
- Suppurative separation of the eschar or graft loss

Necrotising infection/fasciitis:

An aggressive invasive infection with involvement of structures beneath the skin

Microbial etiology of burn wound infections

The burn wound is initially sterile. However, gram positive bacteria from hair follicles, sweat glands and from the surrounding tissue which survive the thermal injury colonize the wound within 48 hours of injury [3, 6]. The number of bacteria grows rapidly beneath the burn eschar, reaching approximately 8.4×10^3 cfu/g on day 4 after the burn.

By day 7, the wound is colonized by other organisms, including gram-negative bacteria (which will gradually supersede the gram-positive organisms) and yeasts. These are derived from the gastrointestinal and upper respiratory flora, urogenital tracts or from the hospital environment[3, 7, 9, 10, 14, 21].

Microorganisms are also transmitted to the burn wound surfaces from recently admitted patients, by the hands of personnel and by fomites[3, 10, 21].

Gram positive cocci such as Staphylococus aureus and Streptococcus pyogenes; gram negative bacilli: mostly Acinetobacter, Enterobacter, E. coli, Proteus spp, Pseudomonas aeruginosa and anaerobic bacteria such as Propionibacterium spp and Klebsiella spp are among organisms commonly found in infected burn wounds. [3, 7, 10, 11, 12, 14, 26, 27]

Gram-negative organisms are most common by virtue of their virulent factors and antimicrobial resistant traits.

The increasing prevalence of resistant and opportunistic infections such as methicillin-resistant Staphylococcus aureus (MRSA), Acinetobacter, multi-drug resistant Klebsiella and Pseudomonas is due to indiscriminate use of antiseptics and antibiotics[3, 9, 12, 14, 21].

Pseudomonas is associated with a high mortality rate that may reach 80%[9].

Anaerobic bacteria are less common. They are typically found in infections from electrical burns or when open wound dressings are used[21].

Fungal infections, especially Candida species, can be present in 30% of burns. They are usually seen in the context of extensive burns complicated by delayed healing, following the use of broad-spectrum antibiotics, and in critically sick patients. Other fungal infecting agents include Aspergillus species, and the agents of mucormycosis[3, 9, 10, 21, 28].

Fungal infections significantly increase the risk of mortality for all percentages of burns[10].

Viral infections are often subclinical and seen in burns greater than 50% TBSA. They have little or no effect on the acute course of the burn wound [6, 9, 21].

Bacterial micro-colonies produce biofilms enveloped within a self-produced matrix, or slime, which acts as an effective barrier against host defenses and antimicrobials and are a source of recontamination. These biofilms can form within 10 - 72 hours[9, 21].

The infective microorganisms in any burn facility change with time. Individual organisms are brought into the burns ward on the wounds of new patients. These organisms then persist in the resident flora of the burn treatment facility for a variable period of time, only to be replaced by newly arriving microorganisms. Introduction of new topical agents and systemic antibiotics influence the flora of the wound[14, 29].
The current spread of multi-drug resistant bacteria has heightened the need for regular bacteriological review of wound infections so as to avoid unguided empirical treatment [1, 20].

The misuse and mismanagement of antibiotics leading to drug resistance is particularly worse in resource-poor countries where sale of antibiotics is poorly controlled [2, 9].

Infections with multi drug resistant pathogens increase morbidity, decrease treatment success, reduce hospital turn-over rate and increase cost of patient care[14].

Diagnosis of burn wound infection

Burn wound infection diagnosis can be made clinically or by use of laboratory investigations.

Clinical signs of wound infection

The wounds have a macerated appearance with an exudative discharge.

There may be rapid purplish, haemorrhagic wound discoloration, deepening of the wound, development of friable or bleeding granulation tissue, eschar separation and tissue necrosis. Ecthyma gangrenosum and spreading peri-wound cellulitis may also occur[9].

Systemic features of burn wound infection include progressive tachycardia and tachypnoea, haemodynamic instability, hyper- (>39°C) or hypothermia (<36.5°C), anaemia,

thrombocytopenia, changes in the WBC count, hyperglycaemia, ileus, abdominal distension, intolerance to enteral feeding, and mental confusion[9, 10].

Following colonization, these organisms start penetrating the viable tissue depending on their invasive capacity, local wound factors and the degree of the patient's immunosuppression. If sub-eschar tissue is invaded, disseminated infection is likely to occur. Great emphasis must therefore be placed on early identification of local signs of burn wound infection and treatment[29].

Laboratory investigations

The purpose of these investigations is to identify the microorganism(s), quantify the bacterial burden and determine their sensitivity and resistance patterns[9].

The results facilitate selection of the appropriate therapy and monitoring of response.

Many methods have been identified and it is important to select an optimal method suitable to local circumstances[9].

Surface swab cultures[3, 9, 10.]

This is the most commonly used technique for evaluating wound infections. It allows identification of surface organisms, but cannot distinguish between contamination and invasive burn wound infection.

The microorganism is identified with the growth expressed as slight, moderate or heavy.

Levine described a non-invasive quantitative swab technique which can diagnose infected burn wounds, with a linear numerical relationship between swab and biopsy counts[30, 31].

Quantitative tissue cultures[9, 10]

Quantitative cultures are useful for indicating the predominant microorganisms in the burn wound, identifying their species, and providing drug susceptibility data.

These cultures are labor intensive but can identify and analyze clinical infection more accurately than surface swabbing.

Three grams of tissue is required from multiple sites. These are then homogenized, serially diluted, plated out on agar plates and incubated for 24 - 48 hours.

A bacterial count of more than 10^5 cfu/g tissue signifies a heavily infected eschar with impending systemic spread.

Swab or tissue biopsy only represents the bacterial profile at that specific site, while there may be a great variation in the number and types of organisms, either colonizing or invading different areas of the wound, even if the wound has a uniform appearance.

Tissue histopathology (biopsy) [9, 10]

Multiple tissue biopsies can be taken from suspect areas and sent for microbiology and histopathology. Gram-positive organisms are detected using H/E stains while the Sandiford stain is used for detecting Gram-negative organisms. Similarly, special stains are used for suspected fungal infections in conjunction with fungal cultures.

Electro-microscopy studies are used for viral infections.

Identification of bacteria on histology represent a heavy intra-eschar bacterial burden. Tissue histopathology allows for staging of the bacterial invasive process as follows[6]:

- Stage 1
    - Superficial – bacteria found on the surface of the eschar.
    - Eschar penetration – variable depth of penetration of the eschar.
    - Sub-eschar penetration and proliferation.
- Stage 2
    - Sub-eschar micro-invasion.
    - Deep invasion into deeper tissues.
    - Vascular and lymphatic involvement.

STUDY JUSTIFICATION

Burns are a major cause of morbidity and mortality in our society[2].

About 75% of the mortalities that occur from burns are due sepsis[3-6, 7, 11].

Infecting microorganisms found in health facilities change with time with appearance of resistant microorganisms to the commonly used antimicrobial agents[13, 14].

Therefore regular monitoring and updating of information on prevalence of major local pathogens and their sensitivity pattern is important particularly to the health personnel responsible for the management of these patients in any given region. This will provide guidance for the usage of antibiotics in burn wound infection based on evidence[5, 14, 29].

The prevalent microorganisms and their antimicrobial sensitivity pattern found on burn wounds of patients admitted at KNH has not been studied, informing the need for this study.

STUDY OBJECTIVES

Main Objective

The study determined the prevalence of infection, microbiologic profile and antimicrobial sensitivity of burn wounds in patients admitted at KNH.

Specific objectives

1. The prevalence of infection of burn wounds in patients at Kenyatta National hospital was determined.
2. The variation in microbiologic pattern of wounds of burns patients at KNH based on the duration post burn, site of the burn, depth of burn, type of burn and patient characteristics was determined.
3. The antibiotic sensitivity pattern of micro-organisms cultured from wounds of burn patients at KNH was also determined.

MATERIALS AND METHODS

Study design

This was a cross sectional study design that allowed for data collection on both colonization of burn wounds and patient characteristics at a single point in time.

Study duration

The study was be conducted over a period of three months from March 2018 to May 2018.

Study Area

The study was conducted at the Kenyatta National Hospital's burns unit and ward 4D.

Study Population

The target population for this study will be the all patients admitted with burns in Kenyatta National Hospital.

Inclusion Criteria

Patients admitted with burn injury to the burns unit and ward 4D during the duration of the study who give informed consent to participate in the study were considered eligible to participate in the study.

Exclusion criteria

The following category of patients were excluded from the study:

- Patients who did not consent to be included in the study.
- Patients with burn wounds younger than 48 hours.
- Patients who were already on antibiotics

Sampling technique

Consecutive sampling was used.

Burns patients admitted in Burn Unit and ward 4D were be recruited into the study until the desired sample size was attained; provided that the patient met the inclusion criteria and gave consent to participate.

Sample Size

$$n_0 = \frac{Z^2 p(1-p)}{d^2}$$

Where n_0 is the calculated sample size assuming finite population of burns patients in KNH

Z is the statistic representing 95% level of confidence = 1.96

p is the prevalence of microorganism colonization of burns wounds in KNH (23.6%[2])

d is the margin of error set at 0.05

$$n_0 = \frac{1.96^2 \times 0.23(1-0.23)}{0.05^2}$$

$$n_0 = 272$$

$$n = \frac{n_0}{1 + \frac{(n_o - 1)}{N}}$$

Where n is the sample size

n_0 is the calculated sample size for infinite population = 272

N is the population of patients in KNH burns unit and ward 4D during the study period = 110 (90 patients admitted through the burns unit and 20 patients admitted straight to ward 4D)

Therefore, n = 79.

Recruitment and methods

Using consecutive sampling, patients admitted with burn wound injuries to Burns Unit and ward 4D of KNH were included in the study. Informed consent was obtained from the time of first contact with the patient for the patients who agreed to participate in the study.

Information was obtained from the patient including:

- Patient's demographic information.
- Duration in the ward.
- Duration since burn injury was occurred.
- Site of the burn wound.
- Size of burn wound (The Land and Browder chart was be used for estimation of the TBSA)
- Type of burn.
- Depth of the burn.
- Comorbidities such as Diabetes Mellitus or HIV.
- History of blood transfusion during the current admission.
- History of steroid use.

Swabs for microscopy culture and sensitivity were then taken from burn wounds of all recruited patients using the Levine technique (described below) by the principle researcher. The swabs were labelled and detailed laboratory request forms attached. The swabs were then be delivered to the microbiology laboratory within one hour of collection.

At the laboratory, some of the specimen was smeared on a glass slide for gram staining.

The swabs were then plated on blood agar, MacConkay and Sabaroud's dextrose agar media for incubation.

After incubation for 18-48 hours at 37^0 Celsius. The isolates were then identified using the vitek 2 system. This was also used for antibiotic sensitivity testing against the commonly used antibiotics at KNH.

All laboratory investigations were carried out at KNH microbiology laboratory.

Levine Method for wound swab for culture & sensitivity[31]

- A sterile cotton tipped swab and transport medium in a pre-packaged collection and transport system were used.
- A swab kit that has the capability for both anaerobic and aerobic cultures wase used and both tests were requested in the request form.
- The wound was then thoroughly rinsed with normal saline (non-bacteriostatic); if the wound is quite dry the swab was pre-moistened in the culture medium before pressing on the tissue.
- Pus, exudate, hard eschar or necrotic tissue was not swabbed. Healthy granulation tissue was swabbed in order to tell what microbes are in the viable tissue and not just what is on the surface.
- The swab tip was rotated in a 1cm square area of clean granulation tissue for a period of 5 seconds, using gentle pressure to release tissue exudate. This may cause discomfort, so the client/patient was prepared for the possibility
- The protective cap was then removed from culture medium and the cotton tipped applicator inserted into the culture medium without contaminating the applicator shaft.
- The swab was then delivered to the laboratory within 1 hour. The swab was not refrigerated.

Quality control protocol

- All the samples were collected by the principal researcher using the Levine technique thus ensuring that the right procedure was followed and done aseptically. The right sample was therefore collected and contamination was avoided.
- Samples were collected using sterile swabs in sealed containers.
- Samples were clearly labelled next to the patient and an accurately and detailed lab request form attached. This avoided errors in assigning the results.
- Samples were not be refrigerated, and were delivered to the laboratory within one hour.

- All laboratory work was done at KNH laboratory which is ISO certified and does its investigations including microscopy culture and sensitivity as per WHO guidelines.

Data Collection Techniques

Variables:

Dependent variable:

- Infection of burn wounds by microorganisms (bacteria and/ or fungi)

Independent variables:

- Site of burn
- Size of burn
- Depth of burn
- Type of burn
- Duration after the burn
- Patient characteristics

Data analysis and presentation

Data was analyzed using IBM SPSS statistics version 21.

The characteristics of the sample was summarized using appropriate descriptive statistics.

Means and standard deviations or medians and ranges were be calculated for continuous data e.g. age.

Percentages were calculated for categorical variables e.g. sex and type of burn wounds.

The dependent variable was determined by calculating the percentage of all burn patients recruited in the study with wound cultures that are positive for microorganism.

The microbiologic pattern was determined by calculating the frequency of occurrence of the various types of microorganisms.

The duration post burn, size of burn, site of the burn, type of burn and patient characteristics was be cross tabulated against microbiologic patterns and associations between microbiologic patterns and these factors determined using chi square test.

Statistical significance will be determined using a p value cutoff < 0.05.

Lastly, the antibiotic sensitivity pattern of micro-organisms cultured from burn wounds was determined by calculating proportions of microorganisms above established cut-off values for antibiotic sensitivity.

Ethical consideration

The purpose of the study was explained by the researcher to all potential participants prior to participation. Informed signed consent was then obtained before recruitment into the study. Assent was obtained from under-age patients unable to give consent.

Approval to carry out the study was sought from the Department of Surgery, University of Nairobi and the Kenyatta National Hospital Ethics and Research Committee (KNH/ERC)

Utmost confidentiality was maintained.

Patient names were not recorded. Data obtained in the study was password protected and only accessible to the principal researcher and data research manager.

RESULTS

The findings of the study are presented in this chapter. The broad objective of the study was to determine the prevalence, microbiologic profile of wound colonization and antimicrobial sensitivity of burn patients admitted at KNH.

Patient Demographics

This section presents the demographic information of the patients, and also looked at the relationship between the patients' demographic status and clinical findings. Where applicable, the Pearson Chi-square and Fisher's exact tests were used to ascertain association amongst the clinical variables and p-values were calculated. Mean and Standard Deviation are reported as Mean (SD). A P value <0.05 was considered statistically significant.

Demographic Characteristics

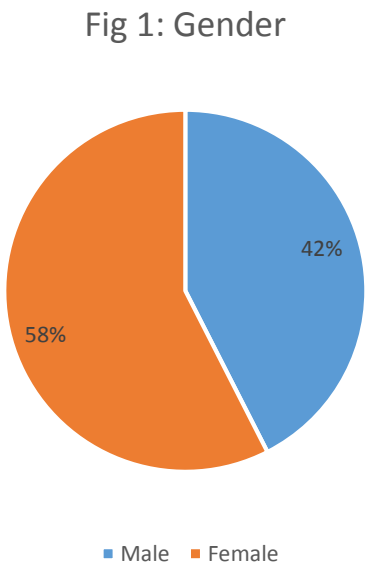


Figure 1: Gender

57.5% (n = 46) of the patients sampled were female while 42.5% (n = 34) were male (fig 1).

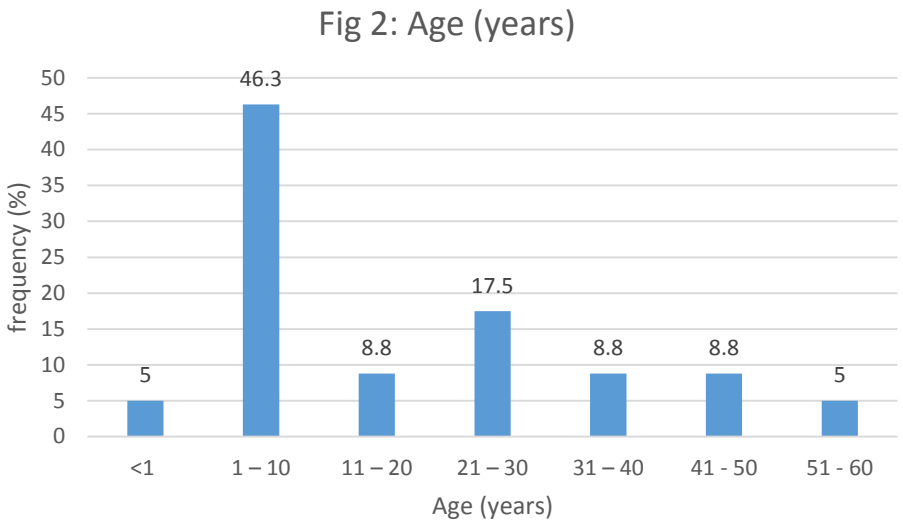


Figure 2: Age (years)

The age group 1-10 years had the highest number with 37 (46.3%) of the patients, this was followed by the 21-30 years age group with 14 (17.5%) of the patients. The median age was 10 years with an IQR of 25 years (fig 2).

Ward

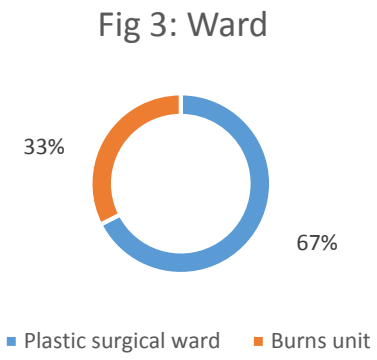


Figure 3: Ward

There were 67.5% (n = 54) patients sampled from the Plastic surgical ward, and 32.5% (n = 26) from the Burns unit (Fig 3).

Duration since Burn Injury

Majority of the patients sampled 52.5% (n = 42) had burn injury for 3 days or longer. 18.8% (n = 15) had the burn injury for one week or less while the rest of the sampled patients had the burn injury for between 8 days and 30 days (fig 4).

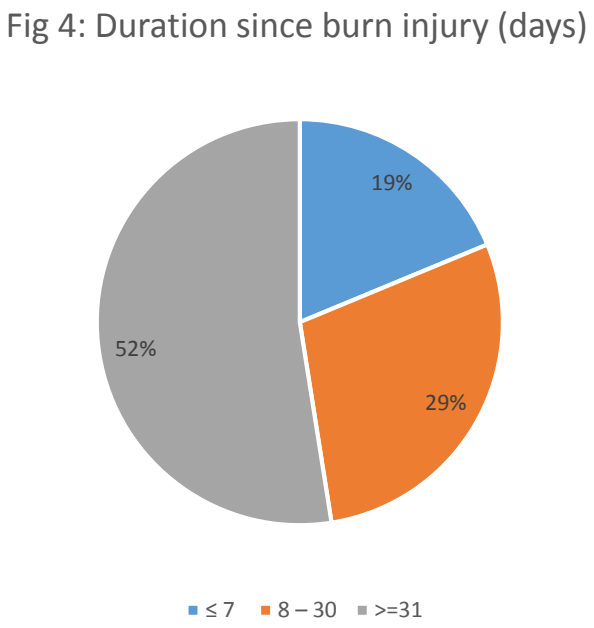


Figure 4: Duration since burn injury (days)

Table 1: Burns Characteristics

The type, percentage, depth, and site of burns of the patients is as shown by the table below.

	Frequency n (%)
Type of burn	
Flame	54 (67.5)
Scald	22 (27.5)
Electric	3 (3.8)
Contact	1 (1.3)
Percentage burn (%)	
<=10	7 (8.8)
11 – 30	50 (62.5)
>30	23 (28.8)
Depth	
Superficial 2nd degree	15 (18.8)
Superficial and Deep 2nd degree	43 (53.8)
Deep 2nd degree	18 (22.5)
Deep 2nd degree and 3rd degree	1 (1.3)
3rd degree	2 (2.5)
4th degree	1 (1.3)
Site	
LL	23 (28.7)
UL	20 (25.0)
Trunk	23(28.8)
Head and neck	12 (15)
Perineum	2 (2.5)

History of Blood Transfusion

36.3% (n = 29) of the sampled patients received blood transfusion during the current admission (fig 5).

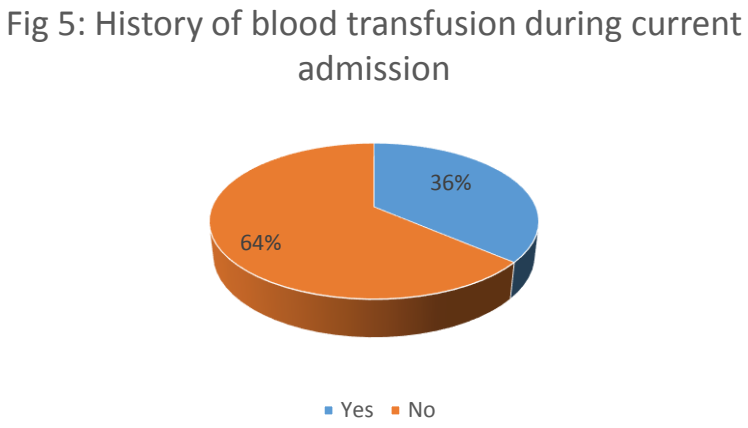


Figure 5: History of blood transfusion during current admission

Comorbidities

The only comorbidity identified on the sampled patients was HIV infection. 7.5% (n = 6) of sampled patients had HIV infection (fig 6).

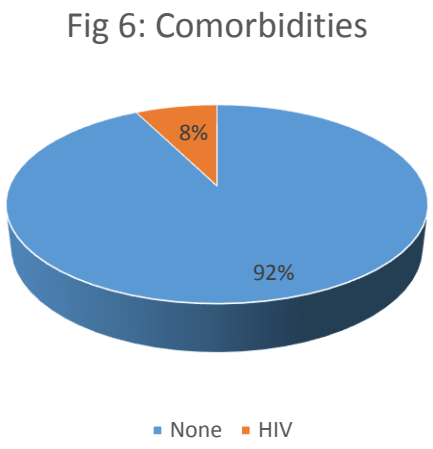


Figure 6: Comorbidities

Hemoglobin

2.5% (n = 2) of the sampled patients had a hb of 5g/dl or less; 40% (n = 36) had a hb of between 5.1g/dl and 10g/dl while 57.5% (n = 46) of the sampled patients had a hb of above 10g/dl (fig 7)

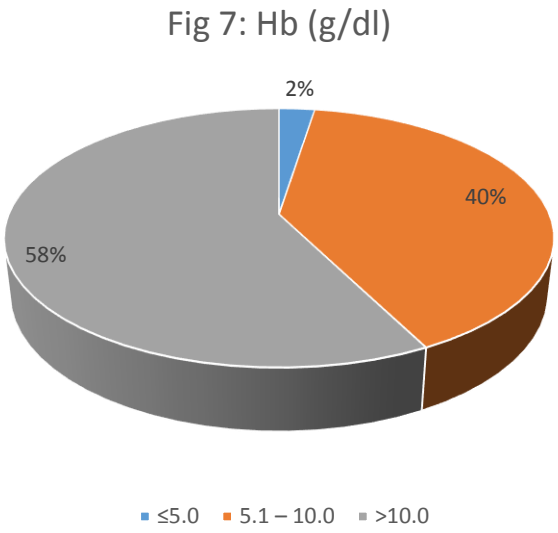


Figure 7: Hb (g/dll)

Table 2: Growth

		Ward n (%)		**Total**
		Plastic surgical ward	**Burns unit**	
Patient growth status	Growth	49 (90.7)	22 (84.6)	71 (88.8)
	No growth	5 (9.3)	4 (15.4)	9 (11.2)
Total		**54 (100.0)**	**26 (100.0)**	**80 (100.0)**

88.8% (n = 71) of all the sampled patients had infected wounds. In the plastic surgical ward, 90.7% (n = 49) had infected wounds while among patients sampled from burns unit, 84.6% (n = 22) had infected wounds (table 2).

Micro-organisms cultured

The following figure shows the microorganism cultured from the plastic surgical ward and the burns unit.

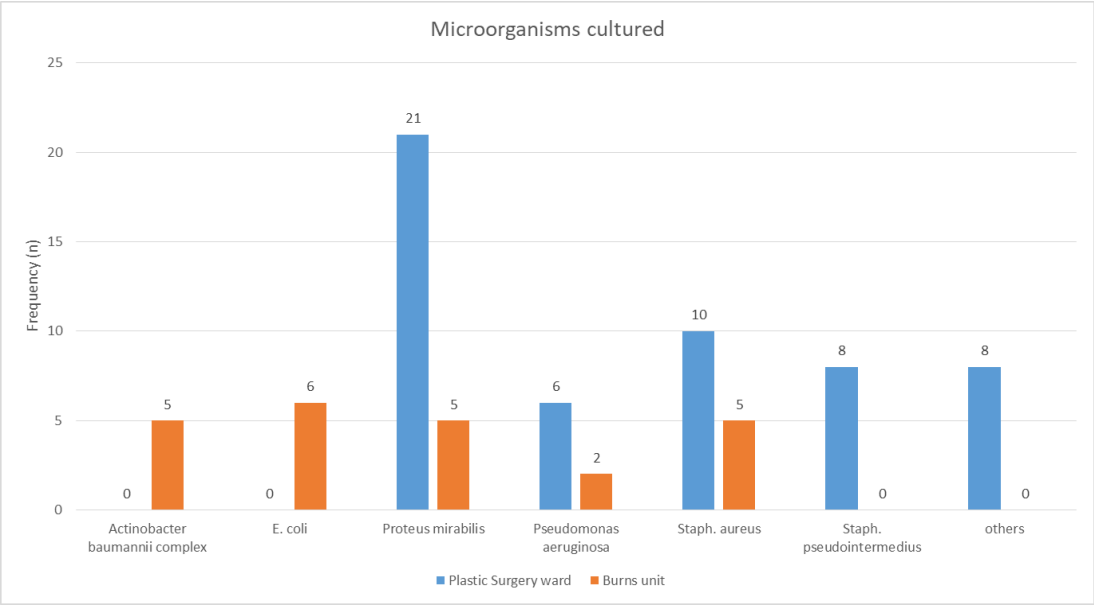


Fig 8: Microorganisms cultured

Table 3: Microbial growth pattern based on patient characteristics

The following table shows the bacterial growth pattern based on the patient characteristics including the gender, age, duration since burn injury, history of blood transfusion, comorbidity present and the hemoglobin level.

Table 4: Microbial growth pattern based on burn Characteristics

The following table show the bacterial growth pattern based on the burn characteristics including the cause of burn, percentage total body surface area burnt, depth of the burn and site of the burn.

Burn characteristic	Frequency n (%)						
	No growth	Actinobacter baumannii	E. coli	Proteus mirabilis	Pseudomonas aeruginosa	Staph. aureus	Staph. pseudointermedius
Cause							
Open Flame	8(14.8)	5(9.3)	6(11.1)	13(24.1)	6(11.1)	10(18.5)	5(9.3)
Scald	0(0.0)	0(0.0)	0(0.0)	12(54.6)	1(1.9)	4(18.2)	3(13.6)
Electric	1(33.3)	0(0.0)	0(0.0)	1(33.3)	0(0.0)	1(33.3)	0(0.0)
Contact	0(0.0)	0 (0.0)	0 (0.0)	0(0.0)	1(100.0)	0(0.0)	0(0.0)
Percentage (%)							
<=10	1(14.3)	0(0.0)	0(0.0)	3(42.9)	1(14.4)	2(28.6)	1(14.3)
11 - 30	5(10.0)	5(10.0)	2(4.0)	20(40.0)	4(8.0)	10(20.0)	7(14.0)
>30	3(13.0)	4(17.4)	4(17.4)	3(13.0)	3(13.0)	3(13.0)	0(0.0)
Depth							
Superficial 2nd degree	1(6.7)	0(0.0)	0(0.0)	3(20.0)	1(6.7)	4(26.7)	3(20.0)
Superficial and Deep 2nd degree	5(11.6)	4(9.3)	4(9.3)	12(27.9)	4(9.3)	10(23.3)	3(6.9)
Deep 2nd degree	2(11.1)	1(5.6)	2(11.1)	9(50.0)	3(16.7)	0(0.0)	2(11.1)
3rd degree	0(0.0)	0(0.0)	0(0.0)	1(50.0)	0(0.0)	1(50.0)	0(0.0)

4th degree	0(0.0)	0(0.0)	0(0.0)	1(100.0)	0(0.0)	0(0.0)	0(0.0)
Site							
Head and neck	1(8.3)	1(8.3)	1(8.3)	5(41.7)	0(0.0)	4(33.3)	1(8.3)
L.L.	4(17.4)	0(0.0)	0(0.0)	5(21.7)	6(26.1)	4(17.4)	0(0)
Perineum	0(0.0)	0(0.0)	0(0.0)	2(100.0)	0(0.0)	0(0.0)	0(0.0)
Trunk	2(8.7)	2(8.7)	3(13.0)	6(26.1)	2(8.7)	3(13.0)	3(13.0)
U.L.	2(10.0)	2(10.0)	1(5.0)	7(35.0)	0(0.0)	4(20.0)	4(20.0)

Table 5: Antibiotic sensitivity of cultured gram negative bacteria

The following table shows the sensitivity pattern of the gram negative bacteria cultured against various antibiotics.

Antibiotic	**Proteus Mirabilis**		**Pseudomonas Aeruginosa**		**Actinobacter baumanii complex**	**E. coli**
	Plastic surgery ward n (%)	**Burns Unit n (%)**	**Plastic surgery ward n (%)**	**Burns Unit n (%)**	**Burns Unit n (%)**	**Burns Unit n (%)**
Amoxi/Clav	16 (76.2)	4 (80.0)	0 (0.0)	0 (0.0)	0(0.0)	0(0.0)
Ampicillin/Sulbactam	10 (47.6)	4 (80.0)	0 (0.0)	0 (0.0)	1(20.0)	0(0.0)
Piperacin/Tazobactam	15 (71.4)	2 (40.0)	1 (16.67)	1 (50.0)	1(20.0)	0(0.0)
Cefazolin	11 (52.4)	4 (80.0)	0 (0.0)	0 (0.0)	0(0.0)	0(0.0)
Cefuroxime	11 (52.4)	4 (80.0)	0 (0.0)	0 (0.0)	0(0.0)	0(0.0)

Cefuroxime Axetil	10 (47.6)	4 (80.0)	0 (0.0)	0 (0.0)	0(0.0)	0(0.0)
Cefotaxime	11 (52.4)	4 (80.0)	0 (0.0)	0 (0.0)	0(0.0)	0(0.0)
Ceftazidime	10 (47.6)	4 (80.0)	2 (33.3)	1 (50.0)	1(20.0)	0(0.0)
Ceftriaxone	10 (47.6)	4 (80.0)	0 (0.0)	0 (0.0)	1(20.0)	0(0.0)
Cefepime	11 (52.4)	4 (80.0)	2 (33.3)	1 (50.0)	1(20.0)	0(0.0)
Aztreonam	9 (42.9)	4 (80.0)	0 (0.0)	0 (0.0)	1(20.0)	0(0.0)
Meropenem	14 (66.7)	4 (80.0)	6 (100.0)	2 (100.0)	1(20.0)	6(100)
Amikacin	19 (90.5)	5 (100.0)	3 (50.0)	1 (50.0)	0(0.0)	6(100)
Gentamicin	13 (61.9)	3 (60.0)	0 (0.0)	1 (50.0)	4(80.0)	0(0.0)
Rifampicin	0 (0.0)	1 (20.0)	0 (0.0)	0 (0.0)	0(0.0)	0(0.0)
Ciprofloxacin	16 (76.2)	3 (60.0)	4 (66.7)	2 (100.0)	2(40.0)	0(0.0)

Table 6: Antibiotic sensitivity of cultured gram positive bacteria

The following table shows the antibiotic sensitivity pattern of the gram positive bacteria cultured during the study against various antibiotics.

Antibiotic	Staph. Aureus		Staph. Pseudointermadius	
	Plastic surgery ward	Burns Unit	Plastic surgery ward	Burns Unit
Oxacillin	1 (10.0%)	2 (40.0%)	0 (0.0%)	-
Amikacin	0 (0.0%)	2 (40.0%)	0 (0.0%)	-
Gentamicin	7 (70.0%)	2 (40.0%)	3 (37.5%)	-
Tobramicin	4 (40.0%)	2 (40.0%)	5 (62.5%)	-
Levofloxacin	9 (90.0%)	4 (80.0%)	5 (62.5%)	-
Moxifloxacin	9 (90.0%)	4 (80.0%)	5 (62.5%)	-
Erythromycin	4 (40.0%)	2 (40.0%)	0 (0.0%)	-
Linezolid	7 (70.0%)	3 (60.0%)	0 (0.0%)	-
Clindamycin	4 (40%)	3 (60.0%)	0 (0.0%)	-
Teicoplanin	6 (60.0%)	3 (60.0%)	0 (0.0%)	-
Vancomycin	4 (40.0%)	4 (80.0%)	0 (0.0%)	-
Tetracycline	3 (30.0%)	1 (20.0%)	0 (0.0%)	-
Tagecycline	0 (0.0%)	4 (80.0%)	0 (0.0%)	-
Fusinic acid	6 (60.0%)	2 (40.0%)	0 (0.0%)	-
Rifampicin	7 (70%)	3 (60.0%)	0 (0.0%)	-
Ciprofloxacin	0 (0.0%)	1 (20.0%)	0 (0.0%)	-
Nitrofurantoin	1 (10.0%)	3 (60.0%)	0 (0.0%)	-

DISCUSSION

Prevalence of burn wound infection among patients admitted in KNH.

80 patients were recruited and participated in the study. 88.8% of these sampled patients had infected burn wounds. This is significantly higher than quoted in previous studies conducted at KNH. A study by Moses Gitau found the rate of infection in KNH to be 23.6%[16]. Another study by Wanjeri J. K. found the prevalence of burn wound infection at KNH to be 18.7%[15]. However, the results from the study by Wanjeri J. K. was based on information gathered from files of patients recruited; whereby, results from culture of wound swabs done earlier or records of notes of doctors who had examined the patients for clinical signs of infection was used[15]. These studies were also done more than five years ago and therefore the prevalence of infection among these patients may have changed.

The most prevalent microorganism cultured in this study was Proteus mirabilis at 30.6% (n = 26) followed by Staphylococcus aureus 18.8% (n =15). Pseudomonas aeruginosa and staphylococcus pseudointermedius were third most prevalent at 9.4% (n = 8) each. A similar pattern was noted among patients in ward 4D.

E. coli was the most prevalent microorganism cultured from burns unit patients at 23.1% (n = 6) followed by Staphylococcus aureus, Proteus mirabilis and Actinobacter baumannii complex at 19.2% (n = 5) each.

The prevalent organisms cultured are similar to ones cultured in a study conducted at KNH by Moses Ngugi whereby 36.4% were pseudomonas, 27.3% staphylococcus aureus, 13.6% E. coli and Proteus was 9.1%[16]. Studies conducted elsewhere have also given similar bacterial pattern with some variation in the specific percentages[13, 24].

Microbiologic pattern of burn wound infection based on the patient characteristics, duration since burn injury and characteristics of the burn injury.

The highest prevalence of infection was among the patients aged above 41 year at 100% (n = 11). Lowest prevalence was among patients between 21 and 30 years at 78.57% (n = 11). Infection prevalence among children less than 1 year old was 75% (n = 3). Extremes of age have been shown to predispose to burn wound infection[4, 8]. This partially explains the results of the study where

older age group of patients had higher infection rate. The low number of patients below the age of one year accrued during the study may explain the lower rate of infection noted from the study.

No particular pattern was noted on the variation of microorganisms causing infection among the various age groups.

The patients with longer durations since burn injury generally had longer periods of hospitalization. The study found that lowest prevalence of infection was among the patients who had 7 days or less since their burn injury. The patients between 8 to 30 days since burn injury had the highest rate of infection at 91.3% (n = 2) which was marginally higher than patients with more than 30 days since burn injury. This agrees with previous studies which showed lengthy hospitalization as a risk factor for burn wound infection[8, 9].

Previous studies show that during the initial 7 days after burn injury, gram positive bacteria are the more prevalent bacteria causing infection of burn wounds[3, 7, 21]. This study found a higher prevalence of gram negative bacteria with the most common being E.coli infection at 40% (n = 6). Gram positive bacteria cultured in this group made up 13.3% (n = 2).

Beyond 7 days, the study shows that the gram negative bacteria are more prevalent than the gram positive bacteria as a cause of burn wound infection. This is agrees to previous studies done elsewhere[10, 14, 21].

Patients with a history of blood transfusion during the current admission had a marginally higher infection rate compared to patients without a history of blood transfusion (89.66% versus 88.24%). This is in line with previous studies which showed that blood transfusion increases the risk of burn wound infection[8, 9].

HIV infection was the only comorbidity encountered during the study. HIV infected patients comprised 7.5% of sampled patients and all of them had infected wounds. 87.84% of the patients who had no comorbidities noted had infected wounds. This was expected and is in line with studies which show comorbidities such as HIV increase the risk of burn wound infection[4, 8, 9].

There was progressive increase in infection rate with reduction of hb level among the patients sampled. Infection rates ranged from 100% (n = 2) among patients with hb of less than 5g/dl to 81.4% (n = 45) among patients with hb of above 15g/dl.

All patients with scalds (n = 22) and the only patient with history of burn with hot object had infected wounds. 85.2% of patients with history of open flame burns had infected wounds.

Patients with burn injury with less than 10% TBSA had the lowest infection rates at 85.7% (n = 6) patients with 11% - 30% TBSA burns had 90% (n = 45) infection rates while patients with more than 30% TBSA had 87% (n = 20) infection rates. Previous studies have shown larger burn surface area (more than30%) as a risk factor for burn wound infection[4 and 8].

Among the flame burn patients, Proteus mirabillis was the most prevalent cause of infection at 24.07 % (n = 13) followed by staph. aureus at 18.52% (n = 10). Pseudomonas aeruginosa and E. coli constituted 11.11% (n = 6) each. Proteus mirabillis was the most common infection causing organism at 54.55% (n = 12) among the patient with scalds followed Staph. aureus and staph pseudointermedius at 18.18%(n = 4) and 13.63% (n = 3) respectively.

No trend was noted on the infection rate or pattern of microbial infection of patients based on the degree of burn injury from the study.

Both the two patients with perineal burn injury had Proteus mirabillis infection. 91.7% (n = 12) of patients with head and neck burns had infected wounds.

Proteus mirabillis was the most common cause of infection culture on most burn wound sites (100% - 26.1%) except for the lower limbs which had the highest cause of infection being Pseudomonas aeruginosa at 26.1% (n = 6) with Proteus mirabillis causing 21.7% (n = 5) of the infections on this site.

Other common causes of infection based on site of burn injury were, Staphyloccocus aureus 33.3% (n =4) on head wound infections, and 20% (n = 4) on the upper limbs. 20% (n = 4) of infections of the upper limbs were caused by Staphylococcus pseudointermedius.

Antibiotic sensitivity pattern

The Proteus mirabillis cultured was found to be most sensitive to amikacin; whereby 90.5% of the bacteria cultured from plastic surgery ward was sensitive to it while 100% of the bacteria cultured from burns unit was sensitive to amikacin. Resistance was found to be highest against rifampicin whereby none of the Proteus mirabilis cultured in plastic surgery ward and only 20% of the bacteria cultured in burns unit was sensitive to amikacin. For the rest of the antibiotics the bacteria was

tested against, the range of sensitivity was from 76.2% (ciprofloxacin and amoxicillin/ clavulanate) to 42.9% (aztreonam) for the cultures from plastic surgery ward. Among cultures from burns unit the range of sensitivity was from 80% (most antibiotics tested against) to 40% (piperacin/ tazobactam). In another study, Proteus mirabillis isolates were found to be 100% resistant to ampicillin, amoxicillin and doxycycline. They were 100% sensitive to nalidixic acid and norfloxacin. Sensitivity to augmentin and ceftriaxone was at 80%, while that for chloramphenicol and ceftazidime was 60% and 40% respectively[14]. Another study found that 68% of the Proteus mirabillis isolates were resistant to amoxicillin, 32% were resistant to ceftriaxone, 37% resistant to ceftazidime, 26% resistant to ciprofloxacin and 21% resistant to gentamicin[20].

Pseudomonas aeruginosa, cultured in both burns unit and the plastic surgical ward were found to be 100% resistant all drugs tested against except for: piprecin/ tazobactam which had a sensitivity of 16.67% in the plastic surgical ward and 50% in the burns unit, the sensitivity to ceftazidime and cefepime was 33.3% in the plastic surgical ward and 50% in the burns unit. The isolates showed sensitivity to amikacin of 50% in both plastic surgery ward and in the burns unit, against cifrofloxacin, there was 66.7% sensitivity in the plastic surgical ward and 100% in the burns unit. Against meropenem, there was 100% sensitivity in both plastic surgery ward and the burns unit. A previous study found pseudomonas spp isolates to be completely resistant to ampicillin, amoxicillin/ clavulanate, amoxicillin and ceftazidime, and 97.5% and 95% were resistant to doxycycline and nalidixic acid. In the study 85% of pseudomonas spp were sensitive to norfloxacin[14]. Another study found the pseudomonas aeruginosa isolates to be 100% resistant to amoxicillin, 46% resistant to ceftriaxone, 21% resistant to gentamicin, 18% resistant to ciprofloxacin and 4% resistant to ceftazidime[20].

Of the Staphylococcus aureus cultured from the plastic surgical ward 100% of the isolates were resistant to amikacin, tagecyclin and ciprofloxacin and 90% were sensitive to levofloxacin and moxifloxacin. Sensitivity against other antibiotics ranged from 70% (gentamicin and linezolid) to 10% (oxacillin). In the burns unit, the range of sensitivity was from 80% (levofloxacin, moxifloxacin, vancomicin and tagecyclin) to 20% (oxacilin, amikacin, gentamicin, tobramycin, tetracycline and ciproflovacin). This is contrary to a study by Tigist et al which found that most of the S. aureus isolates from Yekatit hospital in Ethiopia were susceptible to most commonly used antibiotics except penicillin G to which all isolates were resistant and 31.3% being resistant to

methicillin[14]. Another found S. aureus isolates to be 100% resistant to amoxicillin, 84% resistant to ceftazidime, 52% resistant to ceftriaxone and 29% resistant to ciprofloxacin and gentamicin[20].

CONCLUSION

The infection rate was high among burn injury patients admitted at KNH at 88.8%. This could be a significant cause of morbidity and mortality among these patients.

Low hemoglobin levels, longer duration of admission, and presence of HIV infection as a comorbidity were factors that were associated with increased infection rates among burn patients from this study.

There was significant resistance to many of the commonly used antibiotics by the bacteria cultured from wounds of burn patients admitted at KNH.

RECOMMENDATION

A similar study should be done but using biopsies from the burn wounds as the samples for culture and sensitivity and including a larger sample size in order to corroborate the findings from this study.

Unnecessary use of antibiotics should be avoided. When there is need, samples should be taken for microscopy culture and sensitivity to ensure effective use of antibiotics and help curb development of antibiotic resistance by bacteria found on burn wounds.

Regular monitoring of microbial patterns and antimicrobial sensitivity and resistance patterns among burn patients admitted at KNH should be done in order to advise antibiotic use among these patients.

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APPENDIX 1

Informed consent

MICROBIOLOGIC PROFILE OF BURN WOUNDS AS SEEN AT KENYATTA NATIONAL HOSPITAL

English version.

This Informed Consent form is for patients with burn wounds admitted at the Kenyatta National Hospital burns unit and ward 4D.

This consent will be administered to the patients or parents/patient's guardians.

We are requesting these patients to participate in this research project whose title is "MICROBIOLOGIC PROFILE OF BURN WOUNDS AS SEEN AT KENYATTA NATIONAL HOSPITAL."

Principal investigator: Dr. Mutai Peter Kiplang'at.

Institution: School of Medicine, Department of surgery- University of Nairobi

Supervisors:

1. Dr. Abdullahi A. Adan
   MBChB, MMED (UoN), Fellowship Plastic and Reconstructive Surgery (South Africa),
   Consultant Plastic and Reconstructive Surgeon/ Lecturer
   Department of Surgery, University of Nairobi.

2. Dr. Daniel Ojuka
   MBChB (U.O.N), M.Med Surgery (U.O.N), F.C.S (ECSA)
   Consultant General Surgeon/ Lecturer
   Department of Surgery, University of Nairobi.

This informed consent has three parts:

- Information sheet (to share information about the research with you)

- Certificate of Consent (for signatures if you agree to take part in the study)
- Statement by the researcher

You will be given a copy of the full Informed Consent Form.

Part I: Information sheet

Introduction.

I am Dr. Mutai P. K., a post graduate student at the University of Nairobi pursuing a degree in Master of Medicine in General Surgery.

I am conducting a study on the microbiologic profile of burn wounds on patients admitted at Kenyatta National Hospital. The purpose of this study will be to identify the microorganisms found on burn wounds of patients admitted in burns unit and ward 4D of KNH, and to determine their sensitivity and resistance to antimicrobial agents.

Swabs will be collected from burn wounds and processing then done at the KNH laboratory to determine the above information. Questions on your personal information and on your medical history will also be asked. Results from blood tests done during your admission will also be used in the study.

Purpose of the Research.

Information from this study will inform healthcare providers which drugs are likely to be effective against infections from burn wounds of patients admitted at KNH thus enable early and effective treatment.

Voluntary participation/right to refuse or withdraw.

An invitation to participate in this study is hereby extended to you. Participation is voluntary. You will not be penalized in any way for declining to participate.

You are free to withdraw at any point during the study.

Feel free to ask any questions before you decide on your participation or that of your child in the study; or at any other time during the study. Questions can be directed to me or my assistants.

Confidentiality

All the information acquired regarding yourself or child/kin will be kept confidential. Only the researchers will access this information. Identity of participants will be concealed assigning a number to them and only the researchers can relate the number to the patient.

Sharing of the results.

Information gotten from the study will be shared with other doctors and policy makers through publications and conferences. Confidential information will not be revealed.

Information from the lab tests will be shared with your doctors to facilitate treatment where appropriate.

This proposal has been reviewed and approved by the KNH/UoN-ERC which is a committee whose work is to make sure research participants are protected from harm.

Risks.

This study will not expose you or your child to any risk.

Cost and compensation.

There will be no extra cost incurred for participating in this study nor will there be compensation offered.

Part II: Certificate of consent.

I have read the above information, or it has been read to me. I have had the opportunity to ask questions about it and any questions that I have asked have been answered to my satisfaction. I consent voluntarily to participate as a participant in this research.

Print Name of Participant _____

Signature of Participant _____

Date _____

If Illiterate;

I have witnessed the accurate reading of the consent form to the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Print Name of witness_____ Left thumb print of participant

Signature of witness _____

Date _____

Contacts

In case of queries please feel free to contact the following:

Principle researcher:

Dr. Mutai Peter Kiplang'at

Department of Surgery, School of Medicine, University of Nairobi

P.O. Box 19676 KNH, Nairobi 00202

Mobile phone 0733 291 241

Supervisors

Dr. Abdullahi A. Adan

Department of Surgery, University of Nairobi.

P.O. Box 19676 KNH, Nairobi 00202

Mobile phone: 0722 370 414

Dr. Daniel Ojuka

Department of Surgery, University of Nairobi

P.O. Box 19676 KNH, Nairobi 00202

Mobile phone: 0722 322 246

Kenyatta National Hospital/ University of Nairobi Ethics and Research Committee

College of Health Sciences

P. O. Box 19676-00202 Nairobi

Telephone: (254-020) 2726300-9 Extension: 44355

PART III: Statement by the researcher

I have accurately read out the information sheet to the participant, and to the best of my ability made sure that the participant understands that the following will be done:

- Refusal to participate or withdrawal from the study will not in any way compromise the care of treatment.
- All information given will be treated with confidentiality.
- The results of this study might be published to facilitate knowledge of early complications of hernia repair and their management.

I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

A copy of this Informed Consent Form has been provided to the participant.

Name of researcher/person taking consent _____

Signature of researcher/person taking consent _____

Date_____

MICROBIOLOGIC PROFILE OF BURN WOUNDS AS SEEN AT KENYATTA NATIONAL HOSPITAL

ASSENT FORM FOR CHILDREN 12 YEARS TO 18 YEARS

My name is Dr. Mutai Peter, I am doing a study on the microbiologic pattern of burn as seen at KNH.

Purpose of the study

The study will help us know what microorganisms are present in burn wounds at KNH, what drugs are effective against them and which ones are not. This will help us in deciding which drugs to use so that treatment can be started early using drugs that are going to be effective.

Voluntariness of participation

Participation into this study is voluntary and no one can force you to participate. If you decide to participate in the study, swabs will be taken from your burn wounds. These will be taken to the laboratory to test and determine the microorganisms present and characterize them. Some personal questions, including about your medical history will be asked. Results of some blood tests done during your admission will also be used in the study.

Risks

There are no risks involved in this study. Also you will not incur any extra costs for participating in this study.

Right to withdraw from the study

You can withdraw from the study at any point in time and this will not affect your management at KNH. You will not be denied any service due to your withdrawal

Confidentiality

Other people will not know if you are participating in this study. Your answers and your progress will be kept private.

Your parents or guardian have to agree for you to be in the study. After they agree, you get to choose if you want to participate in it too. If you don't want to be in the study, you will not get into any trouble.

You can stop being in the study at any time.

My telephone number is 0733291241. You can call me if you have questions about the study or if you decide you do not want to be in the study any more.

I will give you a copy of this form in case you want to ask questions later.

Sign this form only if you:

- Have understood what you will be doing for this study.
- Have had all your questions answered.
- Have talked to your parent(s)/legal guardian about this project.
- Agree to take part in this research.

_____

Participant's Signature Name Date

_____

Name of Parent(s) or Legal Guardian(s)

_____

Researcher explaining study

Signature Name Date

APPENDIX II.

Maelezo kwa kiswahili

Hii ni fomu ya idhini ya wagonjwa waliochomeka ambao wamelazwa katika hospitali kuu ya Kenyatta katika wadi ya waliochomeka na wadi 4D.

Hii idhini itapatiwa wagonjwa ama wazazi/ wa wagonjwa ambao tunaomba kujiunga na huu utafiti. Swala la utafiti ni: "MICROBIOLOGIC PROFILE OF BURN WOUNDS AS SEEN AT KENYATTA NATIONAL HOSPITAL."

Mtafiti mkuu: Daktari Mutai Peter Kiplang'at.

Kituo: Shule ya Utabibu, Idara ya Upasuaji, Chuo Kikuu cha Nairobi.

Waadhiri husika:

1. Dr. Abdullahi A. Adan
2. Dr. Daniel K. Ojuka

Fomu hii ya makubaliano ina sehemu tatu:

1) Habari itakayo kusaidia kukata kauli
2) Fomu ya makubaliano (utakapo weka sahihi)
3) Ujumbe kutoka kwa mtafiti

<u>Sehemu ya kwanza: Ukurasa wa habari</u>

Kitambulizi

Mimi ni Daktari Mutai P. K., mwanafunzi wa uzamili katika idara ya upasuaji Chuo Kikuu cha Nairobi.

Ninafanya utafiti kuhusu viini vya ugonjwa katika vidonda vilivyosababishwa na kuchomeka katika wagonjwa waliolazwa katika hospitali kuu ya Kenyatta na kutambua madawa yanayofanya kazi dhidi ya viini hivi na madawa ambayo hayafanyi kazi.

Sampuli kutoka kwa vidonda vyako vya kuchomeka vitachukuliwa na kupelekwa katika maabara ya hospitali kuu ya Kenyatta ili kupata ujumbe huo. Maswali ya binafsi na kuhusu historia yako ya afya yataulizwa pia. Majibu ya vipimo fulani vya damu yako pia yatatumika katika utafiti huu.

Nia ya utafiti huu

Ujumbe utakaopatikana kutokana na utafiti huu utawaeleza matabibu madawa yapi yana uwezo wa kutibu maambukizi ya vidonda vitokavyo kwa kuchomeka kwa wagonjwa waliolazwa katika hospitali kuu ya Kenyatta ili waweze kutibiwa mapema.

Haki ya kukataa utafiti

Kushiriki kwako kwa utafiti huu ni kwa hiari yako. Uko na uhuru wa kukataa kushiriki, na kukataa kwako hakutatumiwa kukunyima tiba. Uko na haki ya kujitoa katika utafiti wakati wowote unapoamua.

Uko huru kuuliza maswali yeyote kabla ya kuamua kujiunga na utafiti huu, ama wakati wowote baadaye utafiti ukiendelea. Maswali yataelekezwa kwangu ama kwa wasaidizi wangu.

Taadhima ya siri

Ujumbe kukuhusu yatahifadhiwa. Ujumbe kuhusu ushiriki wako katika utafiti huu utawezekana kupatikana na wewe na wanaoandaa utafiti na wala si yeyote mwingine. Jina lako halitatumika bali ujumbe wowote kukuhusu utapewa nambari badala ya jina lako.

Hatari unayoweza kupata

Hakuna hatari yoyote ambayo yaweza kutokea kwa sababu ya kuhusishwa kwa utafiti huu.

Gharama au fidia.

Utafiti huu hautakugharimu zaidi ya matibabu yako ya kawaida. Vilevile, hakuna malipo yoyote au fidia utakayopokea kutokana na kujiunga kwako katika utafiti huu.

Sehemu ya pili: Fomu ya makubaliano

Nimeelezewa utafiti huu kwa kina. NakubaIi kushiriki katika utafiti huu kwa hiari yangu. Nimepata wakati wa kuuliza maswali na nimeelewa kuwa iwapo nina maswali zaidi, ninaweza kumwuliza mtafiti mkuu au watafiti waliotajwa hapa juu.

Jina la Mshiriki_____

Sahihi ya mshiriki _____

Tarehe_____

Kwa wasioweza kusoma na kuandika:

Nimeshuhudia usomaji na maelezo ya utafiti huu kwa mshiriki. Mshiriki amepewa nafasi ya kuuliza maswali. Nathibitisha kuwa mshiriki alipeana ruhusa ya kushiriki bila ya kulazimishwa.

Jina la shahidi_____

Alama ya kidole cha gumba cha mshiriki

Sahihi la shahidi_____

Tarehe _____

Anwani za wahusika

Ikiwa uko na maswali ungependa kuuliza baadaye, unaweza kuwasiliana na:

Mtafiti Mkuu:

Dkt. Mutai Peter Kiplang'at,

Idara ya upasuaji, Shule ya Utabibu, Chuo Kikuu cha Nairobi,

SLP 19676 KNH, Nairobi 00202.

Nambari simu: 0733 219 241

Wahadhiri husika:

1. Dkt. A. A. Adan,
   Idara ya Upasuaji, Shule ya Afya,
   Chuo Kikuu cha Nairobi,
   SLP 19676 KNH, Nairobi 00202.
   Nambari ya simu: 0722 370 414
2. Dkt. Daniel K. Ojuka,
   Idara ya Upasuaji, Shule ya Afya,
   Chuo Kikuu cha Nairobi,
   SLP 19676 KNH, Nairobi 00202.
   Nambari ya simu: 0722 322 246

KNH-UoN ERC,

Shule ya Utabibu,

SLP 19676-00202 Nairobi.

Nambari ya simu: (254-020) 2726300-9 Ext: 44355

Sehemuya tatu: Ujumbe kutoka kwa mtafiti

Nimemsomea mshiriki ujumbe kiwango ninavyoweza na kuhakikisha kuwa mshiriki amefahamu yafuatayo:

- Kutoshiriki au kujitoa kwenye utafiti huu hakutadhuru kupata kwake kwa matibabu.
- Ujumbe kuhusu majibu yake yatahifadhiwa kwa siri.
- Matokeo ya utafiti huu yanaweza chapishwa kusaidia utambuzi wa shida zinazotokana na upasuaji wa ‘hania’.

Ninathibitisha kuwa mshiriki alipewa nafasi ya kuuliza maswali na yote yakajibiwa vilivyo. Ninahakikisha kuwa mshiriki alitoa ruhusa bila ya kulazimishwa.

Mshiriki amepewa nakala ya hii fomu ya makubaliano.

Jina la mtafiti _____

Sahihi ya mtafiti _____

Tarehe_____

MICROBIOLOGIC PROFILE OF BURN WOUNDS AS SEEN AT KENYATTA NATIONAL HOSPITAL

FOMU YA IDHINI YA WATOTO WALIO NA UMRI WA KATI YA MIAKA KUMI NA MIWILI HADI KUMI NA MINANE.

Jina langu ni Dkt. Mutai Peter. Ninafanya utafiti kuhusu viini vinavyopatikana katika vidonda vya kuchomeka kwa wagonjwa waliolazwa katika hospitali kuu ya Kenyatta.

Dhamira ya utafiti.

Matokeo ya utafiti yatatuleza viini vya ugonjwa vinavyoambukiza vidonda vya kuchomeka katika hospitali kuu ya Kenyatta, na madawa yanayoweza kuviangamiza. Hii itasaidia matabibu kuamua madawa yapi kutumia.

Hiari ya kushiriki.

Kushiriki katika utafiti huu ni kwa hiari na hamna masharti yoyote ya lazima. Sampuli zitachukuliwa kutoka kwa vidonda vyako vya kuchomeka. Sampuli hizi zitapelekwa katika maabara ili kutambua viini vilivyoko. Utaulizwa maswali binafsi na kuhusi historia yako ya afya. Majibu ya vipimo vya damu pia yatatumika katika utafiti huu.

Hatari ya kushiriki

Hakuna hatari wala gharama ya ziada yoyote itakayokukumba kutokana na kushiriki katika utafiti huu.

Uhuru wa kujiondoa kutoka utafiti.

Una haki ya kujiondoa kutoka ushiriki wa huu utafiti wakati wowote upendao na uamuzi huo hauwezi dhuru matibabu yako kwa vyovyote vile.

Hifadhi ya siri.

Hakuna yeyote mwingine atakaye juzwa ushiriki wako katika utafiti huu. Majibu yako na mwelekeo wa matibabu yako yatakuwa ni siri na hifadhi yako.

Itawabidi pia wazazi au wadhamini wako kukubali ushiriki wako katika utafiti huu. Watakopoamua, utakuwa na uhuru kukubali kushiriki pia. Ijapo hautakubali, hamna madhara yoyote utapata. Una uhuru wa kujiondoa katika utafiti wakati wowote baadaye.

Nambari yangu ya rukono ni 0733 291 241. Waweza kunipigia simu wakati wowote kuulizia zaidi kuhusu utafiti huu au ikiwa ungependa kujiondoa.

Nitakupa nakala ya fomu hii ikiwa ungependa kuuliza maswali zaidi baadaye.

Tia sahihi iwapo;

- Umeelewa ushiriki wako katika utafiti huu.
- Maswali yako yote yamejibiwa vilivyo.
- Umejadili na wazazi au wadhamini wako kuihusu.
- Umekubali kushiriki katika utafiti.

_____

Sahihi yako jina lako tarehe

_____

Jina la mzazi au mdhamini

_____

Mtafiti aliyekupa maelezo ya utafiti

Sahihi jina tarehe.

APPENDIX III:

MICROBIOLOGIC PROFILE OF BURN WOUNDS AS SEEN AT KENYATTA NATIONAL HOSPITAL

Data Collection Sheet

Date_____

Patient identification code _____

Admission date _____

Age (yrs) _____ sex _____

Ward: burns unit ☐ Ward 4D ☐

Duration since burn injury _____

Type of burn:

Flame ☐ Chemical ☐ Electric ☐ Scald ☐ Contact ☐

Percentage of burn _____

Depth of burn: 1st degree ☐ superficial 2nd degree ☐ Deep 2nd degree ☐ 3rd degree ☐

4th degree ☐

Site of burn: Head ☐ Face ☐ ant. Trunk ☐ post. Trunk ☐ lower limb ☐ upper limb ☐ perineum ☐

History of blood transfusion during current admission_____

Comorbidities

Diabetes ☐ HIV ☐ Steroid use ☐

Lab investigations

Full hemogram:

- WBC count _____
- Neutrophil/Lymphocyte ratio _____
- Hb _____

Swab microscopy, culture and sensitivity:

- Growth present: yes☐ No☐
- Microorganism grown (list) _____
- Sensitive to (list): _____
- Resistant to (list): _____